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EXECUTIVE CHAMBERS
HONOLULU

JOHN WAIHEE
GOVERNOR

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May 24, 1991

MEMORANDUM

TO: The Honorable Murray E. Towill, Director
Department of Business, Economic Development and Tourism

SUBJECT: Acceptance of Final Environmental Impact Statement

I am pleased to accept the Final Environmental Impact Statement (FEIS) for the Hawaii Commodities Irradiation Facility as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes.

It is my understanding that the Department of Business, Economic Development and Tourism (DBED) requested that the Office of Environmental Quality Control complete its review on this FEIS, which was submitted in 1988. I also understand that DBED will not pursue this project because of the loss of funding.

My acceptance of the statement is an affirmation of the adequacy of that statement under the applicable laws and does not constitute an endorsement of the proposed action.

John Waihee

JOHN WAIHEE

cc: Honorable John C. Lewin
~~Mr.~~ Brian Choy

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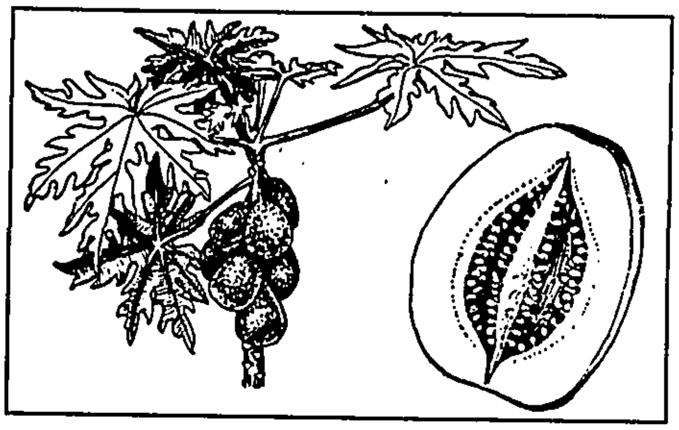
OFC. OF ENVIRONMENTAL QUALITY CONTROL

Hawaii Commodities Irradiation Facility Final Environmental Impact Statement



The State of Hawaii
Department of Business
and Economic Development

WESTEC Services
An ERC International Group

December 1988

FINAL ENVIRONMENTAL IMPACT STATEMENT HAWAII COMMODITIES IRRADIATION FACILITY

Prepared for:

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Department of Business and Economic Development
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December 1988

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS (Continued)

LIST OF TABLES (Continued)

LIST OF APPENDICES

EXECUTIVE SUMMARY

S.1 INTRODUCTION

S.1.1 PURPOSE

This Executive Summary of the Hawaii Commodities Irradiation Facility Environmental Impact Statement (EIS) briefly describes the proposed project and alternatives and presents the environmental impacts and mitigation measures for the project. The reader is encouraged to study the entire EIS document thoroughly. The Executive Summary is intended to serve first as an introduction to the project and its issues and consequences, and then as a summary of its significant findings; however, it cannot possibly represent the detailed analyses and findings adequately enough to form the sole basis of a decision.

S.1.2 PROJECT DESCRIPTION

S.1.2.1 Overview

The State of Hawaii, Department of Business and Economic Development (DBED), Energy Division, has proposed to contract for the design, construction, and operation of a demonstration commodities irradiation facility in Hilo, Hawaii County. The demonstration project would last 3 years, after which the plant would continue commercial operation or be decommissioned at the option of the contractor.

The proposed facility would be used to irradiate fruit products, primarily papayas, which are produced for overseas export and subject to U.S. and foreign quarantine requirements for fruit fly infestation. Proposition to establish and operate a fruit commodities irradiation facility has evolved from the need to find new disinfestation methods for tropical fruits (such as papayas, mangos, and lychees which are susceptible to "tri-fly" infestation) following the U.S. Environmental Protection Agency's (EPA) ban on the use of ethylene dibromide (EDB).

At present, there are two types of insect disinfestation treatment methods being commercially used by Hawaiian papaya packers: double-hot-water dip, and vapor heat. Double-hot-water-dip treated fruit is generally shipped to mainland U.S. markets while vapor-heat-treated fruit is primarily shipped to Japan, with some going to the mainland.

Neither of these methods are satisfactory from fruit quality and treatment efficacy standpoints.

The objective of the proposed commodities irradiation facility is to demonstrate and test the use of irradiation for fruit disinfestation at commercial levels of operation. DBED has identified more specific objectives to include:

- Test of the effectiveness of irradiation.
- Investigation of efficiency of treatment at different radiation dose levels.
- Determination of costs associated with commercial-level irradiation operations.
- Allowance for the transfer of irradiation technology from the U.S. Department of Energy to the private sector.
- Conduct of market research on consumer acceptability of irradiated fruit.
- Provision of consumer education on irradiation treatment.

Additionally, DBED intends to make the facility available for developmental research by the University of Hawaii and others. Finally, the facility will be available to meet part of the commercial demand for fruit disinfestation.

S.1.2.2 Site Locations

A site analysis by DBED established feasible locations according to fruit production areas, transportation routes, land availability, costs, and environmental issues. Three possible sites in Hilo, Hawaii, were identified by DBED as potential locations for the proposed commodities irradiation facility (see Figure 2-1). These sites all facilitate papaya industry operations and are managed by state agencies, The sites would be leased by the state to the contractor that would build and operate the facility. The three sites identified are referred to in this EIS as Site A - Airport Industrial Area, Site B - Old Terminal, and Site C - Railroad Avenue (see Figure 2-2).

<u>Site A - Airport Industrial Area</u>

Site A is adjacent to the frontage road (Kekuana Ave.) along the General Lyman Field (Hilo Airport) access road. It is just east of the airport control tower and is part of the subdivided but undeveloped airport industrial park (Figure 2-3). The land is under the jurisdiction of the Hawaii DOT, Airports Division, and is master planned for airport-related industrial activities. The site is bordered on the south by vacant DOT land and the Hawaii National Guard's Keaukaha Military Reservation (across the access and frontage road); on the north, south, and east by other parcels within the industrial area; and on the west by vacant industrial land. Site A is identified as Tax Map Key parcel number (TMK) 2-1-12:106, 107, and 108.

Site B - Old Terminal

Site B is located just north of the existing air cargo buildings near the old passenger terminal (Figure 2-4) on the western side of General Lyman Field. It falls under the jurisdiction of the DLNR. The site is bordered on the south by the existing access road to the air cargo and general aviation facilities. On its other sides, it abuts vacant land. Site B is identified as TMK 2-1-12:56, 74, and 75.

Site C - Railroad Avenue

Site C is located on Railroad Ave. across from the Hawaii Electric Light Company's (HELCO) main Hilo generating station; it is (HELCO) approximately one-half mile from the airport (Figure 2-5). The land, which is under the jurisdiction of the DHHL, is presently vacant. The site was once used for concrete and gravel operations and is adjacent to asphalt batching and wood mill operations. Site C is identified as TMK 2-1-25:86.

S.1.2.3 Facility Description

The proposed facility would consist of a warehouse building housing the irradiator and ancillary operations. The irradiator equipment would be located inside a concrete-walled room. Ancillary facilities would consist of office space, dosimetry laboratory, storage space for treated and untreated fruit, and employee lockers and restrooms. The project site would be equipped with truck loading and unloading ramps to the warehouse, and truck and employee parking areas. The entire facility would be fenced for security, with access via a secured gate. A conceptual floor plan of the proposed facility is shown in Figure 2-6. Construction of the proposed irradiation facility would involve the development of 4 to 5 acres of land for an approximate 29,000-square-foot irradiator and warehouse building, truck loading and unloading facilities, and parking area (WESTEC 1988).

Facility Process Flow

The proposed commodities irradiation facility would be used to treat papaya, mangoes, lychee, and other fruit or agricultural products which are transported outside the state of Hawaii and are susceptible to fruit fly or other insect infestations, and therefore subject to U.S. or foreign agricultural quarantine requirements. The proposed source of radiation would be gamma rays emitted from the decay of the man-made isotope, cobalt-60, as approved by the U.S. Food and Drug Administration (FDA).

Operational characteristics of the proposed facility are as follows: Fresh picked fruit will be packaged and sealed in boxes and the boxes stacked onto pallets at the offsite packing house, with average pallet loads of 1400 pounds. The pallets will be delivered by truck to the irradiation facility, where they will be unloaded onto an automatic conveyor system; this system will move the pallets through the irradiation chamber, exposing the fruit as uniformly as possible to the gamma ray emissions. The conveyor begins near or in the incoming product preparation area and delivers the processed product without further handling to the processed product holding area. Total radiation dosage given the fruit would not exceed 1000 Gy (international system unit for absorbed dose of radiation), as required by the FDA. After processing, dosimetry examination, recording, and certification will take place, according to FDA and NRC requirements. The processed fruit will then be ready for loading onto refrigerated trucks or air cargo shipping containers, and delivered to shippers for transport to overseas markets, either directly or through Honolulu. A conceptual diagram for the complete process flow is illustrated on Figure 2-8.

In the irradiator itself, the conveyorized commodity will pass through a labyrinth to ensure that radiation will not escape the irradiator. The fruit will pass by both sides of the cobalt source in order to expose both sides of the commodity, thereby providing uniformity of dose. When the irradiator is not in operation, the cobalt source would be lowered into a 24-foot-deep, concrete-lined, water pool which is also encased in steel. The water serves as a radiation shield, allowing workers to enter the irradiation chamber when the cobalt has been lowered into the water. (As an alternative to this "wet storage irradiator," dry storage could be utilized. Dry storage requires the use of a containment vessel such as a shipping cask for storage.)

Safety of the Facility

At no time during plant operation will people be in direct contact with the radiation source or be in the irradiation room during treatment. The radiation source (cobalt-60) would be stored in a water bath or casing within the irradiation room when not in use. All Nuclear Regulatory Commission (NRC) and Occupational Safety and Health Administration (OSHA) rules, regulations, and safety precautions must be observed at all times. Employees must be given initial and periodic safety and operational training programs to ensure that operating procedures are up to date with current recommendations. Constant monitoring procedures for employees will be exercised to assure that radiation exposure levels do not exceed safe limits.

S.1.2.4 Employment

The facility is expected to employ seven people during the demonstration period. Facility personnel would be comprised of employees to handle irradiator operations and employees to handle support activities. The total number of employees would depend on actual annual throughput of products. It is planned that the plant would operate 24 hours a day, 5 to 6 days a week, 50 weeks of the year. Two weeks in the year the plant would be shut down for scheduled annual maintenance, with general maintenance occurring the 1 or 2 days a week when the plant is not in operation.

S.1.2.5 Source Transportation

Approximately 150,000 curies of cobalt-60 will be required to operate the facility at the planned level of throughput. The cobalt-60 source will have to be transported to the site at the commencement of operation and periodically thereafter for source replenishment. DBED predicts that replenishment will be required approximately once every 3 years; thus additional transport of the source will not be required until the end of the demonstration period, if the facility is to continue operation.

S.1.2.6 Decommissioning

A decommissioning plan will be required of the operator as part of its contract with the state. The operator's property lease with the state will require implementation of the plan at the end of the facility's 3-year demonstration, or subsequent commercial activities. The contractor will be required to provide a bond or similar financial instrument to ensure that funds are available for decommissioning.

The decommissioning plan will call for the complete removal of all radioactive materials and demonstration that there is no residual contamination. Radioactive materials will be required to be returned to the fuel vendor or transported to an appropriate nuclear waste repository. All decommissioning activities will be required to conform with applicable NRC, Department of Transportation (DOT), and other regulations. The property lease will specify the level to which the site must be cleared of non-radiation components of the facility (e.g., buildings).

S.1.3 DESCRIPTION OF ALTERNATIVES

The EIS analyzes three alternative sites (described above) in depth. Section 3 in the EIS summarizes the other alternatives that were considered in project and EIS development. The alternatives evaluated have included alternative plant locations, other irradiation technologies, non-irradiation disinfestation methods, and the no-project alternative. Such alternatives include alternate locations, other irradiation technologies, non-irradiation, disinfestation methods, and the no-project alternative.

S.1.3.1 Other Locations

DBED explored the possibility of locating the irradiation facility in other locations throughout the State of Hawaii (see CH2M Hill 1987). The DBED's study concluded that location anywhere except Honolulu or the Hilo area was not feasible given the logistics of the papaya industry. Upon further review, DBED concluded that a location in Honolulu, away from the packing industry, did not sufficiently meet the demonstration and technology transfer objectives of the project and could pose excessive costs to the fruit industry because fruit containers would have to be unloaded and loaded an extra time in Honolulu. In addition, property costs are generally higher in Honolulu than Hilo; thus project development would be more costly.

A Honolulu location would have essentially the same environmental effects as those associated with the three primary alternatives. Because this alternative fails to completely meet project objectives, would have additional costs to industry and possibly the state, and provides no environmental benefit, a Honolulu location alternative is not considered reasonable.

S.1.3.2 Other Irradiation Technologies

A brief review of cesium-137 and marine-source radiation technologies is provided in Section 3.3 of the EIS. In addition non-irradiated technologies are discussed.

Cesium-137 is a by-product of nuclear reactor operation and is a gamma ray source which may be used in place of cobalt-60. The physical plant and associated factors would be essentially the same as the proposed facility. It is slightly, but not significantly, less costly to use cesium-137 than to use cobalt-60 as a source. This is because, although most transport, handling, permitting, and operational costs are similar, the costs for original source material and required shielding are less. Most of the environmental issues associated with the use of cesium-137 are the same as those for the proposed facility; however, there are some differences. Cesium-137 has a half life of 30 years; this is longer than the 5.2 years associated with cobalt-60. More importantly, cesium-137 is water soluble. Thus, environmental consequences in the event of an accident would be relatively greater. Because cesium-137 use is prohibited by legislative mandate, and its environmental impacts are potentially greater, cesium-137 is not considered a reasonable alternative to cobalt-60.

Electric powered machine sources can generate radiation by using an electron beam accelerator. Electron beams have essentially the same disinfestation result as gamma rays (i.e., photons). High energy electron beams are used directly for irradiation processing by focusing and scanning the beam over a distinct target. Alternatively, the electron beam can be directed onto an x-ray converter plate to generate high energy x-rays, which also can be used to irradiate commodities. Machine sources would meet the project's objectives and would avoid many of the risks associated with isotope sources. However, lack of the commercially-sized machine required for the demonstration program results in excessively high cost, delay, and uncertainty of outcome. Thus, this alternative is not considered reasonable at this time. Retrofit of the cobalt-60 facility may be appropriate for consideration in the future if a reliable, commercially-viable, machine source is developed.

S.1.3.3 Non-irradiation Technologies

The following alternatives would, by definition, fail to achieve the proposed project's objective as a demonstration and test of irradiation treatment. Nonetheless, because they may meet the broader objective at which irradiation is aimed, i.e., control of fruit fly infestation, they are summarized below. All of these alternatives would avoid the risks associated with the use of a radio-isotope.

The double-hot-water-dip method is currently used for the majority of the papayas grown for export, and has proven moderately successful in preventing infested fruit from reaching the mainland. The method consists of treating the fruit with two hot-water baths to kill fruit fly eggs. The fruit must be picked at less than one-quarter ripe and then placed in the first water bath at a temperature of 42°C (108°F) for 30 minutes to acclimate the fruit to heat. The fruit is then placed into a second bath with temperatures of 48.9°C (120°F) for 20 minutes to kill fruit fly eggs and larvae. This alternative would not have the environmental effects associated with the primary alternatives. However, because of its inability to meet project objectives, its limited efficacy (as discussed in Section 3), and its resultant poor quality product, double-hot-water dip is not a reasonable alternative.

The use of vapor heat for the disinfestation of tropical fruits has been approved by both the United States and Japan. The exact procedures used are not fully known at this time due to the proprietary nature of the system. Generally, the fruit is picked at about one-quarter ripe and then brought up to a temperature of 47°C (117°F) over a period of 5 to 6 hours by the condensation of water vapor. While this alternative is successful in preventing infestation, it is significantly more costly than the double-dip method and could be more costly than irradiation. Further disadvantages of this process include the vulnerability of papayas to heat, and therefore an increased chance for lumpiness and injury to the fruit.

Unlike the other alternatives, all of which are in commercial use or in late stages of testing, the dry-heat-treatment process is still at the early experimental stage. It involves slowly raising the internal temperature of the fruit to 47°C (117°F) over a period of about 7 hours, allowing the fruit to remain at that temperature for about one-half hour at about 50 to 60% humidity, and then quenching the fruit to a temperature below 30°C (86°F). Preliminary approval by the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) has been granted; however, final rulemaking has not occurred. No packer is using this method commercially. Until additional studies designed to test the efficacy of the treatment method, its cost, its effect on fruit quality, and its applicability to large-scale throughput are completed, dry-heat treatment cannot be considered a proven alternative to either current treatment method or irradiation. This alternative may, however, eventually prove a viable method for commercial papaya disinfestation.

Methyl bromide (MBr) has been approved as a fumigant for citrus fruits, but fruit quality is not consistent since tolerance to MBr fumigation varies by crop and temperature at which the product is treated. Preliminary research has shown the treatment to be effective against the fruit fly eggs, but not against the larvae which are found deeper within ripe papaya. Potentially significant environmental and worker exposure hazards are associated with chamber leakage and exhausting of the gas following fumigation. Such hazards are important since MBr is currently under investigation as a possible carcinogen. The cost of employing MBr fumigation would be similar to that associated with the use of EDB; therefore, it is economically viable. Environmental impacts of other fumigants would be similar to those of fumigation using MBr. Use of chemical treatment methods for tropical fruits is not a reasonable alternative because of damage to the fruit, limited efficacy, difficulty in handling, and most importantly high environmental and human risk.

One possible alternative for the control of agricultural pests is to eliminate the species entirely in an area. This method can be carried out in a number of ways, all of which must reduce the number of fruit flies to an undetectable level. APHIS prepared a Draft EIS on the eradication of fruit flies in Hawaii (USDA APHIS 1986), although a Final EIS was never prepared. The Draft EIS concluded that this alternative has potentially significant environmental effects, such as risk of human exposure to pesticides, destruction of nontarget species, and potential occupation of the fruit flies' ecological niche by other pest species. These environmental effects, plus the potential inability to meet quarantine objectives, make this alternative unreasonable.

The alternative of refrigerating papaya for disinfestation purposes involves submitting one-quarter ripe fruit to temperatures of 0 - 2°C for 10 - 22 days. Its disadvantages are: papaya (and other tropical fruits) are very sensitive to the low temperatures required; the shelf life of some fruits is not long enough to withstand the length of treatment; the process itself is energy intensive and thus expensive; and it is difficult to reliably maintain necessary low temperatures and high humidity. Further, the method has not been approved for disinfestation treatment for Hawaiian papaya. This alternative is currently not feasible.

S.1.3.4 No-project Alternative

The no-project alternative involves foregoing state involvement in the DOE irradiation program and leaving treatment in the hands of the packers. The sites under consideration for the proposed project would remain vacant or otherwise be developed in accordance with their land use designations. Current treatment methods for papaya, vapor-heat and double-dip methods, would remain as the primary techniques to meet disinfestation quarantine requirements. Environmental effects resulting from implementation of the proposed project, as discussed in Section 4, would not occur if the no-project alternative is adopted. Benefits to the papaya industry such as an effective disinfestation method which can be administered at a later stage of fruit development and potentially provide higher quality fruit for market supplies, will be foregone under this option.

S.1.4 COMPARATIVE EVALUATION

In general, none of these other alternatives meets the project objectives as sufficiently as the proposed project. Although some of the alternatives could result in greater or fewer potential adverse environmental impacts, none of the alternatives offers the opportunity to address the questions that the proposed project will regarding the viability of irradiation treatment as a commercial disinfestation method. Similarly, none of the alternatives appear to offer superior economic benefits at least in the short-term. Machine source irradiation and dry-heat treatment may eventually prove viable for commercial disinfestation of papayas.

The no-project alternative would not meet the project objectives and would continue the present potentially unacceptable treatment method. The preferred alternatives satisfy the project objectives and currently provide the best opportunity to assist in meeting the state's goals and objectives to aid and encourage diversified agriculture and increased marketing of Hawaii's fresh fruit crops.

S.2 ENVIRONMENTAL CONSEQUENCES AND MITIGATION

The impacts and mitigation measures where appropriate of the proposed project are summarized in this section.

S.2.1 GEOLOGY, SOILS, AND HYDROLOGY

The geologic issues of the proposed project are risk from lava flows, risk from tephra falls, risk from pyroclastic surges, and indirect volcanic hazards. Flows from the northeast Rift Zone C constitute the threat to the Hilo area. Based on several calculations the EIS estimates there is a 1-in-50 to 1-in-100 chance that an irradiator in Hilo might be overrun by a lava flow during the project lifetime. The risk to the proposed facility from possible lava fountaining is considered slight and there is no evidence that pyroclastic surges (clouds of ash, rock fragments, and heated gases that move outward at high speed from the source vent) constitute a measurable threat anywhere in Hilo. Finally, there appears to be little risk to the area from indirect volcanic hazards such as ground fractures and subsistence. Several large earthquakes have affected the island in the past and due to the earthquake potential, the proposed facility would be designed to the appropriate structural standards. Through proper design and management of the facility, the threat from lava flows and earthquakes can be effectively mitigated.

No impacts to soils are expected from the proposed project and no special mitigation measures are necessary.

The key hydrologic issues of the proposed project are susceptibility to flooding, increased runoff, coastal flooding, surface water quality, and ground-water quality. All three sites are within areas of minimal flooding and there is no history of significant flooding on them. Construction of the irradiator and associated parking will increase the amount of impermeable surface, leading to a reduction in the ground's ability to absorb rainfall. To avoid creating flooding problems, an onsite stormwater collection and disposal system will be provided. This onsite disposal system will eliminate surface runoff from the facility and associated impacts that would otherwise occur. There is little threat to the three sites from coastal flooding because they are well above the historical high-water level for a 100-year tsunami. The irradiation process itself will not affect water quality.

S.2.2 BIOLOGY

Each site is currently disturbed or has been in the recent past. The flora and fauna documented at each site consist of common species which are widely distributed throughout the islands. None of the sites are known to contain threatened, endangered, or protected species of plants or animals. The proposed irradiation facility, therefore, would not have an adverse impact on biological resources at any of the three sites under consideration.

S.2.3 CULTURAL RESOURCES

A field investigation did not identify any cultural resources at the three sites. In the unexpected event that remains are uncovered during construction of the facility, work in the affected area will be suspended and the DLNR Historic Sites Section and Hawaii County Planning Department will be notified. Work will not be restarted until the significance of the findings can be assessed and appropriate measures taken to mitigate the potential loss.

S.2.4 TRANSPORTATION

The proposed facility would generate only a modest number of vehicle-trips both overall and during the peak hour. Analysis shows that there would be no significant change in the level of service at the intersections in the vicinity of the alternative sites and the effect of the project on traffic flow fronting these sites would be negligible.

S.2.5 AIR QUALITY

The project would result in a slight increase in vehicle-generated emissions. This resultant air quality impact would be negligible. Irradiation will generate radiolysis products such as ozone and oxides of nitrogen. The air quality impacts from this operation are also considered insignificant, given control measures discussed in the EIS.

S.2.6 NOISE

The siting of the facility at all three locations would have no significant noise impacts. The sites are located in an industrial area where noise generated by the facility and traffic will be consistent with other noise sources in the vicinity. Sensitive receptors would not be affected by the proposed projects.

S.2.7 LAND USE

Use of the alternative sites is unlikely to have a significant adverse effect on surrounding land uses. The existing and planned uses surrounding the sites are industrial and the irradiator will be compatible with existing and future uses.

S.2.8 PUBLIC SERVICES

It is unlikely that a fire would originate in proximity to radioactive materials; therefore, fire fighting would involve only the normal procedures used to fight structural fires. The facility will not store quantities of flammable material. Impacts to security/police protection are expected to be insignificant. The existing medical facilities are capable of accommodating project-related health problems and accident-related problems, if they were to occur.

S.2.9 HEALTH AND SAFETY

The two main areas of concern related to health and safety are health risks of consuming irradiated food and facility risk assessment. A complete risk assessment study on the safety of irradiated food is included in Appendix G of the EIS. Based on a review of the numerous scientific studies on the safety of irradiated food, it is concluded that consuming food irradiated at the levels proposed for commercial operation presents no unreasonable consequences to human health. The risk assessment in Appendix G also assesses the potential risks to man from radiation that could be released from the transport, use, and disposal of radioactive material.

During normal operation, the irradiation facility would not result in measurable emissions of radiation that could affect man. If an accidental release occurred, however, exposure could result. Consequently, the risk assessment in Appendix G identifies the types of accidents that could occur, estimates the probability of such accidents, and determines the worst-case exposure that could result.

Analysis concluded that the design of the facility would minimize the chances of a significant release of radioactivity that could cause exposure to the general population. Likewise, the analysis concluded that the transportation packaging and operations are sufficiently safe that no significant risk would occur; the U.S. transportation industry's safety record supports this conclusion.

The facility's location near an airport and an active volcano has resulted in questions about a radiation release caused by outside events. The risk assessment screened many potential event scenarios associated with aircraft operations, natural phenomena (e.g., volcanism, flooding), and surrounding activities of man.

Based on the assessments discussed in Appendix G, the following can be concluded:

1. The risk of radiation exposure to workers or the public due to external events affecting the food irradiation facility are extremely low.

2. The massive structure of the facility is the key factor in reducing hazards associated with external events.

3. The only external events that threaten significant public exposure are aircraft crashes into the site. The probability of aircraft crash is in the range of 10^{-5} to 10^{-7} per year, depending on class of aircraft and site considered. The probability of exposure and health effect is far lower.

4. Direct exposure due to reduced or breached shielding is likely to be a more important contributor to public dose commitments than is the dispersal of radioactive materials from the site.

Emergency preparedness will be a critical element in controlling risk associated with loss of facility shielding integrity. Emergency plans must be in place and emergency response personnel thoroughly trained to deal with accidents that damage the facility structure or incapacitate the operators.

S.2.10 AESTHETICS

As a result of past land use patterns, the proposed irradiation facility, which will resemble any industrial type warehousing/processing facility, will blend in and be visually compatible with surrounding uses. The facility will be landscaped in accordance with architectural drawings and county code requirements; chainlink security fencing will surround the perimeter of the facility. No significant impact will occur.

S.2.11 ECONOMICS

The proposed commodities irradiation facility is a 3-year demonstration project to be supported, in part, by federal and state funds. Economic effects will be empirically determined during the life of the project.

Long-term impacts are contingent upon the outcome of the 3-year demonstration, whether there is a demand for irradiated fruit, the cost-effectiveness of using irradiation as a method of disinfestation given certain levels of demand, and the availability of alternate cost-effective methods of disinfestation. Impacts would be incremental and reflect the difference between the existing and proposed facilities, and between the existing and projected levels of production for fresh papaya and other fruit for export.

Irradiation has the potential to beneficially affect the local and state economy by supporting and fostering the ongoing viability of the state's agricultural export sector. However, costs and consumer acceptance are uncertain. The irradiation demonstration program is intended to identify these economic factors.

The demonstration program is not expected to have a significant employment effect. Future commercial operation could result in a net loss of jobs as labor-intensive treatment methods are phased out. The lack of current employment data from the packers precludes quantification of this effect.

S.3 RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS OF THE PROPOSED ACTION FOR THE AFFECTED AREA

The applicable governmental land use policies, goals, and controls affecting the proposed project property are the Hawaii State Plan, the State Agriculture Functional Plan, the Hawaii County General Plan, and the Hawaii County Zoning Code. The proposed project's relationship to these and other land use plans and controls is described in detail in Section 5 of this EIS.

One of the primary purposes and objectives of the proposed project is to conduct irradiation research on papayas and other Hawaiian grown commodities. This will assist in the continued growth and diversification of the state's agricultural activities. As such, the proposed project is in concert with the specific state plan economy objectives and policies regarding agriculture and the support of research and development activities; enhancement of agricultural growth by providing public incentives which will encourage private initiatives; expanding the agricultural base by promoting the growth of the tropical fruit portion of the industry; and promoting a treatment method that could be competitive with and complement other treatment methods.

The Hawaii State Plan - Priority Guidelines establish overall priority guidelines to address areas of state-wide concern. The overall direction, established by the Hawaii State Plan - Priority Guidelines is to assure that the state strives to improve the quality of life for Hawaii's present and future population through the pursuit of desirable courses of action in five major areas of state-wide concern which merit priority attention: economic development; population growth and land resource management; affordable housing; crime and criminal justice; and quality education.

The pursuit of the irradiation facility is in keeping with the priority guidelines of promoting the growth and development of diversified agriculture and encouraging the development and expansion of agricultural activities that offer long-term economic growth potential and employment opportunities.

By the very existence of a complex system of policies, plans, goals, objectives, and controls at both the state and county levels of government, development proposals that involve novel (to the state or county) processes and/or those that require rethinking traditional practices are often faced with inherent apparent conflicts within the regulatory system. As such, the proposed irradiator project must be reconciled against those planned elements that most appropriately apply. The proposed project is generally consistent with the applicable state plan goals, policies, and standards relating to the future growth of the state and the State Agriculture Functional Plan relating to the expansion, diversification, and growth of the agriculture industry. Proceeding as proposed would enable the project to meet initial objectives, as well as provide the advice and guidance necessary to determine a future course of action regarding the use of irradiation as a treatment method. The decision to proceed must be balanced against the risk of environmental effect should one or more of the built-in safeguards against such damage fail. Given the relatively accident-free record of irradiation facilities throughout the world, and the safeguards that would be inherent in the proposed facility, it would appear that a decision to proceed would be safe and prudent and allow the planned demonstration of the efficacy of irradiation as a commercial treatment method to be determined.

S.4 UNRESOLVED ISSUES

The primary outstanding issue is uncertainty about the economic effect of the project. The project could have a significant positive economic effect; there is concern, however, that irradiated fruit would be less marketable than non-irradiated fruit, and a negative economic effect would result. Resolution of this issue is a primary objective of the demonstration project.

Concern has been raised that irradiation alters fruit in ways that could cause adverse health effects in those who eat the fruit. As discussed in Appendix G, however, the preponderance of available evidence indicates that no such effect is expected to exist.

SECTION 1
INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The State of Hawaii, Department of Business and Economic Development (DBED), Energy Division, proposes to contract for the design, construction, and operation of a demonstration food commodities irradiation facility in Hilo, Hawaii County. The demonstration project would last 3 years, after which the plant would continue commercial operation or be decommissioned at the option of the contractor. The Hawaii legislature mandated that this environmental impact statement (EIS) be prepared in accordance with Chapter 343, Hawaii Revised Statutes and Chapter 200 of Title 11, Administrative Rules, to assess the environmental effects of the proposed Hawaii Commodities Irradiation Facility.

1.2 BACKGROUND ON FOOD IRRADIATION

1.2.1 Quarantine Requirements, EDB Ban, and Current Disinfestation Practices

Tropical fruits such as papayas (*Carica papaya*), mangoes (*Mangifera indica*), and lychees (*Litchi chinensis*) are susceptible to pest infestation. The U.S. Department of Agriculture Animal and Plant Health Inspection Services (APHIS) requires quarantine and disinfestation to kill pests and larvae in all susceptible fruit exported from Hawaii to the mainland United States. Foreign countries, such as Japan, have similar requirements.

Papaya is one of the largest Hawaiian export crops subject to APHIS regulation, requiring disinfestation of the fruit to control Mediterranean fruit fly (*Certitis capitata*), Oriental fruit fly (*Dacus dorsalis*), and the melon fly (*Dacus cucurbitae*). Until 1984, disinfestation was accomplished using the chemical fumigant ethylene dibromide (EDB) at the packing houses. In response to findings that EDB was toxic and potentially carcinogenic, the U.S. Environmental Protection Agency (EPA) banned all uses of the chemical, effective September 1, 1984. Consequently, new methods were needed to meet quarantine requirements for tropical fruits exported from Hawaii.

Alternative methods currently used include double hot-water-dip treatment and vapor-heat treatment. These batch processes (discussed in Section 3) present significant product quality problems since the fruit often suffers damage during the heat processing, resulting in loss in appearance, texture, and taste of the fruit. Packers have indicated that this quality loss has had a significant adverse effect on their ability to profitably export fruit to the mainland. These processes are also labor intensive and require very careful evaluation of the fruit's ripeness. Strict APHIS requirements that limit ripeness of treatable fruit potentially result in parts of the crop being determined to be nonexportable. Most importantly, double-dip treatment has been shown to be less than fully effective in meeting APHIS-required levels of disinfestation; larvae have been found in shipments bound for export. Consequently, industry, government, and universities are investigating alternative methods of treatment. Irradiation is one of these alternatives. (A discussion of other alternatives is included in Section 3.)

1.2.2 Irradiation Treatment

On April 18, 1986, the U.S. Food and Drug Administration (FDA), Department of Health and Human Services, adopted rules approving the use of radiation to kill insects and larvae in harvested fruits and vegetables (21 CFR Part 179). The U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) concurred with this approval. Radiation imparts energy to the material to be irradiated (i.e., fruit and infesting pests) which results in the formation of ions, excited molecules, or molecular fragments which interact and cause chemical changes in the irradiated material. For insects, the chemical changes generally result in the impairment of metabolic reactions, causing death. The appropriate level of irradiation to meet treatment objectives for fruits are determined individually since the reaction to radiation treatment is fruit-specific. In order to meet FDA "Probit 9 Security" (FDA's designation as a level of treatment necessary to meet quarantine requirements by killing flies and larvae), required minimum doses of radiation for papayas and mangoes were set at 150 Gray (Gy) and 300 Gy respectively; the maximum allowable dose was set at 1000 Gy (1 kGy). (See glossary appended to this EIS.) An absorbed dosage of 1000 Gy is also the maximum dose that can be given to papaya and mangoes without producing surface scalding and darkening of the fruit. Such exposure levels, using cobalt-60 gamma rays, cannot cause the fruit or other material to become radioactive (CH2M Hill 1987). Unlike disinfestation processes which involve heat, irradiation does not increase the speed of the ripening process.

Irradiation treatment occurs by exposing the material to be irradiated to a radiation source, usually one that emits gamma rays. Cobalt-60 and cesium-137 are radionuclides that are often used as sources of gamma radiation. Cobalt-60 is formed by irradiating the metal cobalt-59 with neutrons in a nuclear reactor. Cobalt-60 has a half-life of about 5 years and emits gamma rays having energies of 1.2 and 1.3 MeV. In a chemical sense, cobalt is relatively stable in that most of its compounds are insoluble in water. Cobalt-60, in the metallic form, is in use in irradiators for various purposes throughout the world. Cesium-137 is usually obtained as a by-product from reprocessing spent reactor fuel. Cesium-137 has a half life of about 30 years, and produces gamma ray of 0.66 MeV energy. Most irradiation sources containing cesium-137 use water-soluble cesium-chloride. Cesium-137 has also been used extensively in irradiators. Small quantities of the radio-isotope are used for commodity irradiation. Fission does not occur and the risks identified with nuclear power plants (e.g., explosion or "meltdown") do not exist. Irradiation can also be conducted using machine-generated electron beam or x-ray sources that do not require the use of a radio-isotope. (These methods are discussed further in Sections 2 and 3).

1.2.3 Department of Energy Demonstration Program

At the direction of Congress, the U.S. Department of Energy (U.S. DOE) has developed a program to establish demonstration agricultural commodity irradiation facilities in six states. Each demonstration facility would be used to treat food specialties of the regions in which it is located, including: vegetables and hides in Oklahoma; citrus fruits in Florida; pork and other meat products in Iowa; apples, cherries, and asparagus in Washington; fish in Alaska; and papayas and other tropical fruits in Hawaii. All six projects are in project development and evaluation phases.

The U.S. DOE's demonstration program is designed to develop and transfer irradiation technology to the private sector. The program intends to promote participation by the private sector to share the cost and responsibilities of constructing and operating each facility. Each facility will be used for research and development, market testing, operator training, and commercial demonstration of the feasibility of irradiating food and other agricultural products.

1.2.4 Status of Hawaii Commodities Irradiation Facility Project

Through a cooperative agreement dated August 4, 1987, between the U.S. DOE's Richland, Washington, Operations Office and the Hawaii DBED, DBED and its contractors would build and operate a demonstration irradiation facility in Hawaii. A preliminary cost estimate for the 3-year demonstration program is $5.5 million. The U.S. DOE is to provide funding of $4 million. Subsequent to agreement with the U.S. DOE, the Hawaii state legislature (Act 216, Session Laws of Hawaii, Section 280, Item A.1.) appropriated $1 million for planning and construction of an irradiation facility and specified that cobalt-60 be used as the radiation source (see discussion on cesium-137 in Section 3). DBED desires that the facility would be owned by the contractor, with the state having the exclusive right to use it during the 3-year demonstration program; the state's involvement would terminate at the end of the demonstration period. A decision to continue in commercial operation would be made by the operator.

One of DBED's initial steps was to commission the *Feasibility Study for a Commodities Irradiation Facility in the State of Hawaii* (CH2M Hill 1987). This study assessed the use of irradiation and alternatives for pest control, reviewed market and health issues, and estimated project costs. It concluded that an irradiation facility in Hawaii is technically and economically feasible but with certain caveats, most importantly consumer acceptance of irradiated products.

The site options for a commodities irradiation facility in Hawaii were also evaluated. That site analysis reviewed fruit production areas, transportation routes, land availability, costs, and environmental issues. It concluded that the facility should be constructed on either the Island of Oahu or Island of Hawaii.

Establishment of the proposed irradiation facility in the Hilo area was determined preferable by DBED for several reasons. First, 80 to 85 percent of the papaya grown in the state for export is cultivated on the Island of Hawaii, particularly in the Puna region southeast of Hilo. Second, seven of the eight papaya packers are located on Hawaii, most of them in the Hilo area. Third, the presence of General Lyman Field (Hilo Airport) and Hilo Harbor facilitate inter-island transport of papaya bound for overseas markets. Finally, location in the airport area would have the least effect on existing transportation systems and infrastructures, thus minimizing costs.

The DBED, in consultation with the State Department of Transportation (DOT), State Department of Land and Natural Resources (DLNR), State Department of Hawaiian Home Lands (DHHL), and County of Hawaii, identified three potential development areas near General Lyman Field. WESTEC Services, in the *Hawaii Commodities Irradiation Facility Site Evaluation Study* (1988) (see Appendix D) identified three potential sites, one within each of these areas. These three sites were chosen specifically because they have suitable access to transportation services for inter-island and overseas transport; have, or can be readily provided with, necessary infrastructure such as water, power, sewer, and roads; have available vacant land; and are under the jurisdiction of the State of Hawaii. All three sites are zoned for industrial use by the County of Hawaii and have already been disturbed by man's activities.

1.3 ENVIRONMENTAL REVIEW PROCESS

The proposal to design, build, and operate the proposed irradiator represents a commitment to expend state funds. The fact that all three sites under consideration are state owned or managed means that the commitment of state land is involved as well. Consequently, the proposed project is subject to Chapter 343, Hawaii Revised Statutes (the state's EIS law) and the Department of Health Regulations (Title 11, Chapter 200) which implement the law. In light of the fact that the project involves the transportation and use of radioactive isotopes, DBED concluded that it could result in potentially significant impacts and that an EIS should be prepared.

Upon its decision to prepare an EIS, the DBED published an Environmental Impact Statement Preparation Notice (EISPN) in the Office of Environmental Quality Control (OEQC) Bulletin, dated March 23, 1988. Pursuant to Title 11, Section 11-200-15(b), DBED requested comments from all agencies and organizations with an interest in the proposed project. A 30-day comment period followed publication of the bulletin for agencies, groups, or individuals to submit written comments regarding the scope of issues to be addressed in the EIS. Over 60 comment letters were received, all of which are included in Appendix C of this EIS.

In addition to the 30-day written comment period, public information meetings were held on May 3 and 4, 1988. At the meetings, DBED representatives described the proposed project and heard public testimony. Approximately 12 people attended the first public meeting, held at the State Capitol Building in Honolulu. The meeting on May 4, held at the

Hawaii Naniloa Hotel in Hilo, attracted approximately 200 people; 66 presented testimony. A "Public Memory" of the comments made at the meeting was subsequently distributed to attendees who provided an address. A copy of this record, meeting announcements, and a list of attendees are included in Appendix C.

Several environmental topics were identified by scoping comments as warranting assessment to determine the potential types and magnitude of impacts that may result from the project as proposed. The primary issues raised related to safety, including:

- Effects on water, air, and soil resources in the event of an accidental radiation leak;
- Special risks associated with natural hazards in the Hilo area (volcanic eruptions, seismic shaking, tsunamis) and resultant potential radiation releases;
- Source transportation, containment, and disposal;
- Nutritional quality of irradiated fruit;
- Potential health risks to plant employees; and
- Protection of the facility from potential aircraft accidents at General Lyman Field.

Another topic area which was the subject of numerous questions had to do with the economics of the project, including sources of funding and the liability for damages if an accident should occur. Numerous individuals also question whether consumers are willing to purchase, or stores to sell, irradiated fruit. Two additional major categories of concern were the effectiveness and cost of other treatment alternatives and the steps involved in decommissioning the facility at the end of its useful life.

Environmental issues also raised, but to a lesser degree, were project design integrity; regulatory criteria such as food labeling, personnel training, and emergency response procedures; and impacts to county services, local traffic plans, and community property values. Requests were also made for an assessment of cumulative impacts and a discussion of the steps that would be taken to protect the facility from sabotage or terrorism.

SECTION 2
PROJECT DESCRIPTION

2.1 Project Need and Objectives

As discussed in Section 1, there is a pressing need to find alternatives to the current methods of commodity disinfestation in Hawaii. The Hawaii Commodities Irradiation Facility project would explore one such alternative.

The general objective of the proposed commodities irradiation facility is to demonstrate and test, for 3 years, the use of irradiation for fruit disinfestation at commercial levels of operation. DBED has identified the following more specific objectives of the demonstration program. (These objectives will be further defined as DBED develops its final research and demonstration plan.)

- Test the effectiveness of irradiation.
- Investigate efficiency of treatment at different radiation dose levels.
- Determine costs associated with commercial-level irradiation operations.
- Allow for the transfer of irradiation technology from the U.S. Department of Energy to the private sector.
- Conduct market research on consumer acceptability of irradiated fruit.
- Provide consumer education on irradiation treatment.
- Determine the potential for irradiation to increase or create new markets for Hawaii-grown tropical produce.

Additionally, DBED intends to make the facility available for developmental research by the University of Hawaii and others. Examples of other possible uses that have been identified include treatment for shelf life extension of taro; disinfestation of wheat and flour; sterilization of soil; preservation of unique articles, such as rare books; and wood preservation.

Finally, the facility will be available to meet part of the commercial demand for fruit disinfestation. Other disinfestation methods would continue to be utilized at other privately-owned facilities in Hawaii.

2.2 CURRENT PAPAYA INDUSTRY ACTIVITIES

Initially, the proposed irradiation facility will be used primarily to treat papaya. This is because (1) papaya is, at 45-50 million pounds per year exported (PAC 1987), by far the largest export crop requiring quarantine; and (2) the papaya industry is large and well organized to participate in the demonstration program.

Seven of the eight papaya packers in the state are located on the island of Hawaii; four of them (Del Monte, Hawaiian Host, Ono Pac, and Pacific Tropical Products) are located in Hilo within 1-1/2 miles of Hilo Airport. Two packers (Amfac and Diamond Head) are located in Keaau, approximately 7 miles south of Hilo. Both are adjacent to Highway 11, which provides direct access to Hilo Airport. Pacific Paradise is located at Kalapana, 30 miles south of the airport on Highway 13. The eighth packer (Best Fruits) is located in Kauai but hopes to participate in the demonstration program if transportation logistics allow (Best Fruits - Martin Consultation).

All of the Hawaii island packers currently ship most of their fruit through Hilo Harbor to Honolulu for transshipment to the mainland. Smaller quantities are shipped by air from General Lyman Field to Honolulu and then on to the mainland (generally by air, but also by ship). A few of the packers also transport fruit approximately 90 miles west to the Keahole Airport for direct shipment to the mainland on passenger planes. Nevertheless, the great majority of the Hawaii papaya shipments move through the vicinity of Hilo airport and harbor.

At present, there are two types of insect disinfestation treatment methods being commercially used by Hawaiian papaya packers: double-hot-water dip, and vapor heat. Double hot-water-dip-treated fruit is generally shipped to mainland U.S. markets while vapor-heat-treated fruit is primarily shipped to Japan, with some going to the mainland. Regardless of the type of treatment or packer, the fruit generally moves through the same types of steps from grower to market. There are slight variations due to different packer's methods of operation and equipment.

In general, the fruit moves from the grower's field to the treatment/packing house via the grower's trucks. The fruit is offloaded onto wooden pallets (skips); graded, sorted, treated, packed into shipping boxes, sealed, stacked on wooden skips, and stored in refrigerators to chill (to about 50°F) by the packer. The fruit is then either stacked into refrigerated containers at the packer's plant or trucked to and stacked in refrigerated containers at Hilo Harbor if it is being shipped by barge. Fruit that is being shipped by air is restacked into air freight containers (LD-7 or LD-3 containers) at the packing house or at the airport and loaded into aircraft.

2.3 SITE LOCATIONS

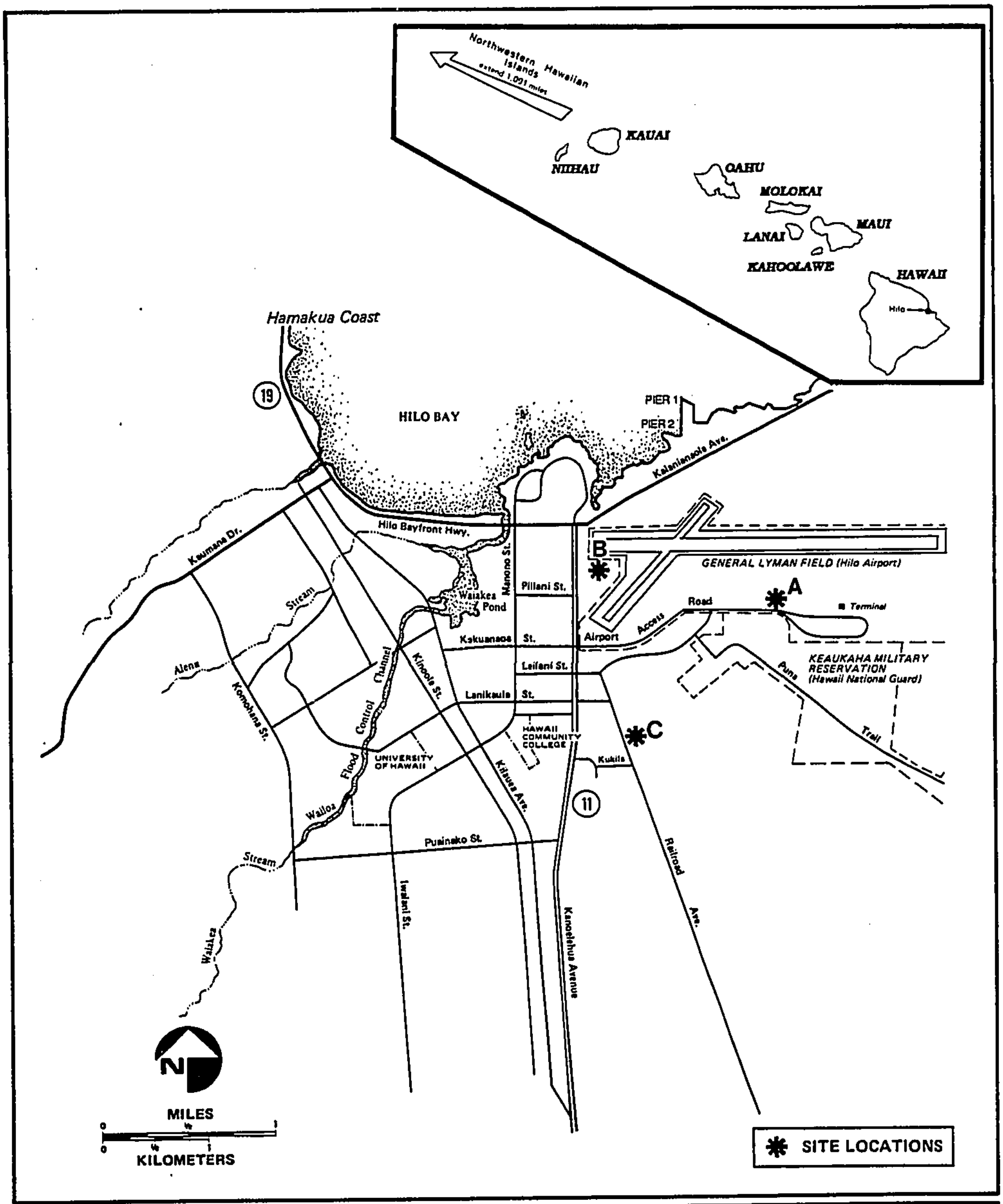
As discussed in Section 1, three possible sites in Hilo, Hawaii, have been identified by DBED as potential locations for the proposed commodities irradiation facility (see Figure 2-1). These sites all facilitate papaya industry operations discussed above and are managed by state agencies. The sites would be leased by the state to the contractor that would build and operate the facility. The three sites identified are referred to in this EIS as Site A - Airport Industrial Area, Site B - Old Terminal, and Site C - Railroad Avenue (see Figure 2-2).

2.3.1 Site A - Airport Industrial Area

Site A is adjacent to the frontage road (Kekuanaoa Ave) along the General Lyman Field (Hilo Airport) access road. It is just east of the airport control tower and is part of the subdivided but undeveloped airport industrial park (Figure 2-3). The land is under the jurisdiction of the Hawaii Department of Transportation (DOT), Airports Division, and is included in the master plan for use by airport-related industrial activities. The site is bordered on the south by vacant DOT land and the Hawaii National Guard's Keaukaha Military Reservation (across the access and frontage road); on the north, south, and east by other parcels within the industrial area; and on the west by vacant industrial land. Site A is identified as Tax Map Key parcel number (TMK) 2-1-12:106, 107, and 108. The site is zoned by Hawaii County for Limited Industrial (ML-20) uses; the irradiation facility would be an allowable use.

2.3.2 Site B - Old Terminal

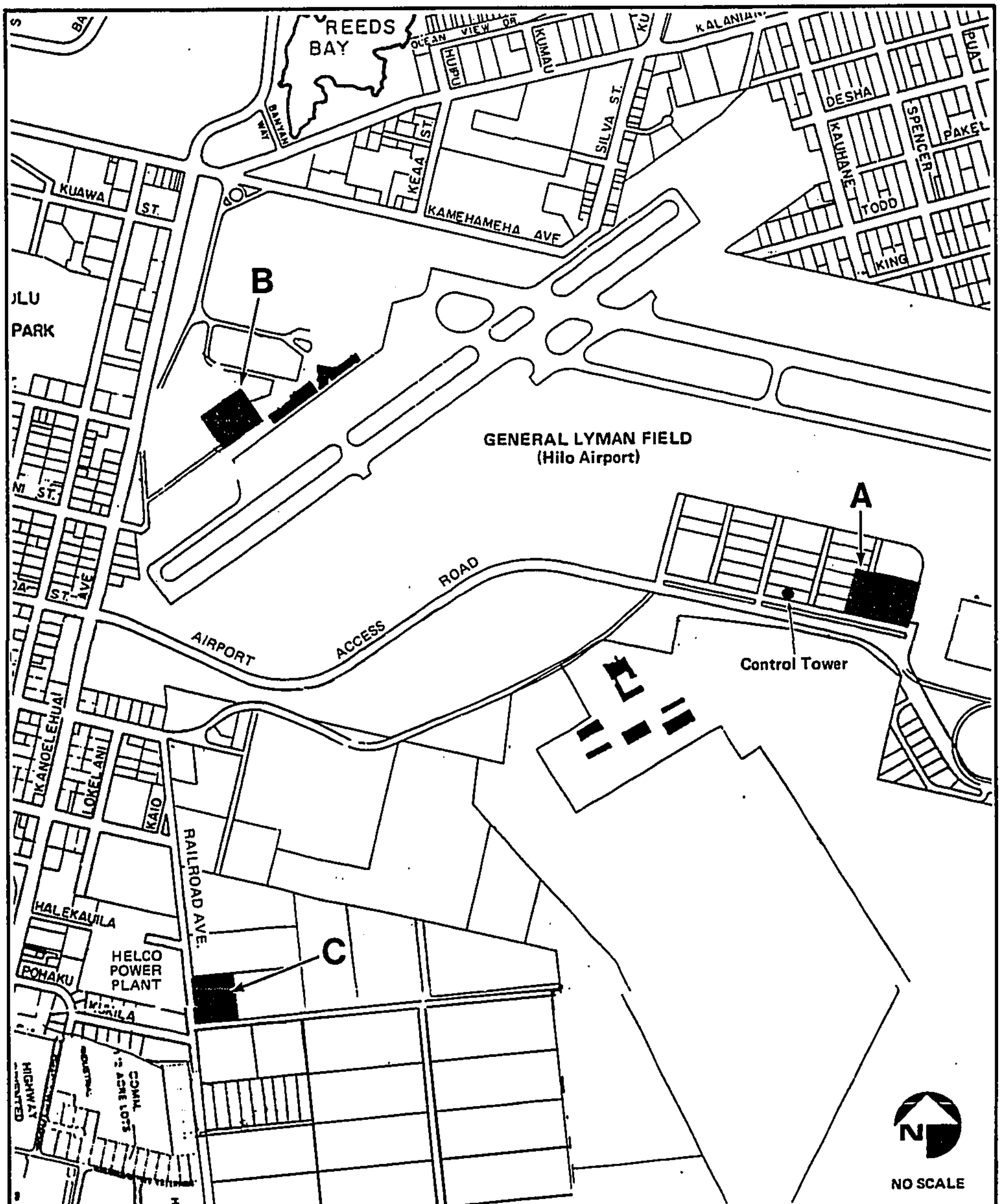
Site B is located just north of the existing air cargo buildings near the old passenger terminal (Figure 2-4) on the western side of General Lyman Field. It falls under the jurisdiction of the Hawaii Department of Land and Natural Resources (DLNR). The site is



Regional Location

FIGURE 2-1

WESTEC Services, Inc.



Site Locations

FIGURE 2-2

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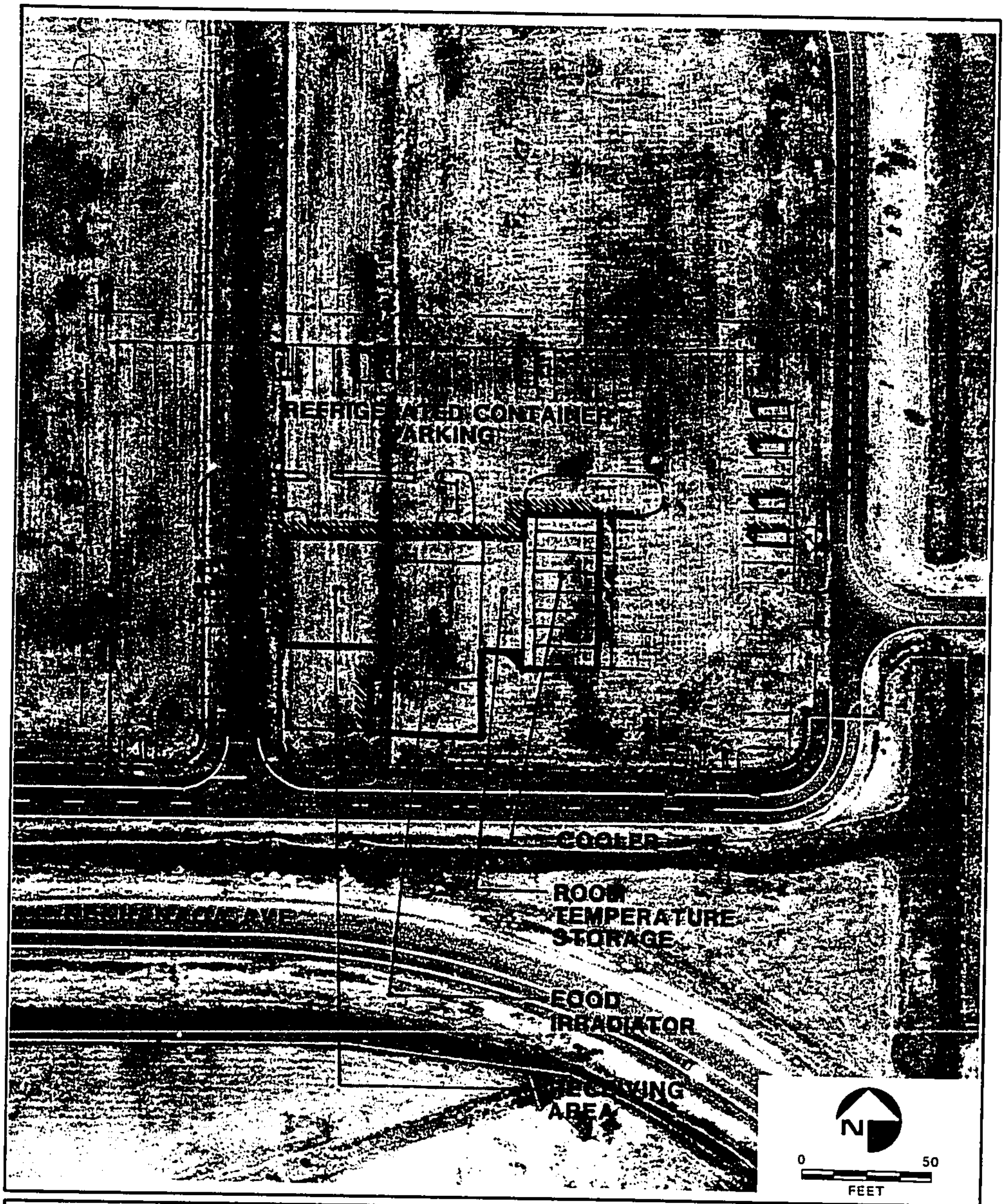

Site A - Airport Industrial Area

FIGURE
2-3

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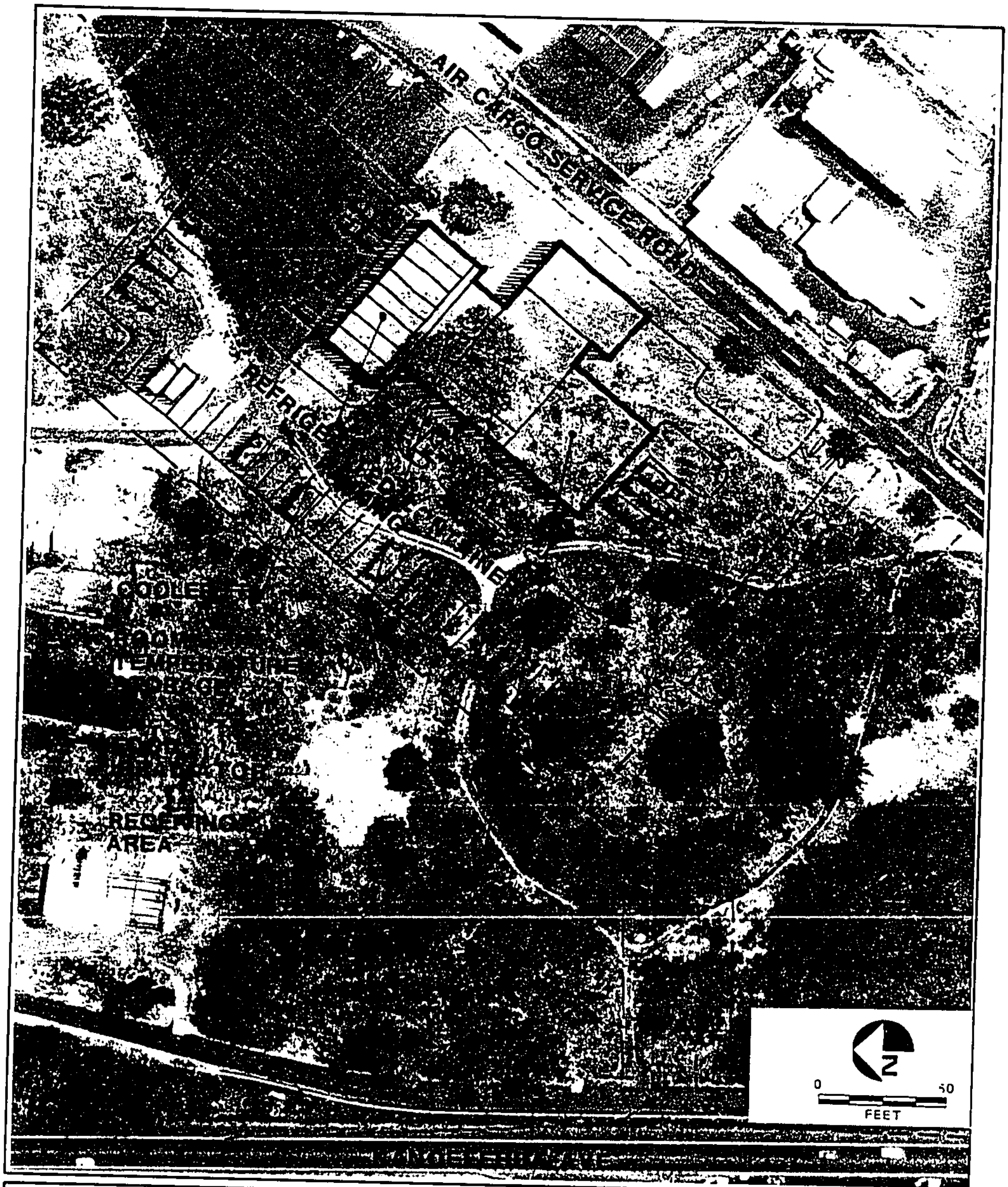


Site B - Old Terminal

FIGURE 2-4

bordered on the south by the existing access road to the air cargo and general aviation facilities. On its other sides, it abuts vacant land. Site B is identified as TMK 2-1-12:56, 74, and 75. Site B is also zoned ML-20.

2.3.3 Site C - Railroad Avenue

Site C is located on Railroad Ave. across from the Hawaii Electric Light Company's (HELCO) main Hilo generating station; it is approximately one-half mile from the airport (Figure 2-5). The land, which is under the jurisdiction of the DHHL, is presently vacant. The site was once used for concrete and gravel operations and is adjacent to asphalt batching and wood mill operations. Site C is identified as TMK 2-1-25:86. Site C is zoned for General Industrial (MG-1a) use, allowing the operation of an irradiation facility.

2.4 FACILITY DESCRIPTION

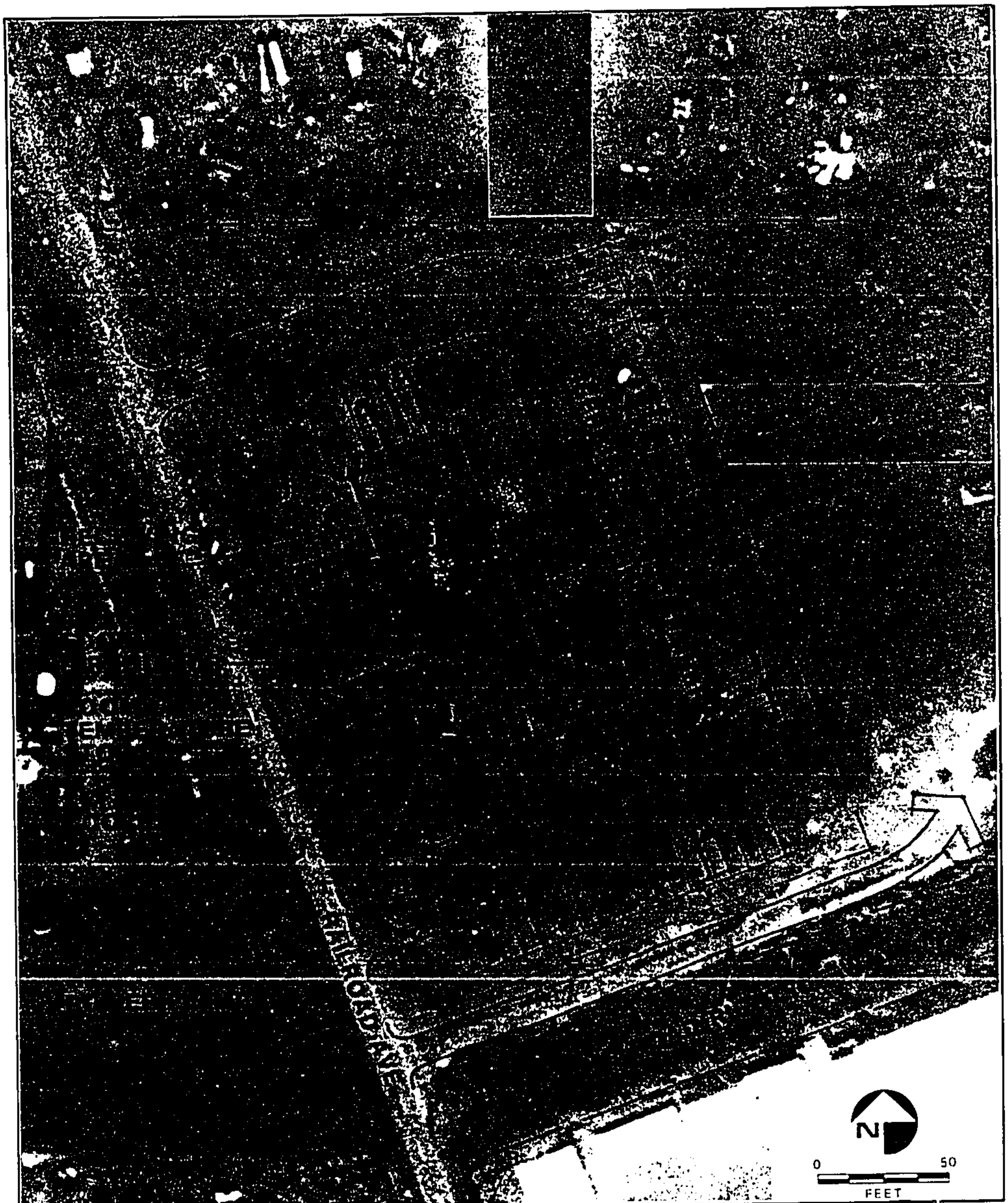
2.4.1 Site Development

Construction of the proposed irradiation facility would involve the development of 4 to 5 acres of land for an approximate 29,000 square foot irradiator and warehouse building, truck loading and unloading facilities, and parking area (WESTEC 1988). The warehouse would contain an irradiation room with concrete walls about 6 feet thick, a chiller, separate treated and untreated fruit storage areas, office space for support operations, dosimetry laboratory for product inspection, equipment storage space, and employee facilities (e.g., lockers, restrooms, lounge). A conceptual floor plan of the proposed facility is shown in Figure 2-6.

Construction and operation will conform with applicable design standards such as the Uniform Building Code and U.S. Nuclear Regulatory Commission (NRC) requirements.

2.4.2 Facility Process Flow

The facility will have the capacity to treat at least 20 million pounds per year and up to 13,750 pounds per hour of papaya. Below is a discussion of the current concept of the treatment process. Specific process steps could be slightly different (e.g., continuous vs.



Site C - Railroad Avenue

FIGURE 2-5

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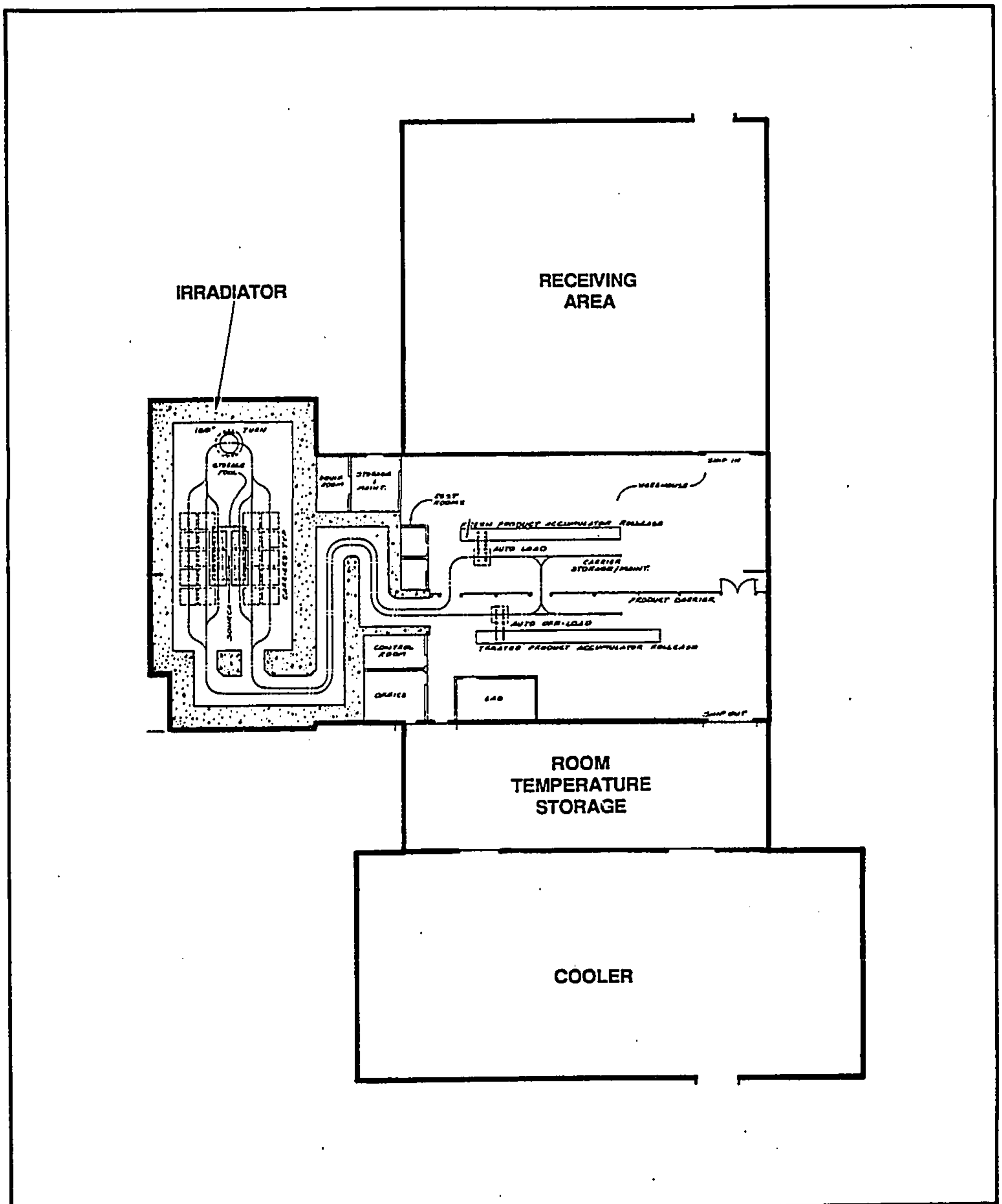


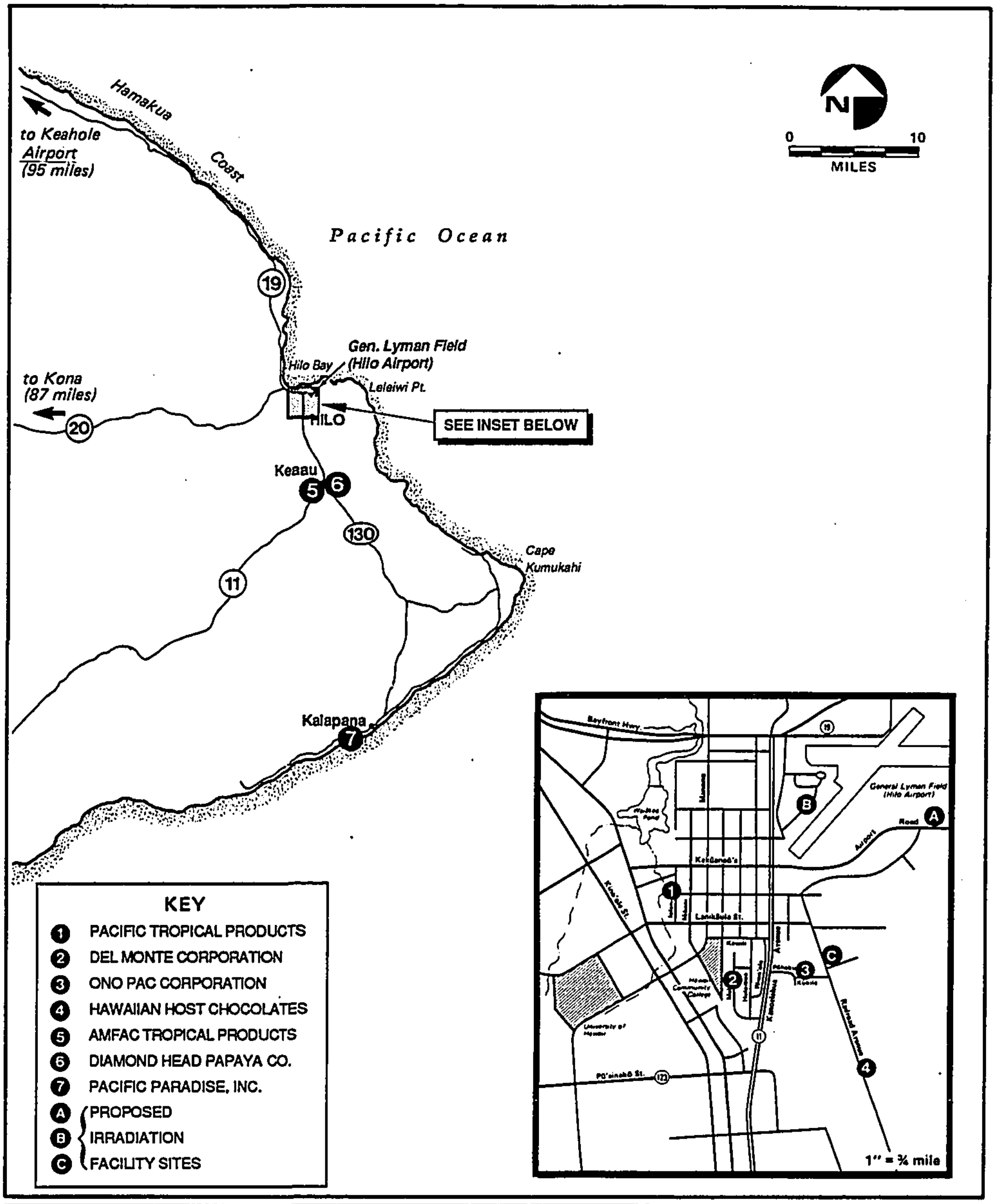
Conceptual Irradiator and Warehouse Floor Plan

FIGURE 2-6

batch treatment). These differences would not materially change potential project environmental effects.

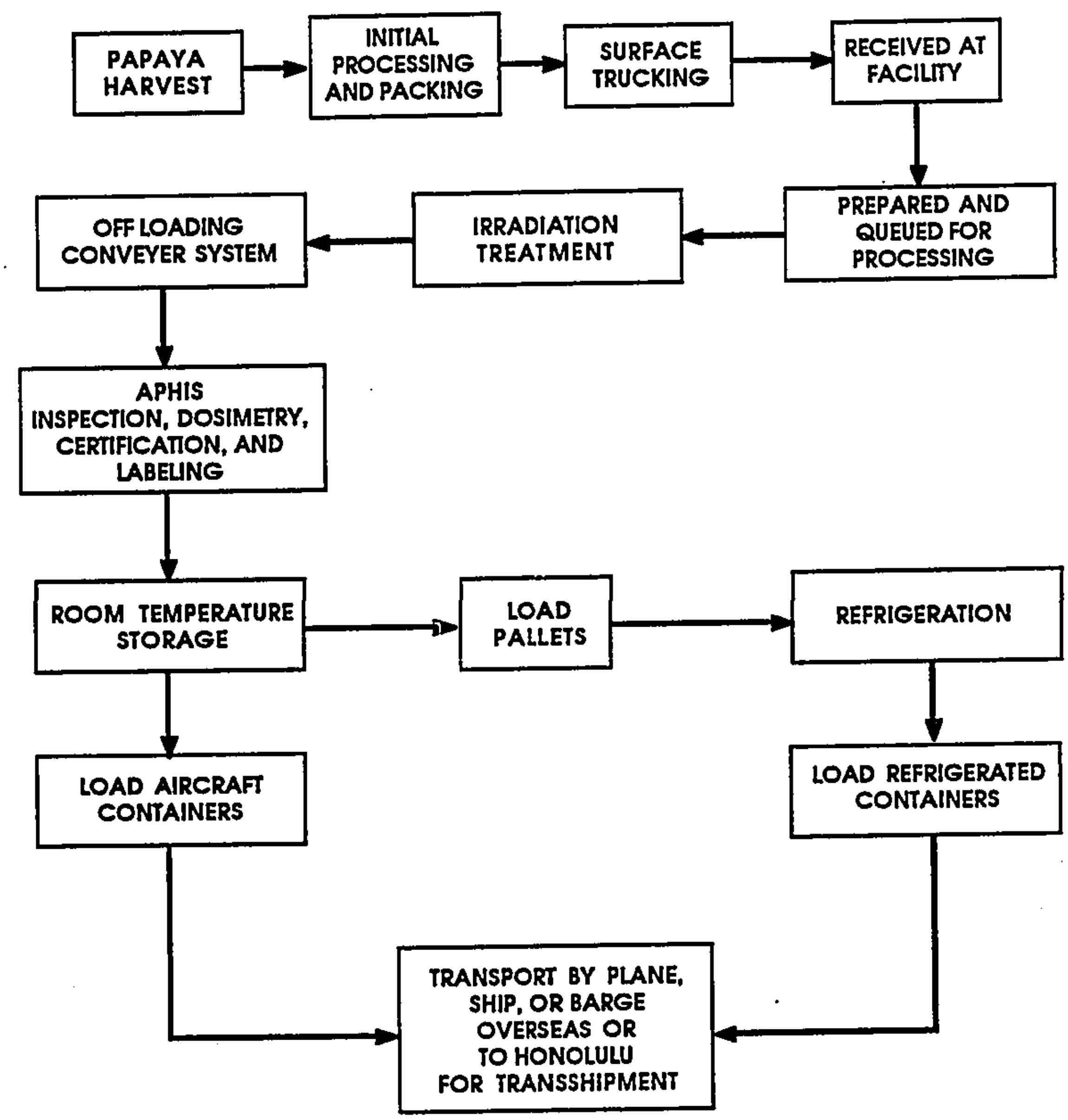
Fresh-picked fruit will be graded, labeled, packaged, and sealed in cardboard boxes at the seven independent packing houses. The boxes will be stacked onto skips about 40 by 48 inches; average skip loads will be 900 to 1400 lbs. The skips of boxed fruit will then be delivered by flatbed trucks from the packing houses (see Figure 2-7) to the proposed irradiation facility. Upon arrival, they will be unloaded onto an automatic conveying system that moves the skips through the irradiator room, exposing the fruit as uniformly as possible to the radiation source. In the irradiator itself, the commodity will pass along a conveyor through a labyrinth to ensure that radiation will not escape the irradiator. The commodity will pass by both sides of the cobalt source in a manner which will expose both sides of the commodity, thereby providing uniformity of dose. When the irradiator is not in operation, the cobalt source would be lowered into a 24-foot-deep water pool which would be constructed of steel-lined concrete. The water serves as a radiation shield, allowing workers to enter the irradiation chamber when the cobalt has been lowered into the water. (As an alternative to this "wet storage irradiator," dry storage could be utilized. Dry storage requires the use of a containment vessel, such as a shipping cask, for storage.)

After passing through the irradiator, the conveying system will then deliver the skips of fruit to the processed product holding area. Incoming and outgoing product areas will be physically separated to prevent mixing of irradiated and non-irradiated fruit. This separation is required to ensure that fruit is irradiated once and only once and to prevent reinfestation of treated fruit. Examination of pallet dosimeters, recordation of results, and certification will immediately follow irradiation treatment. The irradiated fruit will then be chilled and loaded into refrigerated containers or loaded directly into air cargo containers. The loaded containers or airplane pallets will then be used to deliver the fruit for overseas transport either directly from Hilo or through Honolulu. A conceptual diagram for the complete process flow is illustrated in Figure 2-8. Irradiated fruit must be identified with labels using FDA-approved symbols and text. It takes about 4 hours for fruit to complete the total treatment process.



Surface Shipping Routes from Packing Houses to Proposed Facility

FIGURE 2-7



Conceptual Process Flow

FIGURE 2-8

2.4.3 Facility Operations

Through competitive bid, DBED intends to select a contractor to design, build, and operate the irradiation facility. The contractor will be required to operate the facility at the exclusive direction of DBED during the 3-year demonstration period. After that, commercial operation can continue at the option of the contractor, who would have to meet any ongoing permit or license compliance requirements.

During the 3-year demonstration period, primary operation will be to meet the demonstration objectives discussed in Section 2.1. DBED estimates that this will require the treatment of 1 million pounds of papaya in the first year, 3 million pounds in the second year, and 20 million pounds in the last year of the demonstration. This will require the dedication of one 8-hour operating shift, 6 days a week, during the first 2 years and possibly a second shift during the third year (depending on the results of tests on dose requirements which will provide information on the rate at which fruit can be irradiated). Also, treatment times will increase as the source decays (e.g., after 3 years, the source has 70 percent of its maximum radiation energy and would require proportionally longer exposure of product to source).

Beyond the time required for the demonstration program, the facility could be available, with DBED approval, for other research or commercial operations. DBED intends to work with industry, the University of Hawaii, and other agencies such as the County of Hawaii or the Governor's Agricultural Coordinating Committee to develop procedures to accommodate research activities.

Following completion of the 3-year demonstration period, the facility can continue commercial operation at rates determined by the operator, based on industry demand. Potential demand cannot be predicted at this time; such predictions require the information that will be gathered during the demonstration period.

The operator will be required to maintain comprehensive liability insurance and to provide documentation of insurance coverage to the DBED under the demonstration contract and to the appropriate land management agency (i.e., DOT, DLNR, or DHHL) under the land lease.

2.4.4 Employment

The facility is expected to employ seven people during the demonstration period. Positions include factory manager, plant operator, laboratory technician, product handlers, maintenance staff, and a clerk. Commercial-scale operation could employ 14 people. Employees will be hired from the local work force to the extent possible. (See additional discussion in Section 4.14.)

2.4.5 Source Transportation

Approximately 150,000 curies of cobalt-60 will be required to operate the facility at the planned level of throughput. The cobalt-60 source will have to be transported to the site at the commencement of operation and periodically thereafter for source replenishment. DBED predicts that replenishment will be required approximately once every 3 years; thus additional transport of the source will not be required until the end of the demonstration period, if the facility is to continue operation.

Approximately 80-90 percent of the world's demand for cobalt-60, a man-made isotope, is met by Atomic Energy of Canada Limited (AECL) (CH2M Hill 1987). AECL, a potential supplier for the Hawaii Commodities Irradiation Facility, has provided a description of the cobalt-60 transportation process. This description is included in Appendix G and is summarized below.

The cobalt-60 source is generally manufactured into "source pencils," rods of cobalt sealed in an inner capsule of Zincalloy and an outer capsule of stainless steel. These pencils are approximately 1/2 inch in diameter and up to 18 inches long. The pencils are bundled into cages holding up to 64 pencils. This cage with the cobalt-60 pencils in place constitutes the source that is used at the irradiation facility.

The source cage is transported from the manufacturer to the irradiation facility and back by sea or air, in a licensed 11,000-pound, shielded, shipping container that is approximately 58 inches high and 40 inches in diameter. Shipping containers are completely shielded by approximately 10 inches of lead. These containers are generally owned and used by the cobalt supplier, under NRC license.

Trained supplier staff transfers the source cage from the shipping container to the source storage pool. The facility's Radiation Safety Officer will also be trained to conduct source transfer.

Source replenishment is generally accomplished by adding or replacing pencils in the source cage. The fresh pencils would be transported to the facility in the same type container used for the initial source load.

During normal operation, no radioactive wastes will be generated. The spent source pencils will be returned to the manufacturer. Any contaminated waste materials will be shipped by licensed carriers in approved containers to a licensed radioactive waste facility.

2.4.6 Public Utilities Requirements

The utility requirements of the proposed facility are estimated by CH2M Hill (1987) in the *Feasibility for a Commodities Irradiation Facility in the State of Hawaii* and in the *Hawaii Commodities Irradiation Facility Site Evaluation Study* (WESTEC 1988). Those reports indicate that the commodities irradiation facility will consume no more than 1200 gallons of water per day from the municipal water system. The majority of that will be for landscape irrigation. Hence wastewater discharge, none of which will be associated with radiation activities, will be much lower, probably on the order of 300 gallons per day, and will consist solely of domestic wastewater. This wastewater will be disposed of via septic system wastewater treatment systems such as cesspools. Electrical power use by the facility, including refrigerated containers used to store treated commodities, is forecast at approximately 1,200 kilowatt hours per day.

With one exception, all the water and electrical power lines that run past the three sites under consideration have adequate capacity to accommodate the proposed facility; it is expected that service to the facility will be from these sources. The exception is water service to Site C. There, a new 6-inch water main will need to be installed along Railroad Avenue between the site and the existing water main on Kukila Street.

An emergency electrical power generator will be provided onsite to ensure that power needed to maintain the minimum functions of the facility is available at all times.

2.5 DECOMMISSIONING

A decommissioning plan will be required of the operator as part of its contract with the state. The operator's property lease with the state will require implementation of the plan at the end of the facility's 3-year demonstration, or subsequent commercial activities. The contractor will be required to provide a bond or similar financial instrument to ensure that funds are available for decommissioning.

The decommissioning plan will call for the complete removal of all radioactive materials and demonstration that there is no residual contamination. Radioactive materials will be required to be returned to the fuel vendor. All wastes will be sent out of Hawaii. All decommissioning activities will be required to conform with applicable NRC, DOT, and other regulations. The property lease will specify the level to which the site must be cleared of nonradiation components of the facility (e.g., buildings).

2.6 SAFETY MEASURES

The proposed irradiation facility would incorporate extensive measures to avoid accidental release of radioactivity, detect radiation releases if they occur, warn operators of releases, reduce the consequences to people and the environment if a release occurs, and facilitate decontamination. These measures, most of which are required by NRC regulations, are discussed in CH2M Hill's *Feasibility Study for a Commodities Irradiation Facility in the State of Hawaii*. That discussion is summarized below. Further, Section 2.7 includes an outline of NRC's requirements for a "Radiation Protection Program."

- Personnel training. Irradiator operators would be trained in facility operation, emergency procedures, and health physics (radiation safety). Records of training must be maintained and retraining must occur at regular intervals or when procedures or equipment change. A Radiation Safety Officer would be trained and designated to manage monitoring, reporting, and emergency response activities.

- Personnel Monitoring. Each person who enters the irradiator portion of the facility would be provided with appropriate personnel monitoring equipment, designed to be worn or carried for measuring the dose received. Examples are film badges, ring dosimeters, pocket ionization chambers, and thermoluminescent dosimeters.

- Area Monitoring. Radiation detection instruments such as ionization chambers, Geiger counters, or scintillation-type counters would be used to measure the levels of radiation in and around the irradiation facility.

  Other locations that could have radiation monitors are normally exposed only to the background level of radiation and are designed to trigger some particular response should the radiation level rise above this level. One important example is the monitor of the storage pool water circulated through the deionizer, filter, and heat exchanger to ensure that water-born contamination does not occur. At any of these locations, a monitor would indicate source leakage if the radiation level should rise above background level. Air filters in the irradiation room exhaust system will be continuously monitored to immediately indicate a leak while the source is out of the storage pool. One other location that will be routinely and continuously monitored is the conveyor system at the exit from the irradiation chamber.

  A routine testing program for all monitors must be included in facility operating procedures to ensure continued reliability.

- Access Limitation. Access to the source, the machine, or the product conveyors is required for periodic maintenance. Methods to provide radiation safety during such access would be included in the overall operating plans.

  In addition to physical barriers such as shielded doors and maze systems, personnel are further protected from accidental exposure because the source is automatically lowered if a potentially disruptive condition is created. These conditions could include loss of power, opening of a cell door, entrance of personnel into the maze, conveyor failure, or loss of exhaust system. Electronic and mechanical interlocks to ensure that sources returned to a "safe" configuration would be used. Such devices are designed to be "fail safe"; that is, they would produce a "no entry" barrier if interlock fails. Fully functional interlock systems are crucial to safety; all interlocks will be subjected to a routine testing and recordation program to ensure that they are maintained in working order.

- Personnel Exposure. The probability of radiation exposure will be monitored and reduced by the use of radiation monitors, access limiting devices such as electrical interlocks, and shielded walls. However, emergency procedures must be prepared and emergency instruction given to operating personnel, local hospital staff, and civil defense teams. Personnel must be trained to respond to emergencies. Written procedures, including those for evacuation, would be available for use in the event of an indicated over-exposure of personnel, as discussed in Section 2.7.1, below.

Additionally, the U.S. Department of Commerce National Bureau of Standards has issued American National Standard N43.10, *Safe Design and Use of Panoramic, Wet Source Gamma Irradiators* (ANSI N43.10 - 1984). This standard is included in Appendix H. ANSI N43.10 establishes the criteria to be used in the proper design, fabrication, installation, use, and maintenance of irradiators to ensure radiation safety. It specifies testing procedures of equipment, radiation measurement, quality assurance and control, and specific safety features.

2.7 PERMITS, LICENSES, AND REGULATORY REQUIREMENTS

2.7.1 Nuclear Licensing

Regulations governing radiation protection and safety for the proposed irradiation facility are promulgated by the NRC. Licensing of the proposed irradiation facility will follow the regulations and procedures established by the *NRC Regulatory Guide* 10.9, and Title 10 of the *Code of Federal Regulations* (CFR). These regulations, which address both radiation safety (e.g., source integrity, design and operation of safety systems, and training of personnel) and licensing of the facility, are found primarily in the *Standards for Protection Against Radiation* (10 CFR Part 20) and *Rules of General Applicability to Domestic Licensing of Byproduct Materials* (10 CFR Part 30).

Standards for Protection Against Radiation (10 CFR Part 20) and *Rules of General Applicability to Domestic Licensing of Byproduct Materials* (10 CFR Part 30) regulate the facility and specify license requirements. It is the responsibility of DBED to ensure that the licensing information submitted demonstrates to the satisfaction of the NRC that new equipment or design concepts meet the standards set by the current regulations. Appendix H of this EIS includes NRC guidance on license application requirements.

Licensing will require that the following items be submitted to the NRC for review and approval:

- Engineering drawings and specifications.
- Detailed description of design and operation.
- Detailed description of the electrical system, including source instrumentation, safety interlock systems, warning lights, and alarms.
- Detailed description of how the source is adequately shielded in a safe position under emergency conditions, e.g., loss of electrical power.
- Detailed operating and emergency procedures.
- Radiation profile of irradiator in all operating modes.
- Detailed description of tests to be performed to establish the integrity of the irradiator and operation of the control system under normal and emergency conditions.
- Developed fabrication and testing quality assurance programs.

This licensing will occur once a site has been selected and plans prepared for the facility.

In addition to the above information, the applicant is required to supply a complete description of how the facility's safety systems conform with each regulatory requirement in paragraph 20.203 (c)(b) of 10 CFR Part 20.

After completing the above application procedures, the NRC requires applicants to develop and obtain NRC approval of a complete "Radiation Protection Program" which assures the safety of all employees. Such a program includes the following:

- Personnel monitoring equipment (Section 20.202, 10 CFR Part 20).
- Personnel training and procedures for responsibility.
- Decommissioning plans.
- Radiation detection instruments to evaluate the extent of radiation hazards that may be present and to comply with regulatory requirements (Paragraph 20.201 (b), 10 CFR, Part 20).
- Leak testing methods designed to determine whether or not a leak exists from any sealed sources; specifically for a wet source-storage irradiator with an ion exchange system to monitor the ion exchange resin filter bed at least once a week, or a continuous radiation monitoring device attached to the resin filter bed which sounds an alarm if any radioactivity is detected (Section 30.53, Tests, 10 CFR Part 30).
- Operations and emergency procedures which describe all steps to be taken in the event of an emergency or operation malfunction; such procedures must be provided to all plant personnel.
- Documented commitment with a local hospital which states that the hospital is equipped and willing to handle an individual admitted for treatment of radiation exposure.
- Waste management procedures as specified in the general requirements for disposal of licensed material (see Section 20.301 of CFR Part 20).

The facility's license must be obtained before source material is shipped to the site; it must be renewed every 5 years. NRC will inspect the facility a number of times each year. Some of these inspections will be unannounced.

2.7.2 FDA Requirements for Irradiation

Subsequent to FDA approval of irradiation of fruits and vegetables, the agency established a safeguard and regulatory protocol (21 CFR, Part 179). The protocol is summarized below. (See Appendix H of this EIS.)

- The fruit shall be irradiated within APHIS-approved shipping cartons.

- The absorbed dose must be at least 150 Gy for papaya.

- All treated and untreated fruit must be kept separate by a physical barrier such as a wall or chain-link fence 6 or more feet high to prevent the accidental transfer of cartons between untreated and treated parts of the facility, to ensure that produce is treated once and only once.

- The facility must operate a fail-safe automatic system to transport the fruit through the irradiation process.

- Accurate treatment records or invoices for each treated lot must be kept at least 1 year and made available at all times for inspection, to verify that the fruit has received the requisite dosage; such records are important since no chemical or physical test currently exists to determine how much radiation a food has received.

- Treatment methods and operations must be in compliance with all proposed regulations by APHIS as outlined in Section 318.13-4(d) of 7 CFR Part 318.

- Inspectors must be notified prior to each treatment to allow for monitoring which will include examination of treatment records and unannounced visits.

- All treated fruit mus* be packaged in sealed cartons with no openings which would allow the entry of fruit flies, and with visible seals that show if a carton has been opened.

- Each container of treated fruit must be stamped "Treated - United States Department of Agriculture (USDA), APHIS"; the label must measure at least 1.5 x 2.5 inches.

In addition, FDA currently requires that irradiated fruit be labeled in an approved manner. (See Appendix H for labeling requirements). Requirements have been extended beyond the 1988 deadline discussed in Appendix H to April 18, 1990.

2.7.3 Other Permits

The following state and county reviews and approvals will be required to construct the proposed irradiation facility:

State Permits

- Historic Sites Chapter 6E Review
- Registration of irradiation process with Department of Health
- Air emissions permit

County of Hawaii Permits

- Grubbing, Grading, Excavation, and Stockpiling Permit
- Building Permit
- Department of Planning Plan Review
- Sign Permit (if sign to be erected)
- Septic system permit

Additionally, the plant operator would be governed by its contract with DBED during the 3-year demonstration period and by its lease with the appropriate land management agency (DLNR, DOT, or DHHL) during the life of the facility. To ensure compliance with environmental requirements, DBED intends to include the mitigation measures identified in this EIS as conditions of both the contract and lease.

2.8 USE OF PUBLIC LANDS AND FUNDS

As previously mentioned, construction of the proposed project as described herein will require the use of state-owned or managed land on one of the three alternative sites identified above.

State and federal money will be used to plan, design, construct, and operate the project during the 3-year demonstration period. The U.S. Department of Energy will provide up to $4 million for construction and operation during the 3-year demonstration as part of a congressionally-mandated irradiation demonstration project; $1.2 million has been appropriated by the State of Hawaii legislature. These funds will be utilized for the feasibility study, EIS preparation, design, operation, and other elements of the facility.

SECTION 3
OTHER ALTERNATIVES

3.1 INTRODUCTION

Pursuant to Chapter 200 of Title II, of Environmental Impact Statement Rules, the DBED, acting as lead agency for preparing this EIS, has the responsibility to provide the decision makers and the public an "objective evaluation of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid or reduce some or all of the adverse environmental effects. The EIS rules require that "benefits, costs, and risks be included in the agency review process in order not to prematurely foreclose options which might enhance environmental quality or have less detrimental effects." Section 4 of this EIS provides an extensive analysis of three alternative sites on which the proposed irradiator project could be located.

This section describes and evaluates other alternatives that were considered in project and EIS development. In general, the range of feasible alternatives considered has been limited to those that would meet the objectives and provide the same type of service and features as the proposed action at an equivalent cost and with similar efficiencies. However, to ensure that no product disinfestation alternative has been prematurely dropped from consideration, certain alternatives that do not meet the objectives of the proposed project and that do not meet the legislative intent of the proposed project have also been evaluated. The alternatives evaluated have included alternative plant locations, other irradiation technologies, non-irradiation disinfestation methods, and the no-project alternative.

The following subsections describe these other alternatives, discuss their feasibility and the ability to meet the project objectives (as identified in Section 2), and compare their environmental effects relative to those associated with the three primary project alternative sites. Appendix J contains information about some of the alternative treatment methods.

3.2 OTHER LOCATIONS

As discussed in Section 1, DBED explored the possibility of locating the irradiation facility in other locations throughout the State of Hawaii (see CH2M Hill 1987). The DBED's study concluded that only locations in Honolulu or the Hilo area are feasible, given the logistics of the papaya industry as discussed in Section 2.3. Upon further review, DBED concluded that a location in Honolulu, i.e., away from the packing industry, did not sufficiently meet the demonstration and technology transfer objectives of the project, and could pose excessive costs to the fruit industry because fruit containers would have to be unloaded and loaded one extra time in Honolulu. In addition, property costs are generally higher in Honolulu than Hilo; thus project development would likely be more costly.

A Honolulu location would have essentially the same environmental effects as those associated with the three primary alternatives. Because this alternative: (1) fails to completely meet project objectives; (2) would have additional costs to industry and possibly the state; (3) and provides no environmental benefit, a Honolulu location alternative is not considered reasonable.

3.3 OTHER IRRADIATION TECHNOLOGIES

Other irradiation technologies would meet the demonstration objectives. Although DBED's initial proposal to the U.S. DOE provided for the use of cesium-137, the Hawaii State Legislature specified that its appropriated money be used only for an irradiator using cobalt-60. Thus the use of other irradiation technologies is currently inconsistent with the legislature's objectives and is not possible under existing legislative approvals. Nonetheless, a brief review of other irradiation technologies provides a useful perspective on the project.

3.3.1 Cesium-137

Cesium-137 is a by-product of nuclear reactor operation and is a gamma ray source which may be used in place of cobalt-60. The physical plant and associated factors would be essentially the same as the proposed facility. It is slightly, but not significantly, less costly to use cesium-137 than to use cobalt-60 as a source. This is because, although most transport, handling, permitting, and operational costs are similar, the costs for original source material and required shielding are less.

Most of the environmental issues associated with the use of cesium-137 are the same as those for the proposed facility; however, there are some differences. Cesium-137 has a half life of 30 years; this is longer than the 5.2 years associated with cobalt-60. Cesium chloride, the compound which contains the isotope cesium-137, is a solid, but is water soluble. If water-borne cesium-137 escaped containment, it would be difficult to clean up and could migrate downward to contaminate any accessible aquifer. Thus, environmental consequences in the event of an accident would be relatively greater. The Hawaii State Legislature has mandated that cesium-137 not be considered for use in the Hawaii Commodities Irradiation Facility for this reason. Similar environmental risks related to the solubility of cesium-137 are associated with ocean transport; however, DOT, NRC, and state transport regulations minimize this risk to a large degree.

Because cesium-137 use is prohibited by legislative mandate, and its environmental impacts are potentially greater in the event of an accidental release, cesium-137 is not considered a reasonable alternative to cobalt-60 and will not be considered by DBED as a source material.

3.3.2 Machine Source Irradiators

Electric-powered machine sources can generate radiation by using an electron beam accelerator. Electron beams have essentially the same disinfestation capabilities as gamma rays (i.e., photons). High energy electron beams are used directly for irradiation processing by focusing and scanning the beam over a distinct target. Alternatively, the electron beam can be directed onto an x-ray converter plate to generate high energy x-rays, which also can be used to irradiate commodities.

An x-ray source produced with an electron accelerator contains a broad-band photon spectrum covering the entire photon energy range permitted by the FDA. By proper filtering, the spectrum can be adjusted within this range to provide a more penetrating radiation than is possible with any isotope source available for food processing. In addition, the forward scattering of the produced radiation results in a lower radiation field divergence and a more efficient photon usage. The two effects of greater penetration and lower divergence combine to produce good dose uniformity in thick packages of food that is unattainable with unconverted electron beams. The low energy conversion rate, however, makes this method energy intensive.

The viability of a machine source was investigated by DBED. Correspondence with staff at Lawrence Livermore Laboratory (developer of a machine source) is included in

Appendix J. While machine source irradiators might eventually be developed to the point where they are suitable for treating the target commodities, they are not currently available in a size or configuration suitable for commercial processing operations of the type planned in Hawaii. Establishing an appropriately-sized machine radiation source is costly, $2 to 3 million more than the cobalt irradiator. Such development would also add 1 to 2 years to the project development schedule. Because of these factors, Lawrence Livermore Laboratory recommends that Hawaii proceed with the cobalt-60 source (see January 25, 1988, letter from Stephen Matthews, in Appendix J).

Because of the untried nature of a commercial-size machine source, reliability is unproven. Expensive spare parts would have to be kept on hand to allow continued operation in the event of breakdown.

The environmental benefit of this alternative is that transportation, handling, and storage activities are not subject to the risks associated with isotope radiation sources. It relies on the use of a radiation source that does not have residual radioactivity and, therefore, requires shielding only while in operation. There is a risk of exposure to radiation only while the machine is operating. Other effects would be the same as those associated with the primary alternative, although the facility would use significantly more electricity, which may have an adverse impact associated with the current local need for additional power generation.

Machine sources would meet the project's objectives and would avoid risks associated with isotope sources. However, lack of the commercially-sized machine required for the demonstration program results in excessively high cost, delay, and uncertainty of outcome. Thus, this alternative is not considered practical at this time. Retrofit of the cobalt-60 facility may be appropriate for consideration in the future if a commercially-viable machine source is developed, although modifications to the facility would be required to provide the higher level of shielding required because of the machine source's higher energy levels. These modifications would require additional expenditure of funds.

3.4 NON-IRRADIATION TECHNOLOGIES

The following alternatives would, by definition, fail to achieve the proposed project's objective as a demonstration and test of irradiation treatment. Additionally, these alternatives would not allow for achievement of the development research objectives of DBED, the University, and others that are associated with nondisinfestation use of irradiation. Nonetheless, because they may meet one of the broader objectives at which irradiation is aimed, i.e., control of fruit fly infestation, they are discussed below. All of these alternatives would avoid the risks associated with the use of a radionuclide.

3.4.1 Double-hot-water-dip Treatment

The double-hot-water dip method is currently used for the majority of the papayas grown for export, and has proven moderately successful in preventing infested fruit from reaching the mainland. The method consists of treating the fruit with two hot water baths to kill fruit flies. The fruit must be picked at about one-quarter ripe and then placed in the first water bath at a temperature of 42°C (108°F) for 30 minutes to acclimate the fruit to heat. The fruit is then placed in a second bath, with temperatures of 48.9°C (120°F) for 20 minutes to kill fruit fly eggs and larvae.

While this alternative has been generally successful in meeting APHIS quarantine requirements, it is not always effective. For example, federal officials temporarily suspended shipment of double-dip treated Hawaii papayas shipped to California after discovery in Hilo in April 1987 of a batch of fruit-fly infested fruit. This discovery in Hilo followed an early March 1987 discovery by California inspectors of infested papayas from Hawaii. This lack of efficacy apparently occurs because the method is not effective against larvae laid in the navels of some fruit (University of Hawaii - Moy consultation). Additionally, this method is relatively labor-intensive and requires difficult and time-consuming evaluation of ripeness. (Fruit over one-quarter ripe cannot be effectively or legally treated by this method.) Finally, this method of treatment may cause fruit to ripen improperly and often results in fruit with lumps, mottling, and hard shells; as such, the fruit is of marginal quality and less marketable than it would be if it were in an undamaged state (Amfac-Wallis consultation).

As stated in the introduction to Section 3.4, this alternative would not introduce the potential for any radiological effects. However, because of its inability to meet project objectives, its limited efficacy, and its negative effect on product quality, double-hot-water dip is not a reasonable alternative.

3.4.2 Vapor-heat Treatment

The use of vapor heat for the disinfestation of tropical fruits has been approved by both the United States and Japan. The exact procedures used are not fully known at this time due to the proprietary nature of the current system in use. Generally, the fruit is picked at about one-quarter ripe and then brought up to a temperature of 47°C (117°F) over a period of 5 to 6 hours by the condensation of water vapor in a saturated atmosphere. The gradual heating allows for temperature equilibrium and deep heat penetration throughout the fruit to kill both fruit fly eggs which are within 2 to 5 millimeters of the fruit surface, and the larvae which penetrate deeper into the flesh of the fruit (Couey, in CH2M Hill 1987).

While this alternative is successful in controlling infestation, it is significantly more costly than the double-dip method and is generally regarded as being more costly than irradiation (CH2M Hill 1987). The process is carried out by the batch method, making it labor-intensive. The process is energy-intensive because gradual heating requires long treatment times; the initial capital investment is also substantial. Further disadvantages of this process include the vulnerability of papayas to heat, and therefore an increased chance for lumpiness and injury to the fruit. Vapor heat is currently being conducted by Diamond Head Papaya Company and Hawaiian Host, who export papaya to Japan, where high demand allows recovery of this technology's apparent high cost. Current regulations permit vapor-heat-treated fruit to be exported to the mainland, but because of the cost, vapor heat has not been readily utilized by the current packing operations.

3.4.3 Dry-heat Treatment

Unlike the previous alternatives, which are in commercial use or in late stages of testing, the dry-heat treatment process is still in the experimental stage of development. It involves slowly raising the internal temperature of the fruit to 47°C (117°F) over a period of about 7 hours, allowing the fruit to remain at that temperature for about one-half hour at about 50 to 60% humidity, and then quenching the fruit to a temperature below 30°C (86°F). Preliminary studies by the Agricultural Research Service (ARS) of the USDA have demonstrated that papayas would tolerate temperatures beyond the thermal death-point for fruit flies by using dry heat alone. ARS research indicates that this method may be superior to the double-dip and vapor-heat processes because both egg and larval stages are killed with this treatment and because papayas may not be damaged by the dry heat to the extent they are by wet heat. Preliminary study also indicates that dry-heat treatment may be applied to other commodities including mangoes and lychees, two other fruits being considered for treatment at the proposed irradiation facility.

This alternative would avoid the risks of radiation but would not meet the project's demonstration objectives. Dry-heat treatment has not yet been commercially proven. Some tests have shown that treatment periods of up to 7 hours were required to sufficiently treat the fruit. Treatment periods of this length are considered impractical by the packing industry. Additionally, research is required to determine the level of damage to fruit that may occur from this process, since the process involves heating the fruit. Finally, the dry-heat-treatment method is conducted as a batch process which is not generally as efficient as the continuous treatment process proposed with the irradiator.

Approval by APHIS has been tentatively granted for dry-heat treatment although the APHIS rulemaking procedure is not completed; however, no packer is using this method commercially. Until additional studies designed to test the efficacy of the treatment method, its cost, its effect on fruit quality, and its applicability to large-scale throughput are completed, dry-heat treatment cannot be considered a proven alternative to either current treatment methods or irradiation. Such studies may ultimately show that dry heat can be a viable commercial treatment process.

3.4.4 Chemical Treatment

Methyl bromide (MBr) has been approved as a fumigant for citrus fruits, but the resulting fruit quality is not consistent since tolerance to MBr fumigation varies by crop and temperature at which the product is treated. Severe damage to fruit has occurred when the fumigant was used at ambient temperatures; thus, higher temperatures are required for treatment. The ARS is studying the efficacy of using MBr as a fumigant for papaya. Preliminary research has shown the treatment to be effective against the fruit fly eggs, but not against the larvae which are found deep within riper papaya. Therefore, some fruit selection based on maturity would be necessary with MBr fumigation. Potentially significant environmental and worker exposure hazards are associated with chamber leakage and exhausting of the gas following fumigation. Such hazards are important since MBr is currently under investigation by the U.S. EPA as a possible carcinogen. The cost of employing MBr fumigation would be similar to that associated with the use of EDB; therefore, it is economically viable.

The USDA has performed tests which indicate that the combined use of fumigation and hot-water dips may be efficient for treatment of certain fruits. However, even though the lower temperature and shorter treatment time of the hot-water dip reduces damage to the fruit as compared to either method used alone, many tropical fruits would still be vulnerable to the lower dosage of MBr fumigant. Therefore, this combined method would only be realistic for those commodities that can tolerate MBr fumigation. Environmental and economic issues for the combined treatment method would be similar to those of MBr fumigation.

Other fumigants used for treatment of food commodities include aluminum and magnesium phosphides, hydrogen cyanide, ethylene oxide, and carbon disulfide. Environmental impacts would be similar to those of fumigation using MBr. Use of chemical treatment methods for tropical fruits is not a reasonable alternative because of damage to the fruit, limited efficacy, difficulty in handling, and most importantly, high environmental and human risk.

3.4.5 Insect Eradication

One possible alternative for the control of agricultural pests is to eliminate the species entirely in an area. This method can be carried out in a number of ways. One is to use a sterile insect technique which releases sterile male flies into the pest population. Another method is to use malathion bait sprays to suppress fly populations in extremely high fruit fly density areas. Eradication efforts can also be carried out by releasing substantial numbers of species-specific parasites or predatory species into the Hawaii environment to suppress the fruit fly populations. All of these methods must reduce the number of fruit flies to an undetectable level to be commercially effective.

Laboratory experiments have shown that chemical treatment with methoprene can prevent the pupae of Hawaiian fruit flies from reaching the adult stage, thus making them unable to reproduce. The disadvantage of this method is that methoprene affects the physiological state of the pest, but does not kill the larvae or the fruit fly eggs. Furthermore, this type of treatment does not provide for Probit 9 quarantine security as required by the APHIS.

Finally, although the method has been registered for a number of uses since 1985, it has not yet been approved for use on fresh fruits.

APHIS prepared a Draft EIS on the eradication of fruit flies in Hawaii, although a Final EIS was never published (USDA APHIS 1986). The EIS concluded that this alternative has potentially significant environmental effects, such as risk of human exposure to pesticides, destruction of nontarget species, and potential occupation of the fruit flies' ecological niche by other pest species. These environmental effects, plus the potential inability to meet quarantine objectives, make this alternative unreasonable.

3.4.6 Refrigeration

The alternative of refrigerating papaya for disinfestation purposes involves submitting one-quarter ripe fruit to temperatures of 0 - 2°C for 10 - 22 days. Its disadvantages are: papaya (and other tropical fruits) are very sensitive to the low temperatures required; the shelf life of some fruits is not long enough to withstand the length of treatment; the process itself is energy-intensive and thus expensive; and it is difficult to reliably maintain necessary low temperatures and high humidity. Further, the method has not been approved for disinfestation treatment for Hawaiian papaya. This alternative is currently not feasible.

3.4.7 No-project Alternative

The no-project alternative involves foregoing state involvement in the U.S. DOE irradiation program and leaving treatment in the hands of the packers. The three sites under consideration for the proposed project would remain vacant or otherwise be developed in accordance with land use designations described in the Hawaii County General Plan or the Airport Master Plan for Hilo Airport. Current treatment methods for papaya, vapor-heat and double-dip methods, would remain as the primary techniques to meet disinfestation quarantine requirements. Environmental effects potentially resulting from implementation of the proposed project, as discussed in Section 4, would not occur if the no-project alternative is adopted. However, potential benefits to the papaya industry and for the development of other agricultural crops in need of an effective disinfestation method and the potential to provide higher quality tropical produce for market supplies, will be foregone under this option.

3.5 Comparative Evaluation

In general, none of these other alternatives to fruit irradiation meets the project objectives to the same degree as the proposed project. Although some of the alternatives could result in greater or fewer potential adverse environmental impacts, none of the alternatives offers the opportunity to address the outstanding questions regarding the viability of irradiation treatment as a disinfestation method. Similarly, none of the alternatives appear to offer superior economic benefits either in the short or long term. Table 3-1 summarizes general conclusions about the various project alternatives.

The no-project alternative would not meet the project objectives and would continue the present potentially unacceptable treatment method. The preferred alternatives satisfy the project objectives and provide the best opportunity to assist in meeting the state's goals and objectives to aid and encourage diversified agriculture and increased marketing of Hawaii's fresh fruit crops.

Table 3-1

SUMMARY OF ALTERNATIVES

Alternative	Meets Demonstration Objectives	Could Meet Disinfestation Needs	Commercially Proven	APHIS Approved	Operationally Practical	Cost Relative to Cobalt-60	Relative Potential Environmental Effects
Irradiation at Other Locations	Yes	Yes	Yes	Yes	No	Potentially higher	Same as proposed alternatives.
Cesium-137	No (legislatively prohibited)	Yes	Yes	Yes	Yes	Slightly lower	Greater potential effect if source shielding were to fail.
Machine Source	Yes	Yes	No	Would require protocol changes	Probably	High	No radiation risks when not in operation.
Double-hot-water Dip	No	Generally yes	Yes	Yes	Yes	Lower	Essentially no significant effect.
Vapor Heat	No	Yes	Yes	Yes	Yes	Higher	Essentially no significant effect.
Dry Heat	No	Yes	No	Pending	Yes	Unknown	Essentially no significant effect.
Chemical	No	Yes	Yes	Yes	Yes	Lower?	Possible effects associated with use of toxic chemicals.
Insect Eradication	No	Maybe	No	No	No	High	Ecological impacts.
Refrigeration	No	Maybe	No	No	No	Possibly higher	Essentially no significant effect.

SECTION 4
EXISTING CONDITIONS, IMPACTS, AND MITIGATION MEASURES

4.1 INTRODUCTION

The environmental setting and impacts of the proposed project are discussed in this section. The analysis presented here not only focuses on the probable significant effects of the project but also covers the full range of potential concerns, to demonstrate the comprehensive nature of the analysis that has been conducted. Consequently, both minor and potentially significant effects are discussed.

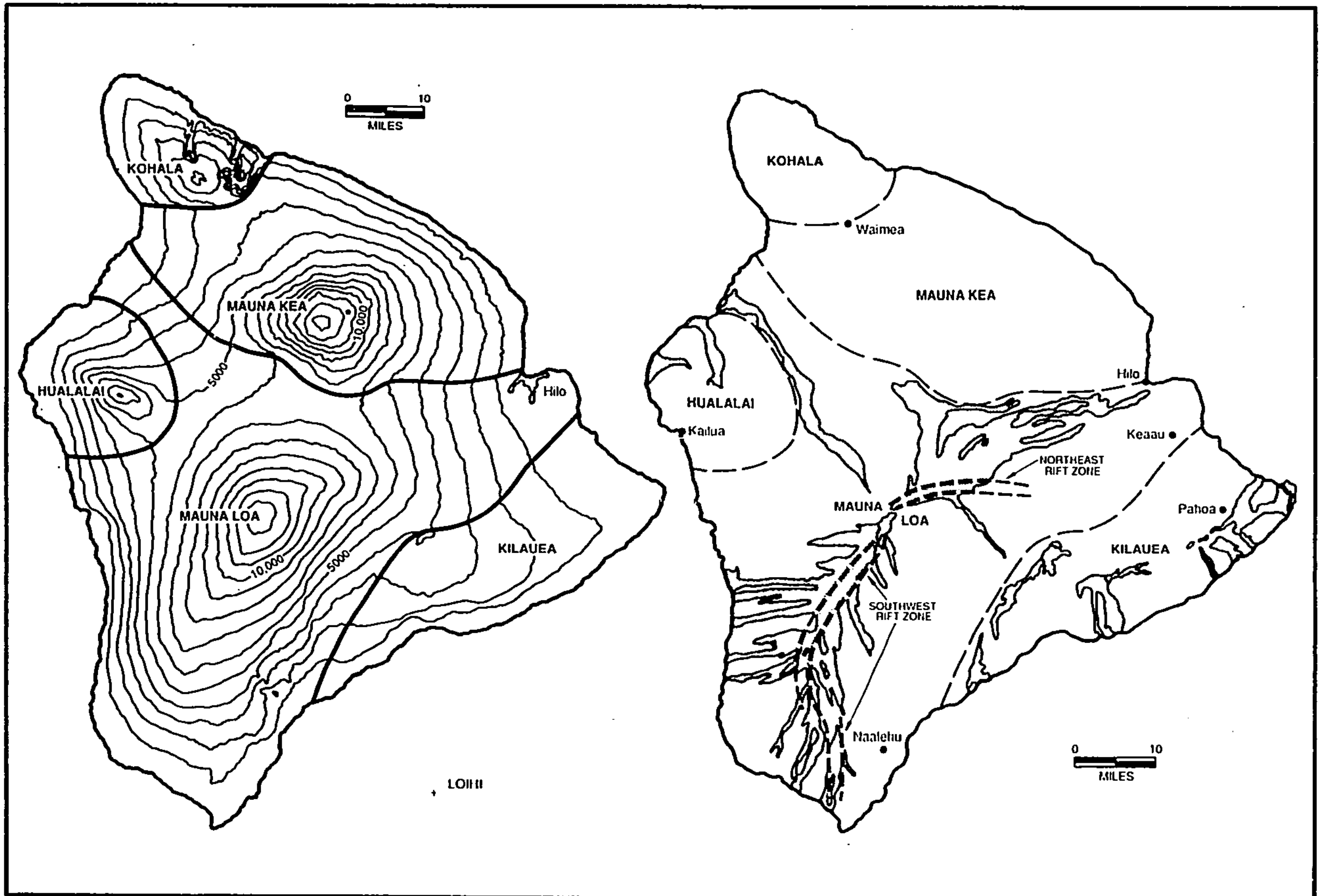
Where it is either necessary or appropriate, measures to reduce or avoid an adverse project effect are suggested for adoption. If mitigation does not appear necessary, this conclusion is so stated.

4.2 GEOLOGY

4.2.1 Geological Setting

The Island of Hawaii, the youngest in the Hawaiian chain, is composed of five large shield volcanoes. Two of these, Mauna Loa and Kilauea, are still in the shield-building stage. Two others, Mauna Kea and Hualalai, are in a later stage of development characterized by much less frequent, but more explosive, eruptions. Kohala Volcano, the oldest of the five, is considered extinct. The town of Hilo is located on flows from Mauna Loa near the boundary between Mauna Loa and Mauna Kea volcanoes (Figure 4-1).

Lockwood and Lipman (1987) have prepared an in-depth analysis of lava flows from Mauna Loa that is extremely useful in assessing the risk to the proposed facilities from lava flows. Mullineaux et al. (1987) have prepared a comprehensive, but less detailed, analysis of other risks associated with volcanic activity on the Island of Hawaii. Their report evaluates direct volcanic hazards from tephra falls, lava flows, pyroclastic surges, and volcanic gases, as well as from a number of indirect hazards such as earthquakes, ground subsidence, and earth cracks.



Location and Topography of the Five Volcanoes that Form the Island of Hawaii.
(Stippled Areas Indicate Pre-1975 Historical and Prehistorical Lava Flow.)

FIGURE 4-1

WESTEC Services, Inc.

The remainder of Section 4.2 summarizes the information that is available from these and other sources; it then uses that information to assess the potential risks to the proposed facility. The threat from lava flows, which constitutes the greatest of any threat to Hilo, is evaluated first and in greatest detail.

4.2.2 Risk from Lava Flows

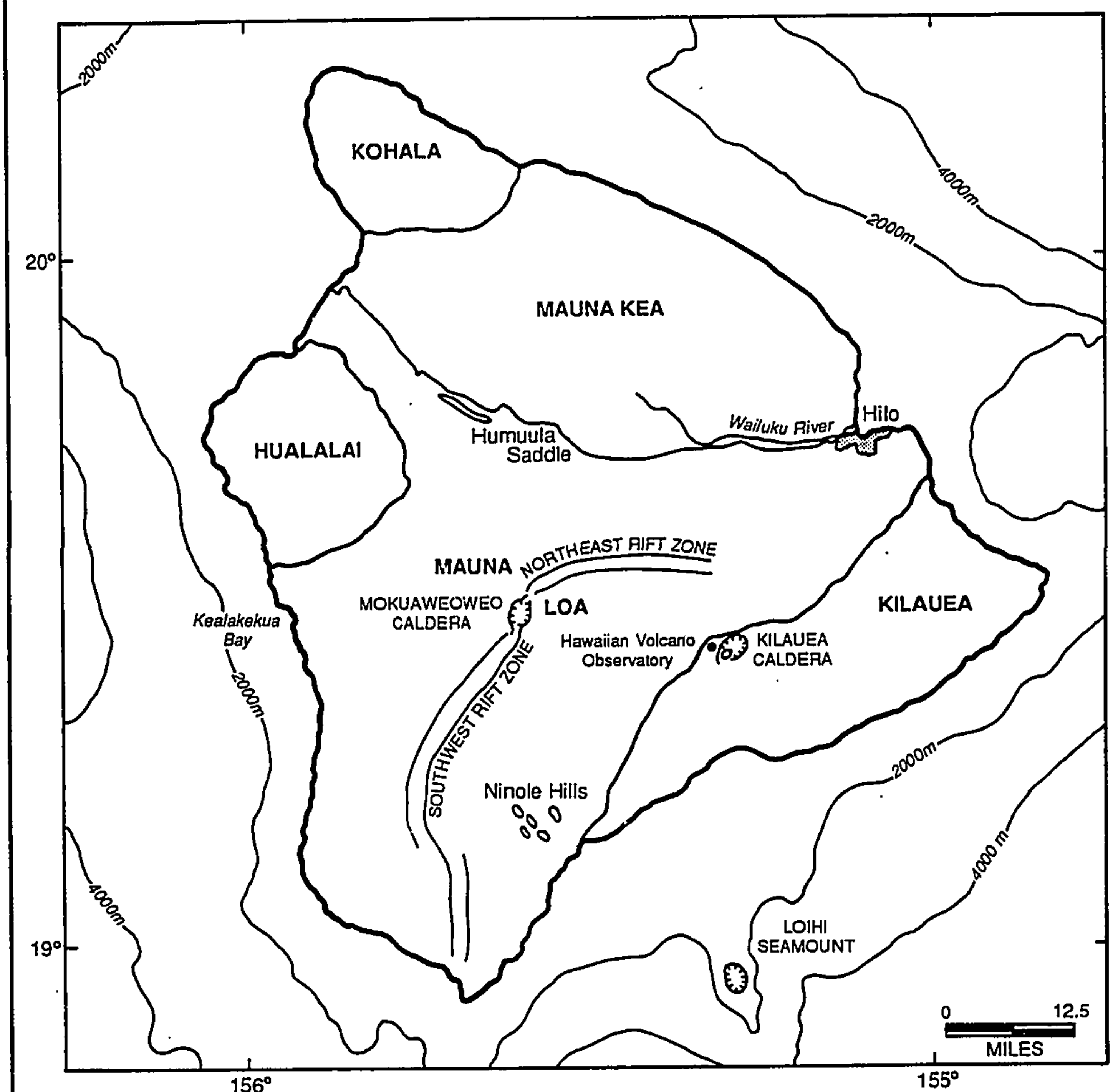
4.2.2.1 Overview

Mokuaweoweo, a 2-mile by 3-mile wide collapsed caldera, is located at the summit of Mauna Loa. Two rift zones extend from the summit; they are known as the Southeast Rift Zone (SERZ) and the Northeast Rift Zone (NERZ) (Figure 4-2). It is flows from the NERZ that constitute a threat to the Hilo area.

Only 30 miles of the NERZ are exposed; historical activity (i.e., volcanic activity that has occurred since comprehensive written records began in 1843) has been limited to the uppermost 40 percent of its length. The eruptions that have occurred during historical times can be divided into summit eruptions, which are restricted to the immediate vicinity of Mokuaweoweo, and flank eruptions, which begin with activity at the summit but release most of their lava from lower-elevation vents along the rift zone. It is flank eruptions that are of concern in Hilo, which is located over 35 miles from the caldera.

4.2.2.2 Volcanic Activity Since 1843

Lockwood and Lipman (1987:511) calculate that 14 percent of the mapped area of Mauna Loa (12.5 percent of the mountain's total area) is covered by flows that have originated since 1843. This is equal to a coverage rate of approximately 9 percent per century. However, they note that the activity was significantly greater before 1860 than it has been more recently. For example, they calculate the rate of land coverage by fresh lava flows between 1843 and 1859 at about 17 percent per century, while the average rate of coverage since 1859 is calculated at about 7 percent per century.



Island of Hawaii, the Five Volcanoes, Major Structural and Geographic Features, and Bathymetry of Adjacent Sea.

FIGURE 4-2

Calculations of the volume of lava that is being erupted from Mauna Loa also indicate a significant decrease in activity when the 1843 to 1877 period is compared with 1877-1984 (47 million cubic yards per year versus 21 million cubic yards per year). The change in eruptive volume coincides with a major shift in the minor element composition of the lavas; Lockwood and Lipman hypothesize that these changes in the rate and composition of the eruptions may be related to the magnitude 7.5 earthquake of 1868.

Since 1843, virtually all of Mauna Loa's eruptions have begun with activity in or near Mokuaweoweo; hence, volcanic activity is most frequent near its summit (Klein 1982). The duration of individual eruptions has ranged from 1 day to 4-1/2 years of almost continual activity between 1872 and 1877. Eruptions along the NERZ have been substantially longer, on average, than those from the SERZ (117 days versus 16 days).

4.2.2.3 Eruptive Activity Before 1843

Establishing eruptive patterns for the period before 1843 is more difficult. Lockwood and Lipman (1987:512) report that 466 surface lava flows have been recognized to date on Mauna Loa. They divide these into five age groups based on the degree of weathering and available radiocarbon dating:

Group	Age Range	No. of Flows	Avg. Flows/ 100 years	% NERZ Surface Total	% NERZ Surface Sea Level
Historical	1843 A.D. - 1984	22	15	18	7
Group IV	1250 A.D. - 1843 A.D.	74	12	17	3
Group III	500 A.D. - 1250 A.D.	117	16	17	29
Group II	4000 B.C. - 500 A.D.	147	6	19	28
Group I	Before 4000 B.C.	106	3	22	33
Ash		—		7	0
	TOTAL	466		100	100

They also note that caution must be used in interpreting this data, which is based almost entirely on the rocks exposed on the surface of the land. Potential sources of error include:

- The possibility that several small, unweathered flows high on Mauna Loa that might actually have occurred during historical times were counted as Group IV flows because they could not be specifically identified.

- Geographically extensive flows that occurred during historic times were counted as one eruption because witnesses could prove that they were from the same source; if they had occurred during the prehistoric period and been preserved as widely separated remnants around the periphery of younger flows, they would likely have been counted as several separate flows.

- An historic period eruption which produced flows from multiple vents was counted only once, whereas the same eruption might have been counted as several events if it was from the Group IV time period.

Lockwood and Lipman conclude that, when all factors are considered, the relatively high frequency of Group II flows (i.e., originating between 500 and 1250 A.D.) seems to indicate that Mauna Loa was more active during that period than it has been in more recent years.

4.2.2.4 Location of Lava Flows

Lockwood and Lipman (1987:512) estimate that approximately 90 percent of Mauna Loa's surface is covered with flows that have originated within the past 4,000 years. Extrapolating average coverage rates to earlier times, they suggest that approximately 98 percent of the volcano's surface has been buried at least once during the past 10,000 years.

Vents on Mauna Loa are most numerous between 8,200 and 11,500 feet above sea level. In the NERZ they are typically 20 miles or more from the ocean; relatively few of the lava flows which they produce reach the shoreline. Nonetheless, with Kilauea Volcano to the south and Mauna Kea to the north, the topography is such that many of the rift zone eruptions on this flank of the mountain do have the potential to send streams of lava in the general direction of Hilo.

The four historical flows which have approached Hilo most closely (in 1852, 1855, 1881, and 1942) originated from radial vents at elevations ranging from 8,200 to 10,200 feet above sea level. Two of the four flows (1852 and 1942) stopped at an elevation of 2,600 feet. The 1855 flow extended to the top of Ponahawai Homesteads (about 1,500 feet above sea level). The 1881 flow was the most threatening to Hilo. From the Kaumana area seaward, it followed a route just south of the existing Saddle Road, stopping near the *mauka* side of what is now the University of Hawaii's Hilo campus. This terminus is 150 feet above sea level, 2,500 feet from sites A and B and 3,500 feet from Site C.

The rate at which lava flows advance varies as a function of the temperature and composition of the lava, the rate of discharge from the vent(s), and the topography. Values typically observed range from a few tens of feet per day for flows that are far from the vent and fed only by lava already in the vent system to several thousand feet per day for flows close to an active vent. Because of the great distance between the vents that have been active during the past 10,000 years and Hilo town (nearly 25 miles), an irradiator located there would have at least several weeks advance warning of approaching flows.

4.2.2.5 Risk to Irradiator from Lava Flows

The lava flow age-distribution maps developed by Lockwood and Lipman (1987:319 for generalized version) indicate that Sites A and B are on Group II flows (i.e., flows between 1,500 and 4,000 years old) and Site C is on a Group III flow (750 to 1,500 years old). This is consistent with Site C's slightly greater proximity to the rift zone, but it should <u>not</u> be taken to mean that there is a significant difference in the probability that they would be overrun by lava in the future.

Lockwood and Lipman (1987:523) have conducted a regional analysis of the relationship between ground elevation and the area covered by flows in each of their five age groupings. Their analysis showed that only 10 percent of the area below 500 meters (1,640 feet) in the NERZ has been buried by lava during the past 1,250 years, and the risk tends to be even less than this average at the sites under consideration for the irradiator, due to topography and geography.

It is difficult to convert the data assembled by Lockwood and Lipman into an estimate of the probability that lava would overrun the commodities irradiation facility some time during its expected 30-year useful life (assuming continued operation beyond the 3-year demonstration period). The changing eruptive pattern of the volcano; the fact that the available data consists only of flows that are still exposed at the surface; the strong, but unpredictable, effect of local variations in topography; and a host of other factors complicate the analysis and make it impossible to achieve great precision. Because of this, the problem of quantification was approached in three different ways; estimates resulting from each approach are presented below.

1. One approach utilizes the data in Figure 18.12 of Lockwood and Lipman (1987), relating percent lava coverage by time period to elevation. That figure shows that approximately 40 percent of the land area below an elevation of 1,640 feet (500 meters) is covered by lava which is less than 1,500 years old. A probability of 1 in 1,500 years is equivalent to 0.02666 percent per year. Hence, the probability that a site in this elevation zone will be overrun in 30 years can be calculated as follows:

   $$1.0 - 0.0002666 = 0.9997333$$
   $$(0.9997333)^{30} = 0.9920308$$
   $$1.0 - 0.9920308 = 0.007969$$
   $$0.007969 \times 100 = 0.7969\%$$
   Say 0.8%

2. A second calculation of the risk of the site being overrun by a lava flow was made using the portion of Figure 12.2 in Lockwood and Lipman (1987:523) that graphically portrays the geographic distribution of lavas of different ages. It indicates the following age distribution of lavas that have reached the NERZ shoreline:

Age of Lava	% of Shoreline Covered	Probability of Coverage in 30 years
0 to 750 years	0	0.0%
750 to 1500 years	70	1.39066%
1500 to 4000 years	15	0.11244%
4000 to 10,000 years	15	0.04499%
		1.54089%
		Say 1.5%

3. The final approach incorporates assumptions which probably tend to overstate the probability that a lava flow will cover the site within the irradiator's 30-year lifetime. It is based on the data presented in Figure 18.2 of Lockwood and Lipman's paper and the questionable assumption that this is indicative of future

risk (1987:519) which shows that Sites A and B were most recently overrun between 750 and 1,500 years ago. Assuming the midpoint of that range gives a 1 in 1,125 chance of being overrun in one year, or a 2.6 percent chance during the 30-year lifetime of the facility. Site C was last overrun between 1,500 and 4,000 years ago, and a similar calculation for that site places the probability of it being overrun during the 30-year life of the irradiator at 1.08 percent.

All of these calculations necessarily incorporate assumptions which may, or may not, prove accurate. Nonetheless, the fact that they are all of the same order of magnitude suggests that they provide a reasonable approximation of the actual level of risk. If so, there is probably a 1-in-50 to 1-in-100 chance that an irradiator in Hilo might be overrun during the project's lifetime. Unmitigated, such overrun could damage the irradiation facility.

4.2.3 Other Volcanic Risks

4.2.3.1 Risk from Tephra Falls

Tephra consists of volcanic ash and coarser fragments. In Hawaii it is produced most frequently by lava fountains, but can also be formed by explosive magmatic eruptions and steam blast explosions. Tephra can seriously affect vegetation and manmade structures and machinery, burying, burning, or abrading them. Ash can also smother vegetation.

During historic times, tephra falls in excess of 15 centimeters have occurred only within 2 kilometers of active vents. All of the irradiator sites are 30 kilometers or more from the nearest active vents. Mullineaux et al. (1987) have placed the areas being evaluated for the food irradiator at the outer fringe of Tephra Hazard Zone 2. Therefore, based on local historical findings, the risk to the proposed facility from possible lava fountaining is considered slight. No significant impact is expected to occur.

4.2.3.2 Risk from Pyroclastic Surges

Some explosive eruptions produce pyroclastic surges. These are clouds of ash, rock fragments, and heated gases that move outward at high speed from the source vent. Although pyroclastic surges tend to move along the ground surface, they may or may not follow topographic depressions. While such surges represent a severe hazard when they do occur, they are much less frequent than lava flows.

Mullineaux et al. (1987) conclude that the only evidence of pyroclastic surges that has been found on the Island of Hawaii is immediately adjacent to Kilauea's caldera. While they note that such surges could conceivably be produced at other locations where ground or seawater can interact with magma, there is no evidence that such activity constitutes a measurable threat anywhere in Hilo.

4.2.3.3 Indirect Volcanic Hazards

Ground fractures, subsidence, and earthquakes can occur together as a result of the movement of magma within volcanos. Most fractures in Hawaii result from lava movement, subsidence of landslide blocks, or earthquake shaking. The two largest earthquakes to affect the island during historical times occurred in 1868 and 1975. They had magnitudes greater than 7, and were probably caused by the movement of magma into the rift zones of Mauna Loa and Kilauea, respectively, followed by a sudden collapse (Mullineaux et al. 1987). Because of the earthquake potential, the County of Hawaii Building Code bases its structural design standards on Seismic Zone 3 forces, and the proposed irradiation facility would be designed to this standard.

Finally, Mullineaux et al. have divided the island into four hazard zones for fracture and small-scale subsidence. All of Hilo is located in Zone 4, the area which is <u>least</u> susceptible to damage from this threat. Consequently, there appears to be little risk of impact from this source.

4.2.4 Mitigation of Risks from Geologic Hazards

As indicated in the preceding sections, the only geologic hazards that are of significant concern at the sites under consideration for the proposed irradiator are lava flows and earthquakes. Through proper design and management of the facility, both of these can be effectively mitigated.

4.2.4.1 Mitigation of Risks from Lava Flows

The lava flow threat stems from eruptions along Mauna Loa's NERZ. The closest of these vents is over 20 miles from Hilo. At the fastest rates of advance observed during historic times, lava from this source would take many weeks to reach Hilo. As discussed below, the cobalt-60 source can be removed from the irradiator and shipped to a safe location elsewhere on the island or overseas in a much shorter period of time, thereby eliminating all possibility of radioactive contamination.

Cobalt-60 source rods are transported in special casks designed to maintain their integrity and prevent the release of radioactivity even when subjected to extreme stress. These casks are expensive, typically costing between $100,000 and $200,000. Hence, facilities usually do not maintain spare casks onsite. Instead, casks are stored at regional centers and brought to the site only when needed to transport the radioactive material to or from the places it is used.

In the case of an irradiator in Hilo, AECL indicated that a transport cask could be delivered to the site between 24 and 48 hours from the time it is requested, and probably in less than 24 hours. It takes only a few hours to remove the cobalt-60 rods from the irradiator and place them in the transport cask. Removal is a straight-forward task that is accomplished using the transport cask and a crane (Battelle-Tingey consultation). Even if the crane that is built into the facility for the purpose of loading and removing the rods should fail, a mobile crane can be used as a substitute without incurring a time penalty of more than a few hours. Based on the preceding, it is estimated that the cobalt-60 used in the facility could be removed from the facility within 2 to 3 days from the time a decision is made to do so.

If a lava flow should threaten Hilo, it is likely that a major evacuation effort will be initiated. This could disrupt the normal transport system. Hence, it is advisable to begin removing the radio-isotope earlier than might otherwise be required. To accomplish this, the facility's emergency response plan should specify a procedure for determining when to begin removing the source rods. The procedure should include consultation with civil defense officials and the scientist-in-charge at the Hawaiian Volcanoes Observatory. The facility NRC license will specify this plan for response to lava risk.

4.2.4.2 Mitigation of Risks from Earthquakes

The Hawaii County Building Code requires that structures be designed to withstand forces expected to occur in Seismic Zone 3. As discussed in the risk assessment portion of this report (see Section 4.12.2), the Nuclear Regulatory Commission requires that facilities such as the irradiator be able to withstand expected seismic forces with a margin for safety.

4.3 SOILS

4.3.1 Existing Soils and Soil-related Constraints

The USDA Soils Conservation Service (SCS) has classified the soils on Site A in the Airport Industrial Subdivision and on Site C in the Kanoelehua Industrial Area as Papai extremely stony muck (Sato et al. December 1973: Plate 74). The Papai series consists of thin, well-drained, extremely stony organic soils overlying *a'a* lava. In a representative profile, the surface layer of the soil is very dark brown and about 8 inches thick. The soil is highly permeable, runoff is slow, and the erosion hazard is slight. Excavation in *a'a* lava is typically relatively easy. The SCS considers the potential for agricultural use of this soil to be low.

Site A was rough graded when the Airport Industrial Subdivision was constructed. Hence, the soil profile in this area is probably somewhat atypical of the classic Papai series. Nonetheless, its fundamental characteristics are believed to be relatively unchanged. Hence, it presents no special problems or constraints relative to the proposed food irradiation facility. Neither of the sites having this soil series (Sites A and C) have been designated as "Agricultural Lands of Importance to the State of Hawaii" by the State Department of Agriculture.

The SCS has categorized the soils on Site B near the old airport passenger terminal as Keaukaha extremely rocky muck (Sato et al. December 1973: Plate 74). Keaukaha series soils are thin organic soils overlying *pahoehoe* lava bedrock. Bedrock is typically found 2 to 10 inches beneath the surface, and rock outcrops occupy about 25 percent of the area. In a representative profile, the surface layer is very dark brown muck about 8 inches thick. The soil above the lava is rapidly permeable. The underlying *pahoehoe* lava is very slowly permeable, but water moves rapidly through its many cracks. The runoff potential of this soil is medium, and the erosion hazard is slight.

Keaukaha extremely rocky muck places no significant limitations on urban development. The SCS's overall capability rating for the soil is poor; hence, this area also has not been designated as Agricultural Lands of Importance to the State of Hawaii by the State Department of Agriculture. The soils on Site B present no special problems and will not constrain construction of the proposed irradiation facility.

4.3.2 Impacts

None of the sites under consideration is currently used for agriculture or possesses soils which are well-suited for agricultural purposes. Similarly, they have no significant soil-related constraints which would adversely affect their suitability as an irradiator site. Consequently, no impacts are expected.

4.3.3 Mitigation Measures

Special mitigation measures do not appear necessary at this time. Should future soils investigations indicate otherwise, appropriate engineering, design, and construction mitigation measures would be taken.

4.4 HYDROLOGY

4.4.1 Surface Runoff and Flooding

4.4.1.1 Susceptibility to Flooding

Average annual rainfall in the vicinity of the sites under consideration for the irradiator is about 130 inches per year (National Oceanic Administration 1986). Moreover, with 10- and 50-year 1-hour rainfalls of 5.0 and 6.1 inches, respectively, rainfall intensities can be quite high (U.S. Department of Commerce, Weather Bureau 1960). Despite this, and the fact that rainfall is even higher in areas above the sites, there is no history of significant flooding on them. This is due to the presence of highly permeable soils and porous lava throughout the region that allows water to percolate rapidly into the ground. What little flooding is experienced in Hilo has generally been limited to areas immediately adjacent to defined water courses, such as the Wailua River.

The Federal Emergency Management Agency (FEMA) has published Flood Insurance Rate Maps for Hilo. The area occupied by the three alternative project sites is contained on maps 155166-0880-C and 155166-0885-C dated September 16, 1988. These maps show that all three sites are within Zone X, "Areas determined to be outside 500-year flood plain."

4.4.1.2 Increased Runoff

As indicated in Section 4.3, the permeable nature of the soil and underlying strata on the potential irradiator sites limits the amount of surface runoff that is generated. Construction of the irradiator and associated parking will increase the amount of impermeable surface that is present on each site; this will lead to a proportionate reduction in the ground's ability to absorb rainfall. There is no regional storm drainage system into which this runoff can be discharged.

To avoid creating flooding problems on adjacent properties as a result of increased surface runoff from the site, an onsite stormwater collection and disposal system will be provided. This system will collect runoff from roofs, parking areas, and other impermeable surfaces and convey it to onsite "dry wells" for disposal. These dry wells are typically covered pits dug into the lava. Water entering the pits percolates out through their sides and bottom. This is possible because the pits end well above the water table. Clogging tends not to be a problem because of the thin soils and high porosity of the underlying lava. This onsite disposal system eliminates surface runoff from the facility and the impacts that would otherwise be associated with it.

4.4.2 Coastal Flooding

Approximately 50 tsunamis have struck the island of Hawaii during historic times; higher ocean waves occasionally cause damage to low-lying shoreline structures. Tsunamis cause, by far, the greatest damage; waves in 1946 and 1960 caused widespread destruction along the Hilo shoreline.

The flood hazard maps published by the FEMA indicate that the tsunami having a recurrence interval of 100 years would reach a ground elevation of approximately 10 feet above mean sea level in the vicinity of Hilo Harbor. Since the most exposed irradiator site is situated about one-half mile from the shoreline at an elevation of approximately 25 feet above sea level, it is well above the historical high-water level.

4.4.3 Water Quality

4.4.3.1 Surface Water Quality

As discussed in Section 4.4.1.2, runoff from the site will be collected and disposed of onsite. Consequently, the irradiator will not affect surface water quality.

4.4.3.2 Groundwater Quality

The rock which forms the base of the Island of Hawaii is saturated with salt water from the surrounding ocean. Rain falling on the land percolates downward until it encounters this water-saturated rock. There, the fresh water displaces the sea water from the upper levels of the rock, forming a lens-shaped water body known as the Ghyben-Herzberg lens. Most of the groundwater beneath the island is contained in this basal lens, although in a few localized areas groundwater is perched atop layers of fine ash and other relatively impermeable material (MacDonald 1970).

As groundwater accumulates beneath the higher rainfall/high recharge areas of the island, a hydraulic gradient is created. This gradient, which typically ranges from 1 to 8 feet per mile, produces a slow movement of fresh groundwater outward to discharge points near the shoreline.

Static water table data from the wells nearest the three areas being evaluated suggest the following approximate depths to water table for each area:

Location	Ground Elevation	Water Table Elevation	Depth to Water Table	Source of Water Table Data
Site A	42'	5'	37'	DLNR Report R34 Page 141
Site B	25'	4'	21'	DLNR Report R34 Page 145
Site C	60'	7'	53'	DLNR Report R47 Pocket Report Map

The schematic plan for the proposed irradiator developed by CH2M Hill (1987) indicates that the outside wall of the irradiator's source storage pool would extend approximately 25 to 30 feet below grade. This would leave the pool well above the water table at Sites A and C, but it would probably extend below the water table at Site B. The only consequences of this are that some temporary dewatering might be required during construction and that the design will have to provide for that. This dewatering would not have a noticeable effect on water quality.

The irradiation process itself does not involve any activities with the potential to affect water quality. The fruit is packaged before it reaches the facility and remains in the same container throughout the treatment. Fruit handling is confined to indoor areas so that accidental spills of fruit can be completely removed. The treatment does not involve the use of chemicals or other materials with the potential to adversely affect water quality. The only liquid discharge will be seepage from an onsite septic system. This will consist of low volumes of domestic wastewater (approximately 200 to 300 gallons per day for a single shift operation).

4.4.4 Mitigation Measures

Dry wells will be constructed for the disposal of site surface runoff. For Site B, foundation design will account for construction below the water table. No other mitigation measures are required.

4.5 BIOLOGY

4.5.1 Existing Conditions

The biological resources of the three alternative sites were assessed by Char and Associates and Gordon Chapman Consulting Services under contract to WESTEC Services. A botanical report, prepared by Char and Associates (1988), documents vegetation communities based on field investigations, discusses potential impacts to existing botanical resources, and identifies necessary mitigation measures. A zoological survey, conducted by Gordon Chapman Consulting Services (1988), describes existing wildlife at each site. The report by Char and Associates (included as Appendix E) and findings by Chapman Consulting Services are summarized below.

4.5.1.1 Site A

Area A consists of a mowed lawn surrounded by chain-link fences. An assortment of grass species which include carpetgrass (*Axonopus compresus*), Hilo grass (*Paspalum conjugatum*), dropseed (*Sporobolus sp.*), foxtail (*Setaria gracilis*), molasses grass (*Melinis minutiflora*), and Natal redtop (*Rhynchelytrum repens*) make up the predominant cover. Weedy herbaceous species common in this area include polygola (*Polygola paniculata*), sleeping grass (*Mimosa pudica*), and beggar's tick (*Desmodium incanum*). Where there are pockets of loose rock and along the fenceline, the grasses become sparse and plants of sword fern (*Nephrolepis multiflora*), white-flowered Spanish needle (*Bidens alba*), and sleeping grass become more numerous.

A few shrubby species occur only on the face of the terrace cut where the rocky surface is exposed. However, the plants are cut back regularly by maintenance personnel.

The fauna of Site A is limited to a few birds and small mammals. Bird species commonly found at the site include the barred dove (*Geopelia striata*), spotted dove (*Steptopelia chinensis*), common myna (*Acridotheres tristis*), house sparrow (*Passer domesticus*), and nutmeg mannikin (*Lonchura punctulata*). It is likely that the golden plover (*Pluvialis dominica*) also frequents the site when they winter in Hawaii. Mice, rats, and other common small mammals are likely to frequent the site, although none were sighted during preliminary site investigations. None of the above-listed bird species are known to nest on the site, and no known threatened, endangered, or otherwise protected species inhabit or frequent the site.

4.5.1.2 Site B

The flora of Site B is characterized by a grassy lawn with scattered trees. In most areas, the lawn is composed of a mixture of grass species, although in places, large patches of a single species may be found. The grasses include carpetgrass (*Axonopus compresus*), Hilo grass (*Paspalum conjugatum*), crabgrass (*Digitaria ciliaris*), dropseed (*Sporobolus* sp.), Glenwood grass (*Sacciolepis indica*), foxtail (*Setaria gracilis*), and California grass (*Brachiaria mutica*). The more common weedy herbaceous species growing among the grasses in this area are Asian pennywort (*Centella asiatica*), borreria (*Spermococe assurgens*), blue day flower or honohono (*Commelina diffusa*), common plantain (*Plantago major*), and beggar's tick (*Desmodium incanium*). A few trees of pandanus

(*Pandanus tectorius*), java plum (*Syzygium cumini*), gunpowder tree (*Trema orientalis*), African tulip (*Spathodea campanulata*), and coconut (*Cocos nucifera*) occur on the site.

There is a rocky depression which has been left in a relatively unmaintained condition near the central portion of Site B. It supports a small stand of trees, with clumps of guava (*Psidium guajava*) and pluchea (*Pluchea symphytifolia*) shrubs between the trees. California grass, molasses grass, and sword fern form dense mats up to 5-feet tall in some areas. Where the jumble of rocks is exposed, sword fern is abundant.

The flora of Site B is almost the same as that on Site A. However, in addition to the species of birds found on Site A, Japanese white-eye (*Zosterops japonica*) and house finches (*Carpodacus mexicanus*) frequent the site, as does the common small Indian mongoose (*Herpestes auropunctatus*). It is also likely that domestic and feral cats and dogs frequent the area, and that mice and rats inhabit the area. There are no known threatened, endangered, or otherwise protected species inhabiting the area. Some species of birds, such as Japanese white-eye, common mynas, house sparrows, and house finches, and the small Indian mongoose may nest and breed on the site.

4.5.1.3 Site C

The flora of Site C is more varied than that on Sites A or B. This is due primarily to the fact that it has had time to revegetate since its use as concrete batch plant and it is presently subjected to infrequent human use. Roughly one-half of the site is covered by broomsedge (*Andropogon virginicus*) and molasses grass (*Melinis minutiflora*). The other half supports an open woodland of weedy, fast-growing melochia trees (*Melochia umbellata*).

Gravel and rock piles, as well as a large open trench, are found in the grassy area. Besides the two grasses mentioned above, other plants frequently found here include sword fern, kaunoa'oa (*Cassytha filiformis*), several *Desmodium* species, and seedlings of melochia, 1- to 3-feet tall. Locally abundant, especially near road areas, is wedelia (*Wedelia trilobata*) an ornamental species which continues to persist and spread even if left untended. *Melochia* trees, 15- to 25-feet tall, form an open woodland with a few, scattered gunpowder trees. The understory layer is dense, and species composition varies from place to place. Thorny sleeping grass may form mats up to 6-feet high; in other areas, California grass and comb hyptis (*Hyptis pectinata*) form a different association; and in some places sword fern or molasses grass may form dense patches. Climbing up onto the shorter trees and shrubs are maile pilau (*Paederia scandens*), kaunoa'oa (*Cassytha filiformis*), and koali-awahi'a (*Ipomoca indica*).

The fauna of Site C includes the same species as Site B. There are no known threatened, endangered, or otherwise protected animal species inhabiting or frequenting the site. As with Site B, it is likely that Japanese white-eye, mynas, doves, and other bird species and the small Indian mongoose, rats, and mice nest and breed on the site.

4.5.2 Impacts

The vegetation on all three sites is composed almost exclusively of introduced species. Of the three Sites, Site C contains the most native species (i.e., indigenous and endemic plants), as it has not been maintained for some time. The native species include mamaki (*Pipturus*), koaliawahi'a (*Ipomoca indica*), kaunoa'oa (*Cassytha filiformis*), and 'uki (*Machaerina mariscoides* ssp. *meyenii*). However, none of these is considered rare, threatened, or endangered and all occur throughout the islands in similar habitats.

Each site is currently disturbed or has been in the recent past. The flora and fauna documented at each site consist of common species which are widely distributed throughout the islands. None of the sites are known to contain threatened, endangered, or protected species of plants or animals. Based on this information, the proposed irradiation facility would not have an adverse impact on biological resources at any one of the three sites under consideration.

4.5.3 Mitigation Measures

No specific mitigation measures are necessary because there would be no adverse significant effects to the biological resources at any of the three sites.

4.6 CULTURAL RESOURCES

A cultural resources study of the three alternate sites was conducted by Paul H. Rosendahl, Inc.(1988), a consulting archaeologist under contract to WESTEC Services. The object of the study was to review and evaluate available archaeological and historical literature relevant to each site; to conduct a surface reconnaissance survey to determine the presence or absence of significant archaeological resources within the three proposed sites;

and to assess what effect, if any, the proposed irradiation facility might have on existing archaeological resources. Findings from field surveys and literature review were evaluated and recommendations made in accordance with guidelines issued by the DLNR Historic Sites Section and the Hawaii County Planning Department. The results of this study (reproduced in its entirety in Appendix F) are summarized below.

4.6.1 Existing Conditions

Rosendahl's literature review uncovered only three reports dealing with the archaeology of the Hilo area (Hudson 1932; Athens 1982; and Rosendahl 1988). None of these contained information specific to the irradiator sites, although they did provide useful background material. The reconnaissance-level field survey conducted by Rosendahl found no evidence that any significant cultural resources are present on the potential irradiator sites.

4.6.2 Impacts

Due to the apparent absence of cultural resources at Sites A, B, and C, the proposed project is not expected to have a significant effect on cultural resources (Rosendahl 1988).

4.6.3 Mitigation Measures

The results of Rosendahl's reconnaissance survey indicate that no mitigation measures will be needed to prevent adverse effects on cultural resources. However, in the unexpected event that remains are uncovered during construction of the facility, work in the affected area will be suspended and the State Historic Preservation Officer, the DLNR Historic Sites Section, and the Hawaii County Planning Department will be notified. Work will not be restarted until the significance of the findings can be assessed and appropriate measures taken to mitigate the potential loss.

4.7 TRANSPORTATION

4.7.1 Setting

All three of the sites under consideration for the commodities irradiation facility are located along the eastern side of Hilo (see Figure 2-1). Primary road access is via Kanoelehua Avenue (Highway 11) and local streets. The principal source of project-related traffic will be trucks carrying produce to and from the facility. Employees, researchers, and visitors driving to and from the facility will generate additional vehicle trips. The remainder of this section discusses the magnitude of this project-related traffic and its implications for vehicular movement on existing streets.

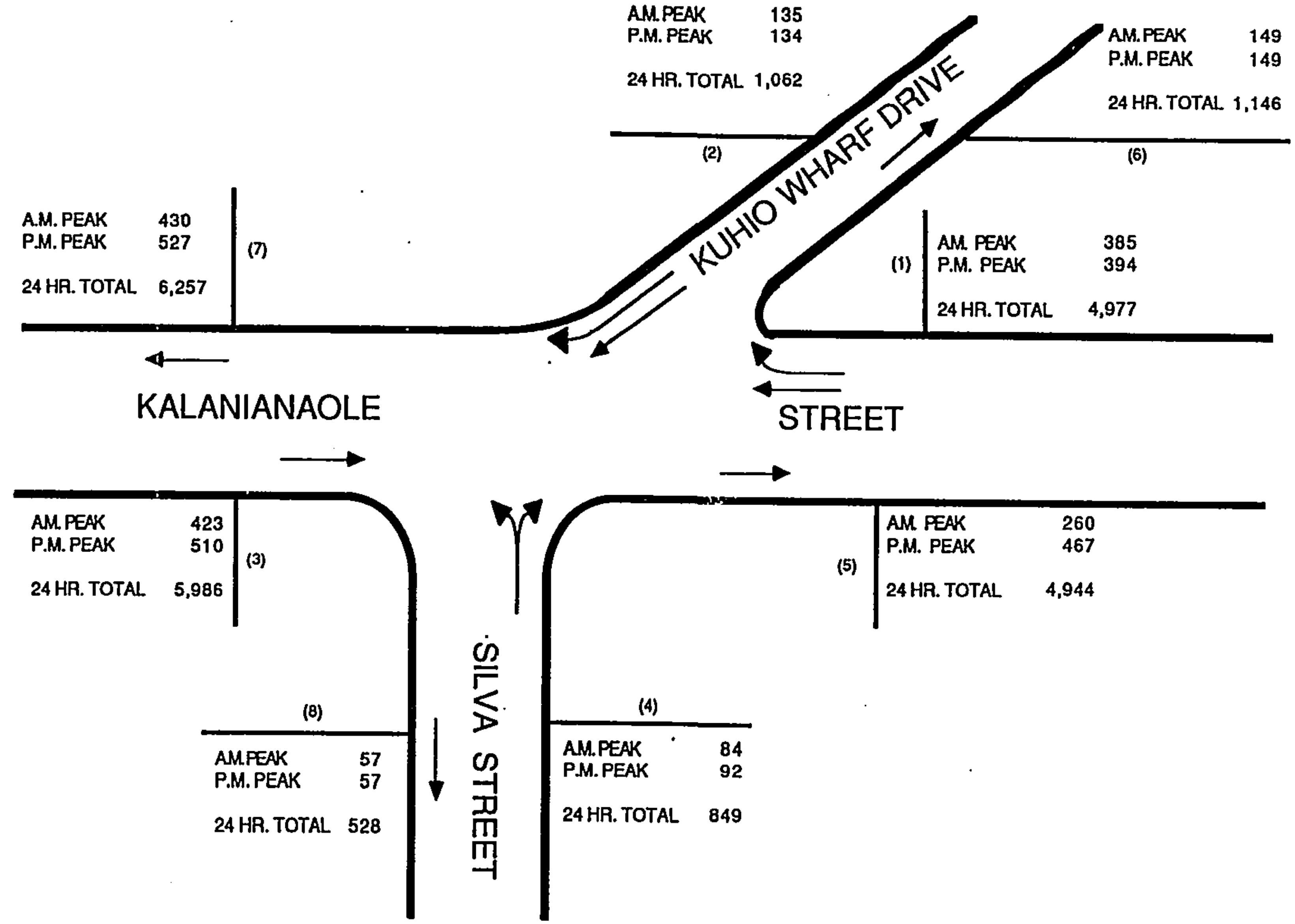
The State Department of Transportation conducts periodic traffic counts on a number of the streets in the vicinity of the three potential irradiator sites. Data from four of these stations for morning peak-hour, afternoon peak-hour, and 24-hour periods is summarized in Figures 4-3 through 4-6. These data are from the most recent traffic counts that have been conducted.

While no formal traffic counts have been conducted on the roadways immediately fronting the potential irradiator sites, numerous visits have shown that traffic volumes there are quite low. Estimates of current volumes are as follows:

- Site A is located in an undeveloped portion of the airport industrial area, and there is no passing traffic at the present time.

- Vehicles inbound toward the existing air cargo and general aviation facilities at General Lyman Field pass Site B. Based on short-term observations and a review of the existing land use in the vicinity, this is estimated at well under 1,000 vehicle trips per day. The peak volume is estimated at less than 100 vehicles per hour.

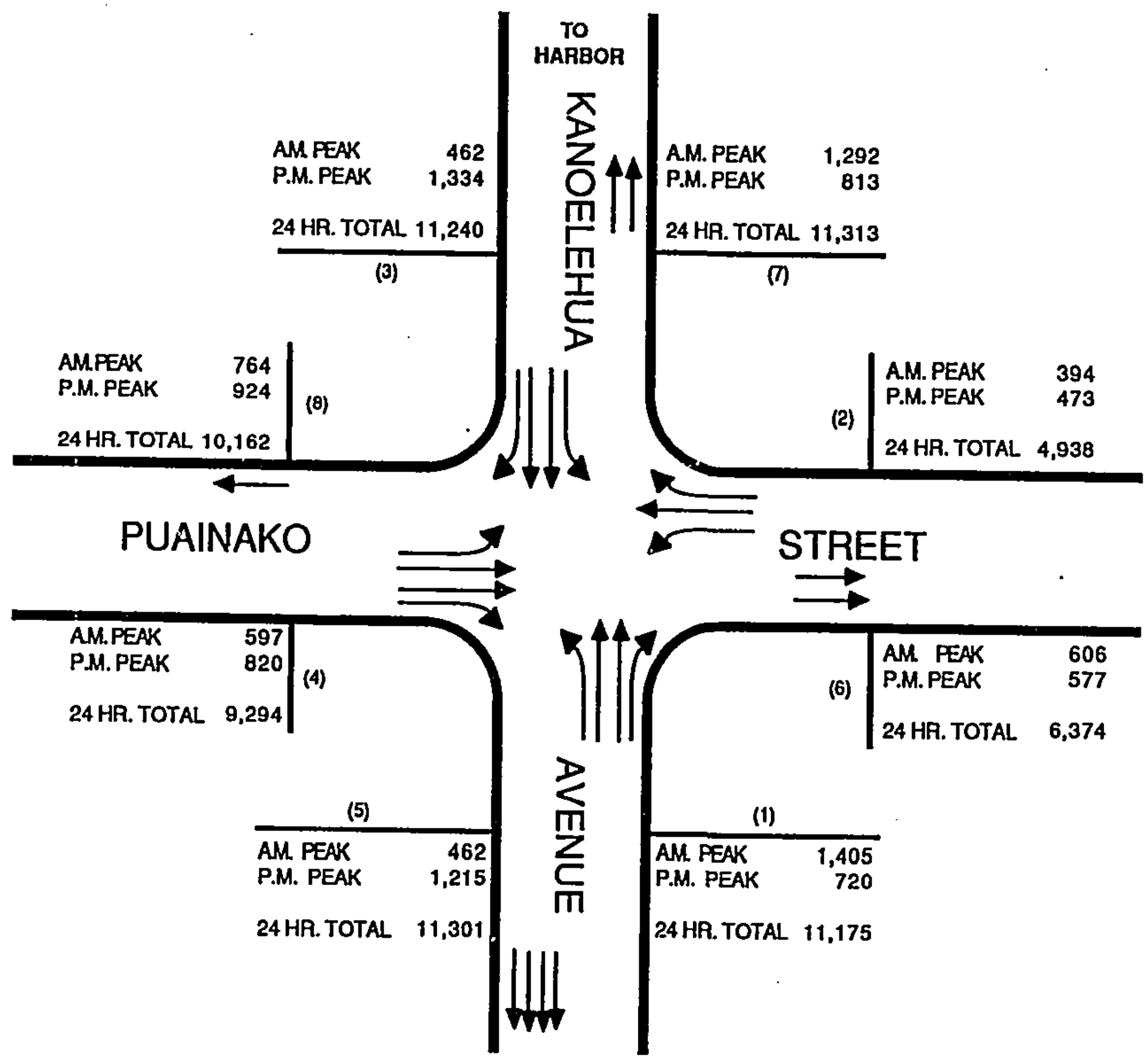
- Vehicle traffic on Railroad Avenue in the vicinity of Site C is also very light. This is due to the low density of development on parcels adjoining that roadway. Like Site B, the average daily traffic is estimated at well under 1,000 vehicle trips, and the peak traffic probably does not exceed 100 vehicles per hour.



Kalanianaole Street at Kuhio and Silva Streets (9/10-9/11/86)

FIGURE 4-3

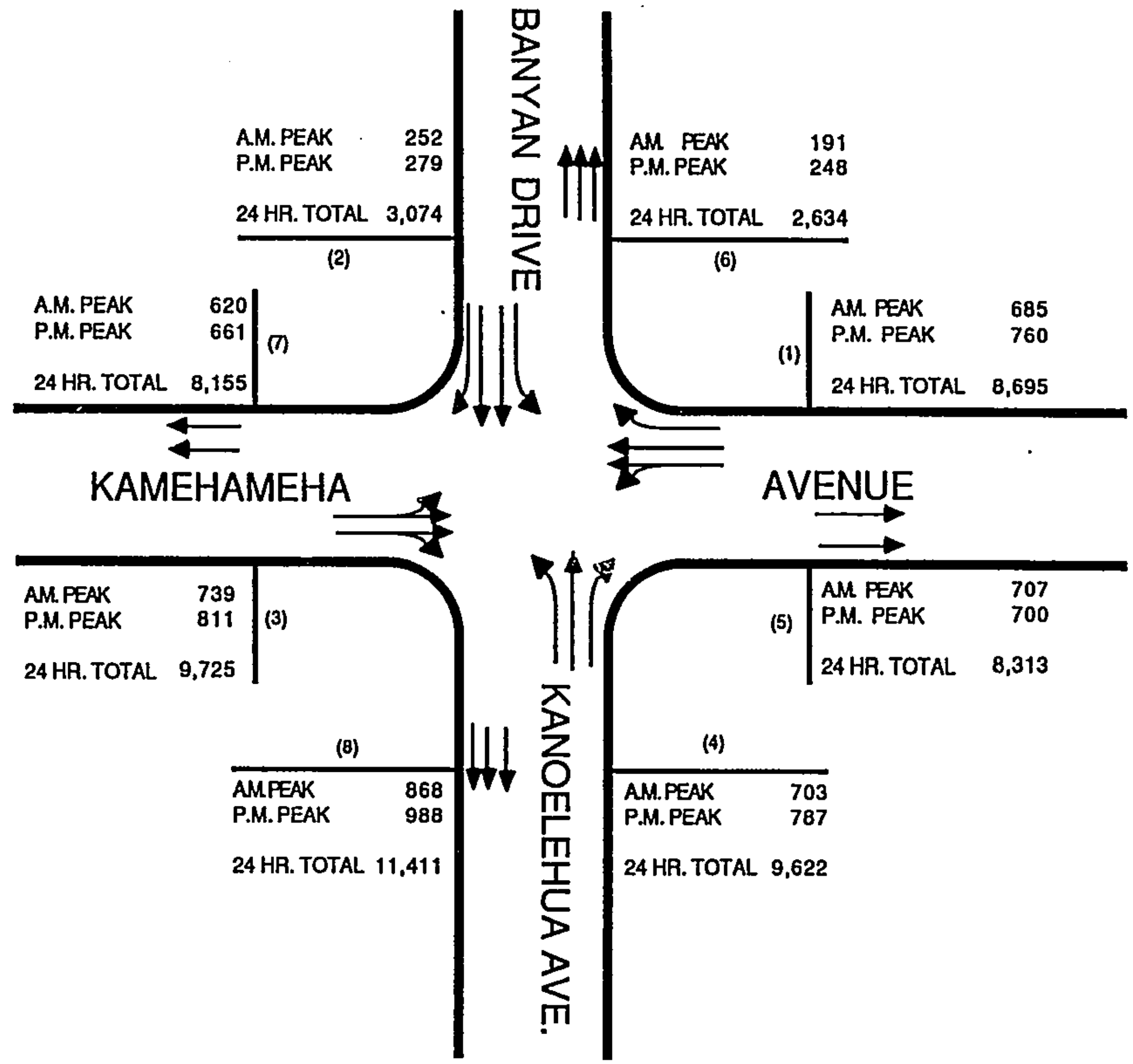
WESTEC Services, Inc.



Kanoelehua Avenue at Puainako Street (9/22-9/23/88)

FIGURE 4-4

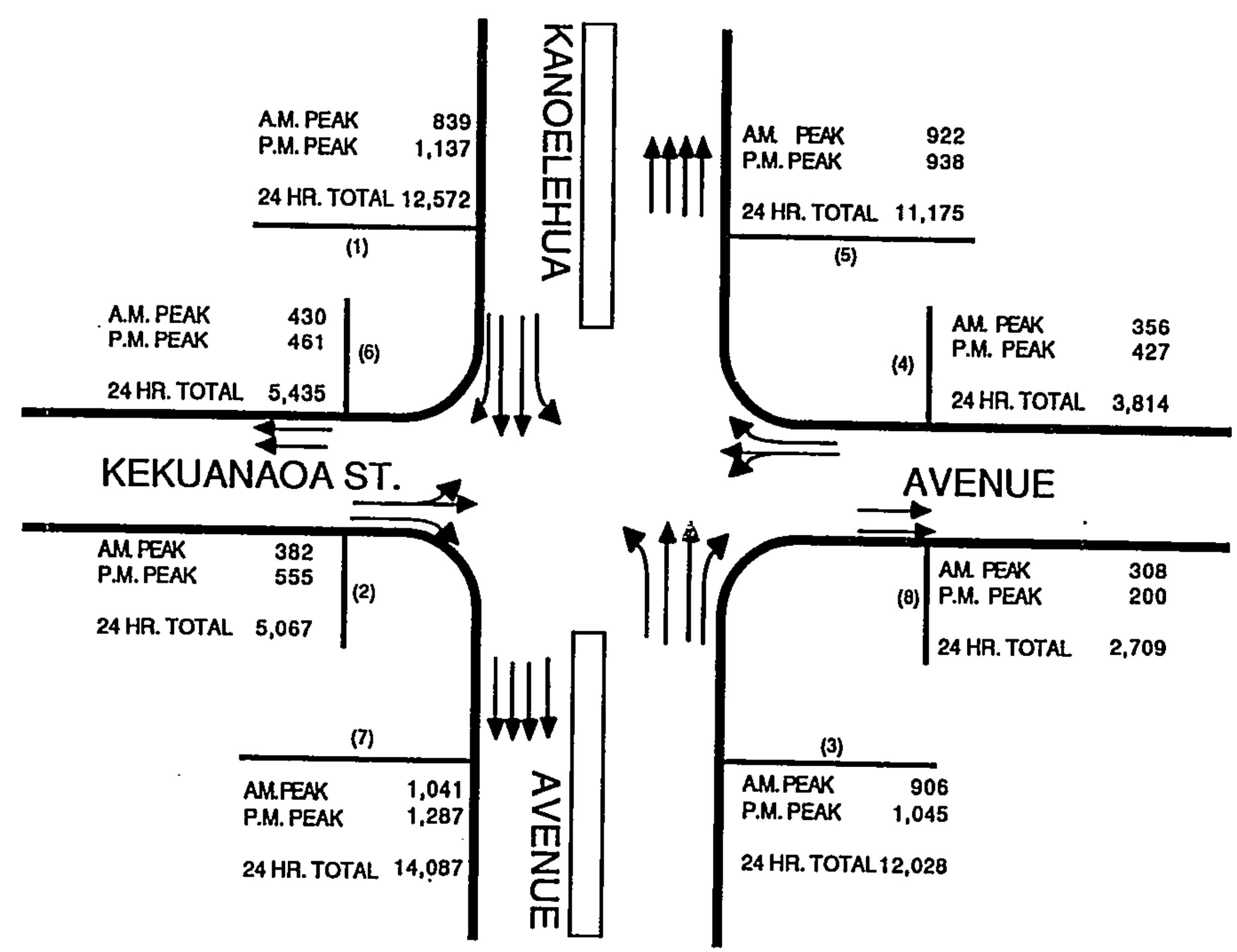
WESTEC Services, Inc.



Kanoelehuaa Avenue at Kamehameha Avenue and Banyan Drive
(9/22 - 9/23/88)

FIGURE 4-5

WESTEC Services, Inc.



Kanoelehua Avenue at Kekuanaoa Street (New Airport Access Road) (9/8 - 9/9/88)

FIGURE 4-6

WESTEC Services, Inc.

4.7.2 Impacts

4.7.2.1 Trip Generation

Employee Vehicle Trips

Employment at the proposed irradiator will vary depending upon the number of shifts that are operated. During the demonstration phase, only one 7-person shift will be needed. If the facility is commercially successful and continues in operation beyond the end of the demonstration phase, it could be used for as many as three 8-hour shifts per day, 6 days per week. For a single-shift operation, half of these commuter trips would occur between 6:30 a.m. and 7:30 a.m.; all of these would be in-bound. The other half of the trips would occur between 3:30 p.m. and 4:30 p.m.; all of these would be out-bound. For a multiple-shift (two or three) operation, the three second-shift employees would arrive during the same time period that first-shift employees are departing.

For the most part, employees in Hilo rely on private automobiles for transportation to and from work; car-pooling is not common. Hence, it is most reasonable to assume that there will be one car per employee, and one home-to-work and one work-to-home vehicle trip per employee per day. The potential irradiator sites are close enough to nearby commercial areas to make some offsite travel during the lunch hour practical. Not everyone would make such a trip every day, and car-pooling is common for this type of trip; hence, one-vehicle round-trip per day per four employees is considered likely. Normally, all of these trips would be made between 11:30 a.m. and and 1:00 p.m.

Product Movement Trips

Fruit and other products will move to and from the facility by truck. This section discusses the vehicle-trips which this will generate.

Papaya, which is used as the basis for this analysis, is packed in boxes holding from 10 to 11 pounds of fruit. Normally, 132 boxes are stacked together on a pallet to form a unit 76 inches high by 41 inches deep by 48 inches wide (Sakenashi personal communication 1988). Each of these pallets contains approximately 1,320 pounds of fruit.

According to CH2M Hill (1987), the design load of the facility is 45,000 pounds per 8-hour shift. This amounts to 330,000 pounds per day if three shifts are operated. At 1,320 pounds of fruit per pallet, the output of a single shift is equivalent to 84 pallet loads. If the facility is operated three shifts per day, the output would be three times as high, or 252 pallets per day. Note that these figures apply to full-scale operation at the design throughput of the facility. The facility would operate at a greatly reduced rate during the demonstration period (the first 3 years), and the number of container loads shipped would be correspondingly less.

Incoming Fruit

Most of the fruit would probably be brought to the facility on flat-bed trucks. These typically have 8-foot by 20-foot beds. Fully loaded, they are capable of carrying 8 to 10 loaded pallets, but scheduling requirements and other factors would undoubtedly result in an average load well below that. Assuming that the average capacity of the trucks is 9 pallets and that, on the average, they are two-thirds full, the facility would average 6 pallets per truck load. Dividing 84 pallets per shift by 6 pallets per truck load indicates an average of 14 inbound truck loads per 8-hour shift. This amounts to 42 inbound truck loads per day if the facility operates three shifts (24 hours) per day.

For the purposes of this worst-case analysis, it was assumed that all of the fruit would arrive at the facility during the 8-hour day shift (even if there is three-shift operation of the irradiator), and that the rate of transport during the busiest hour would be twice the average hourly rate for the full day, i.e., 25 percent of the 8-hour total. As noted in the following section, it was also assumed that the untreated fruit delivery trucks would not be used to transport irradiated product from the facility to the shipping point.

The time at which the greatest movement of incoming fruit would occur could vary considerably from day-to-day. However, given the assumption that the shipments will all be made during the day shift, it could affect any hour between 8:00 a.m. and 4:00 p.m. This does not overlap the employee commute period, but could correspond with the peak generation rate period for other traffic components.

Outgoing Fruit

The handling of outgoing fruit is not as well defined as that of the incoming papaya; several factors complicate the effort to assess its transportation implications.

- First, unlike the incoming fruit, outgoing fruit has multiple destinations, some of which may not involve travel on public roadways. Fruit being shipped by air from a facility located on Sites A or B could go directly onto cargo aircraft, for example, avoiding the need to travel over surrounding roads.

- Second, packers choose from among a number of available transportation routes and modes based upon market demand, price, and the amount of belly cargo space that is available on outgoing, overseas aircraft; consequently, there is no one, readily definable, routing for the treated product.

- Third, depending upon the specific arrangements made between packers and shippers, irradiated produce could be transported from the irradiator to the harbor by trucks making a return trip to the packing house or by trucks which have arrived empty.

For this analysis, the following assumptions were made.

- Trucks which have delivered untreated fruit to the facility will not carry treated fruit from the irradiator to the harbor as part of their return trip to the packing houses. Such double use of the delivery trucks is certainly possible, but the fact that delivery to the facility is expected to be largely on flat-bed trucks, while shipment to the harbor will be by refrigerated container, makes it unlikely.

- Approximately 90 percent of the outgoing product will travel by sea via 24-foot refrigerated containers, each containing an average of 16 pallets. The remaining 10 percent of the outgoing product will be shipped out by air from General Lyman Field in Hilo. (Shipment by air from General Lyman Field means that this trip component will not affect the roads surrounding Sites A and B, since they have direct airfield access. Air shipments from Site C would generate a small number of trips by trucks carrying treated fruit from the facility to the airport, but the number is so small, and the timing of the trips so unpredictable, that they are not accounted for here.)

When operating at design capacity, the facility will process 34 pallets per 8-hour shift. Approximately 90 percent of this (31 pallets) would go by truck to Hilo Harbor. At an average of 14 pallets per 24-foot container (slightly less than their 16-pallet theoretical capacity), this is equivalent to between 2 and 3 containers per 8-hour shift, or 6 to 9 containers per day if there is a three-shift operation.

Under normal conditions, treated fruit will be loaded into refrigerated containers at the irradiator. These will be parked temporarily in the container storage area at the facility, then trucked to the harbor. These irradiator-to-harbor movements will occur during the daytime. From the irradiator's standpoint, it would be desirable if the trucking occurred on a daily basis, meaning that the output of more than two shifts (12 containers) would never be present in the facility awaiting transport to the harbor. Under this normal scenario, irradiator-to-harbor shipments would be 6 per day for a single-shift operation and 18 per day for a three-shift operation.

In this normal situation, the treated fruit transport rate was assumed to vary only moderately within the 8-hour period. Hence, the peak-hour rate was estimated at about 30 percent above the average rate for the entire 8 hours. The peak-hour was assumed to occur at the same time as the peak for the incoming fruit, but after the peak employee commute period.

For the worst-case scenario, it was assumed that the container parking stalls at the harbor cannot be used to store the 24-foot refrigerated containers full of irradiated fruit. In this event, these containers would accumulate in the storage area at the facility until all 45 storage stalls at the facility are filled. These containers, together with the additional output of the facility during the transport period, would then be trucked to the harbor during an 8-hour day shift when the barge is available for loading. This scenario indicates a peak-day movement of approximately 50 containers for a single-shift operation (i.e., 45 plus 5) and 60 containers for a three-shift operation (i.e., 45 plus 15). The assumption is that all of these would be moved to the harbor during a single 8-hour shift. This scenario also incorporates the same assumptions concerning intraperiod variability and the timing of the peak as the normal scenario described above.

Visitor/Researcher Trips

During the demonstration phase of the project, researchers will be using the facility on a regular basis to conduct experiments with different exposure rates, handling methods, and commodities. Based on the assumption that experimental work would be carried out during the day shift, and that no more than three scientists would have experiments scheduled on a given day, 24-hour and peak-hour trip estimates for this component of traffic are estimated at 8 and 4, respectively. While the peak hour for this component will most often occur at the same time as that of other employee trips, it could frequently occur somewhat later. Therefore, it has been assumed that this component's peak could coincide with that of the other major trip generators.

Summary of Trip Generation

Based on the foregoing, it is anticipated that the proposed irradiator will generate the following vehicle trips at the entrance to the facility when it is operating at its design capacity (see Table 4-1).

Table 4-1
SUMMARY OF TRIP GENERATION

Trip Generator	No. of Vehicle Trips/Day		Maximum No. of Vehicle Trips in Component's Peak Hour		Maximum No. of Vehicle Trips in Facility's Peak Hour	
	One Shift	Three Shifts	One Shift	Three Shifts	One Shift	Three Shifts
Employee Commuter Trips	14	26	7	7	2	5
Employee Personal Trips	7	13	4	4	2	2
Incoming Fresh Fruit	28	84	7	21	7	21
Normal Outgoing Fruit	12	36	2	6	2	6
Visitor/Researcher Trips	0.20	0.24	4	4	0.4	0.4
Normal Total	81	183			17	38
Worst-case Outgoing Fruit	120	120	20	20	20	20
Worst-case Total	189	267			35	52

4.7.2.2 Trip Assignments (Routing)

While the trip-generation rates at the facility entrance presented above are largely independent of the facility's location, the routes that vehicles will follow while moving to and from it are not. This section discusses the routes that would be used by vehicles traveling to and from each of the possible facility locations.

Site A

Both employees and trucks traveling between the packing houses and an irradiator located on Site A would use Kanoelehua Avenue (Highway 11), Kekuanaoa Street (the main entrance road to General Lyman Field), and the airport industrial subdivision frontage road (see Figure 2-1). Since all of the packing houses are south of the intersection of Kekuanaoa Street and Kanoelehua Avenue, all incoming trucks would make right turns, and all outgoing trucks left turns, at that intersection. Based on the location of this site relative to neighboring residential areas, it is estimated that 50 percent of employee vehicle trips would be to and from the south, 25 percent to and from the west, and 25 percent to and from the north. All of the vehicles are assumed to use the easternmost of the two access points to the airport industrial area frontage road rather than the access point west of the post office.

During the worst-case scenario used in establishing the peak-trip generation rates, essentially all of the trucks carrying irradiated produce would travel a continuous circuit between the irradiator and the harbor. They would use the airport industrial area frontage road, Kekuanaoa Street, Kanoelehua Avenue, and Kalanianaole Avenue. This is a distance of less than 3 miles, and would probably involve a 20- to 30-minute round trip.

Site B

Until reaching the Kanoelehua Avenue/Kekuanaoa Street intersection, trucks delivering fruit to a facility located on Site B would follow the same route as those destined for Site A. However, instead of turning right onto Kekuanaoa, they would continue northward on Kanoelehua Avenue until the next street (the eastward extension of Piilani Street which serves as an entrance to the general aviation, air cargo, and other facilities located on the western side of the airport). Once they delivered the fruit, the empty trucks would exit the airport to the north using the entrance road to the old passenger terminal. They would turn left onto Kamehameha Avenue westbound and left again onto Kanoelehua Avenue southbound for their return to the packing houses.

Trucks pulling loaded containers from the irradiator to the harbor would exit the airport to the north using the entrance road to the old passenger terminal. They would then turn right onto Kamehameha Avenue and left onto either Keaa Street or Silva Street for the short trip to the harbor on the north side of Kalanianaole Street. They would then return to the irradiator using the same route.

Site C

Site C is located further south than the other two sites. Consequently, not all of the trucks carrying fruit to it would approach the facility via Kanoelehua Avenue southbound. Deliveries from Pacific Paradise, Inc., Diamond Head Papaya Company, and AMFAC Tropical Fruit Products would follow Kanoelehua southbound, turning right onto Lanikaula Street to reach Railroad Avenue. Trucks traveling between the facility and Hawaiian Host and Ono Pack would only use Railroad Avenue, and deliveries from Pacific Tropical Products and Del Monte (which are located west of Kanoelehua Avenue) would probably arrive and depart via a Lanikaula Street/Railroad Avenue route.

Trips from the irradiator to the harbor facilities or the airport would follow Railroad Avenue southbound to Lanikaula, Lanikaula Street westbound to Kanoelehua Avenue, Kanoelehua Avenue northbound to Kalanianaole Street, and Kalanianaole Street eastbound to the entrance to the harbor facilities. Returning vehicles would reverse this route. The distance is about the same as for Site A, and a round trip would take about the same length of time.

4.7.2.3 Traffic Impacts

As indicated by the forecasts presented above, the proposed facility would generate only a modest number of vehicle-trips, both overall and during the peak hour. Note that these are generally not new trips but redirection of existing commodity transportation routes between packers and the harbor or airport. Thus, any effects would be limited to roadways immediately adjacent to the project sites. Trips are summarized below:

	One Shift	Three Shifts
Number of Vehicle Trips/Day	189	267
Number of Vehicle Trips during Peak Hour of Generator (normal)	17	8
Number of Vehicle Trips during Peak Hour of Generator (extreme)	35	52

The normal peak-hour estimate is the volume expected when containers are moved from the irradiator to the harbor on a daily basis as the fruit is processed. The extreme peak-hour estimate is for the situation in which (1) regular daily trucking to the Hilo Harbor has not occurred, (2) containers filled with irradiated fruit have accumulated at the facility until all 45 stalls in the container storage area at the facility have been filled, and (3) the stored containers are moved to the harbor (together with the output of the current day's output) during a single 8-hour shift.

As can be seen from the foregoing, the facility would generate only a modest number of vehicle trips. The effect that these trips would have on the level of service on the roads surrounding each of the sites is discussed below.

Site A

As previously indicated, Site A is located in a corner of the airport industrial area past which no traffic flows at the present time. Consequently, the level of service at the intersection of the facility entrance road and the adjoining frontage road would remain high.

At present, peak traffic at the intersection of Kekuanaoa Street and the Airport Industrial Area frontage road is approximately 1,000 vehicles per hour. Under normal circumstances, single-shift operation of the facility as would occur during the demonstration period would increase this by less than 20 trips per hour. Normal full-capacity (3-shift) operation of the proposed irradiator would increase this by approximately 38 vehicle trips, or less than 4 percent. Even in the worst-case scenario, the increase would be only 52 trips per hour, or 5 percent.

An analysis of the intersection using the Highway Capacity Manual indicates that the service level for all legs of the intersection would remain at "A", the best possible (see

Table 4-2 for descriptions of levels of service), under all of these operating scenarios. Hence, the facility's impact on traffic flow at this location must be considered negligible.

The effect that project-related traffic would have on the intersection of Kekuanaoa Street and Kanoelehua Highway was also reviewed. The results of this review indicate that: (1) the intersection currently has excess capacity on all approaches, (2) most of the traffic from the proposed project would affect the legs of the intersection which have the greatest excess capacity, and (3) there would be no significant change in the level of service provided at the intersection if the irradiator were to be located on Site A.

Site B

Existing traffic past Site B is light, with peak hourly volume estimated at 100 vehicle trips or less. Vehicles would experience no delays entering or leaving an irradiator constructed on this site.

Vehicles moving from the irradiator to the harbor would probably turn right out of the facility and take the existing service road to Kanoelehua Avenue northbound. They would follow this to Kamehameha Avenue and turn right before branching left immediately onto Kalanianaole Avenue to the harbor. Very few vehicles make the right turn onto Kanoelehua Avenue, the northbound cars on that road are in relatively well defined platoons as a result of the upstream traffic signal at Kekuanaoa Street, and an acceleration lane is provided. Hence, no change in the service level at that location is expected.

Vehicles outbound from the facility to destinations south of Site B (such as the packing houses, university, or employees' homes) would leave via the old entrance to the airport and Kamehameha Avenue. Traffic at that intersection is moderate, but congestion at the Kanoelehua Avenue/Kamehameha Avenue/Kalanianaole Avenue intersection sometimes causes backups on Kamehameha Avenue westbound which affect the intersection. The congestion can be avoided by turning right onto Kamehameha Avenue eastbound, left onto Keaa Street northbound, and then left onto Kalanianaole Avenue westbound. The modest number of peak-hour vehicle trips that would follow this route (between 10-15) and the availability of alternate routes means that the additional traffic from the facility would not significantly reduce vehicle travel time along this route, even under worst-case conditions. During the 3-year demonstration period and normal 1-shift operation, the effect of the project on traffic flow on these streets would be negligible.

Table 4-2

DESCRIPTION OF LEVELS OF SERVICE FOR INTERSECTIONS

Level of Service	Description
A	Free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. If signalized, conditions are such that no approach phase is fully utilized by traffic, and no vehicle waits through more than one red indication. Very slight or no delay.
B	Stable flow. The presence of other users in the traffic stream begins to be noticeable. If signalized, an occasional approach phase is fully utilized; vehicle platoons are formed. This level is suitable operation for rural design purposes. Slight delay.
C	Stable flow. The operation of individual users becomes significantly affected by interactions with others in the traffic stream. If signalized, drivers occasionally may have to wait through more than one red indication. This level is suitable operation for urban design purposes. Acceptable delay.
D	Approaching unstable flow or operation; queues develop, but are quickly cleared. Speed and freedom to maneuver are severely restricted. Tolerable delay.
E	Unstable flow; small increases in flow or minor perturbances within the traffic stream will cause breakdowns; the intersection has reached ultimate capacity; this condition is not uncommon in peak hours. Congestion and intolerable delay.
F	Forced flow or breakdown. Demand exceeds available capacity. Jammed. Queues form.

Source: 1985 Highway Capacity Manual, TRB Special Report 209.

Site C

By virtue of the low existing traffic volumes on Railroad Avenue, traffic into and out of an irradiator located on Site C would have no adverse effect on traffic flow fronting the site. Two other factors argue against any other substantial adverse traffic impact of a facility located on this site as well.

First, unlike, the other locations under consideration, not all vehicles traveling between packing houses and the site will use Kanoelehua Avenue. Instead, some can use east-west streets and Railroad Avenue.

Second, all of the intersections that would be used by vehicles traveling between the site and the harbor (i.e., Railroad Avenue/Lanikaula Street, Lanikaula Street/Kanoelehua Avenue, and Kanoelehua Avenue/Kamehameha Avenue) have adequate traffic controls and substantial excess capacity. Because of this, the additional traffic that would be generated by the proposed facility can be accommodated without significantly reducing existing service levels, even under worst-case conditions.

4.7.3 Mitigation Measures

As indicated by the foregoing, the proposed irradiator is not expected to have a significant adverse effect on traffic, regardless of the site alternative that is selected. Hence, no special mitigation measures are necessary.

4.8 AIR QUALITY

4.8.1 Existing Conditions

Quantitative information to characterize present air quality levels in the Hilo area is extremely sparse. Historical monitoring data are available for sulfur dioxide (SO_2) and particulate levels in Hilo (State of Hawaii 1982-1985), but no data on other regulated pollutants (carbon monoxide, ozone, oxides of nitrogen) were identified for Hilo or any other location on the Island of Hawaii. Because of the general lack of information, there is no substantive basis for differentiating between baseline air quality levels at the three project sites currently under consideration. Consequently, the following commentary is equally applicable to all three sites.

The lack of an extensive air quality data base for the project area is not considered a serious deficiency for purposes of this analysis. The information that is currently available suggests that air quality in Hilo is generally good. As discussed later, this conclusion is reinforced by consideration of the city's population, degree of industrialization, and climate. In any event, neither the direct nor indirect pollutant emissions that will result from operation of the proposed irradiation facility will be significant. Project impacts are discussed in Section 4.8.2.

Current Pollutant Levels

No routine air quality data collection has been conducted in the Hilo area since October 1985, when operation of the state monitoring station at the University of Hawaii - Hilo campus was discontinued. A summary representing four of the most recent years of monitoring at this site is provided in Table 4-3. These data show that the ranges of observed annual and 24-hour SO_2 and total suspended particulate (TSP) concentrations are well below applicable federal and state standards (Table 4-4). No data for shorter averaging times are available. The Hilo SO_2 and TSP levels are surprisingly similar to those recorded in Kona (not shown), despite the clear differences in emissions and weather patterns in the two areas. No data for the other pollutants addressed in the ambient standards were identified for any location on Hawaii. Traffic levels in the streets that would be affected by the proposed project are light (see Section 4.7.2.1), such that air pollution from vehicular sources (e.g., ozone (O_3) carbon monoxide (CO) and nitrogen oxides (NO_x)) is probably well below allowable concentrations. For perspective, Honolulu, with substantially greater traffic volumes, records maximum O_3 and CO concentrations that are only marginally above the state standards (State of Hawaii 1982-1985).

Current air quality issues considered important in the project area involve pollutants that will not be emitted in significant quantities by the proposed facility. For example, acid deposition due to ongoing volcanic activity and emissions from Kilauea's Pu'u O'o vent has been linked to crop and flower damage, in addition to possible lead contamination of water supply facilities as a result of acid reaction with metal catchment and storage tanks. Development of geothermal resources in the Puna area 25 to 30 miles from Hilo could increase local levels of hydrogen sulfide (H_2S) and SO_2, but these effects are expected to be negligible near the proposed irradiation facility site.

Table 4-3

HILO AIR QUALITY DATA (1982 - 1989)[a,b]

	1982		1983		1984		1985	
	SO_2	TSP	SO_2	TSP	SO_2	TSP	SO_2	TSP
Period of Sampling (months)	12	11	12	12	12	12	9	9
Number of Samples	45	45	43	47	50	55	43	35
Maximum 24-hour Concentration ($\mu g/m^3$)	6	31	23	50	7	27	6	28
Minimum 24-hour Concentration ($\mu g/m^3$)	<5	8	<5	7	<5	7	<5	8
Annual Arithmetic Mean ($\mu g/m^3$)	<5	16	5	17	5	15	<5	15
Number of Days Above State Air Quality Standards[c]	0	0	0	0	0	0	0	0

[a]Sources: Hawaii Air Quality Data for the Period of January 1982 - December 1984 and "1985 Annual Summary of Hawaii Air Monitoring Stations," both provided by State of Hawaii, Department of Health, Environmental Protection, and Health Services Division.

[b]The Hilo monitoring site was located on the University of Hawaii - Hilo campus and was shut down October 1, 1985.

[c]Hawaii 24-hour standards for TSP and SO_2 are 100 $\mu g/m^3$, respectively.

Table 4-4

SUMMARY OF STATE OF HAWAII AND FEDERAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Standards: Hawaii State Standard	Standards: Federal Primary Standard[a]	Standards: Federal Secondary Standard[b]
Carbon Monoxide			
1 hr.	10 mg/m³	40 mg/m³	40 mg/m³
8 hr.	5 mg/m³	10 mg/m³	10 mg/m³
Nitrogen Dioxide			
1 hr.	---	---	---
24 hr	---	---	---
Annual (Arithmetic)	70 µg/m³	100 µg/m³	100 µg/m³
Particulate Matter			
24 hr.[c]	100 µg/m³	150 µg/m³	150 µg/m³
Annual[c]	55 µg/m³ (Arithmetic)	50 µg/m³ (Geometric)	
Ozone			
1 hr.	100 µg/m³	235 µg/m³	235 µg/m³
Sulfur Dioxide			
3 hr.	400 µg/m³		1300 µg/m³
24 hr.	80 µg/m³	365 µg/m³	
Annual (Arithmetic)	20 µg/m³	80 µg/m³	
Lead			
3 mo. (Arithmetic)	1.5 µg/m³	1.5 µg/m³	1.5 µg/m³

[a]Designed to prevent against adverse effects on public health.

[b]Designed to prevent against adverse effects on public welfare, including effects on comfort, visibility, vegetation, animals, aesthetic values, and soiling and deterioration of materials.

[c]Federal particulate matter standards apply only to particles with diameters of 10 microns or less (PM_{10}).

Climatic Effects

Climatic normals, means, and extremes for Hilo and other Hawaiian cities are summarized in Table 4-5 (State of Hawaii 1987). The high frequency of clouds and precipitation, as well as the relatively cool temperatures compared with other Hawaiian cities, inhibit the atmospheric formation of photochemical pollutants, such as ozone. In addition, the dampness of the area (over 275 days per year with at least 0.01 inches of rain) minimizes dust, despite the substantial surrounding agricultural activity.

Although Hilo's location on the east side of Hawaii exposes the city to the prevailing tradewind flow, average and maximum wind speeds are relatively low, especially at night. Wind patterns at General Lyman Field result largely from the interaction between the northeast trade wind flow and the effects of the 13,000-foot Mauna Loa Volcano. During the daylight hours, winds with an easterly component occur about two-thirds of the time (Belt Collins 1987). Easterly wind speeds exceed 7 knots for about 50 percent of daytime hours. At night, winds with a westerly component are recorded 85 percent of the time, and the associated speeds are substantially lessened. Pollutant dispersion is thus enhanced during the day, when shipment of fruit to and from the proposed irradiation facility is expected to occur. Downslope nighttime flow from Mauna Loa opposes the trade wind, resulting in substantially less ventilation. However, on the basis of available evidence, this condition does not significantly affect local pollution levels.

4.8.2 Impacts of Project Sources

Emissions of air pollutants associated with the proposed project will occur during construction and operation. During construction, some dust will be generated by site preparation activities and localized emissions from gasoline and/or diesel-fueled construction equipment will also occur during this project phase. Since these activities will take place for only a short period and will involve only a few pieces of equipment at any given time, no pollutant concentrations in excess of applicable air quality standards are expected. As noted in the previous section, the high frequency of rainfall events at General Lyman Field would be expected to suppress dust raised by operations of construction vehicles and equipment in exposed areas.

Only two categories of pollutant emissions have been identified for the operational irradiation facilities. During fruit irradiation, the energy of the gamma rays from cobalt-60

Table 4-5

CLIMATIC NORMALS, MEANS, AND EXTREMES FOR HILO, KAHULUI, HONOLULU, AND LIHUE AIRPORTS[1]

Subject	Hilo	Kahului	Honolulu	Lihue
Normal temperatures (°F):				
Daily maximum	81.2	83.8	84.2	81.1
Daily minimum	65.9	67.2	69.7	69.3
Monthly: Coolest month	71.1	71.5	72.6	71.2
Warmest month	75.8	79.2	81.0	79.1
Annual	73.5	75.5	77.0	75.2
Extreme temperatures (°F):				
Record highest	94	96	94	90
Record lowest	53	48	53	50
Normal degree days, base 65°F:				
Heating	---	---	---	---
Cooling	3,134	3,851	4,389	3,758
Precipitation (inches):				
Normal	128.15	19.85	23.47	44.02
Maximum monthly	50.82	14.46	20.79	22.91
Minimum monthly	0.28	0.00	T	T
Relative humidity (percent):				
8 a.m.	80	75	72	78
2 p.m.	68	57	56	66
Wind speed (m.p.h.):				
Mean	7.1	12.8	11.5	12.0
Fastest observation, 1 minute[2]	35	44	46	65
Percent of possible sunshine	41	68	68	56
Mean number of days:				
Clear	35.9	130.5	87.5	53.7
Partly cloudy	128.8	144.3	179.3	179.8
Cloudy	200.6	90.5	98.4	131.8
Precipitation (0.01 inch or more)	278.3	97.4	99.8	200.9

[1]Source: State of Hawaii DBED. (Nov. 1987). The State of Hawaii Data Book, 1987: A Statistical Abstract.

[2]Kahului figure refers to fastest mile.

T = Trace amount.

will cause radiolysis of the air in the irradiator room, causing the formation of some toxic gases, including O_3 and NO_x (CH2M Hill 1987). The proposed facility design should include provision for sufficient ventilation capacity to dilute these gases to safe concentration levels prior to their being exhausted to the atmosphere. In addition, it may be necessary to deny personnel access to this room following product irradiations until gas concentrations fall to safe levels. According to CH2M Hill (Sloan consultation 1988), a conservative (high-side) estimate of O_3 generation during operation of the radiation source is 1.0 to 2.0 liters per minute. Sufficient air must be mixed with this O_3 before atmospheric discharge to achieve an outlet concentration less than 0.10 ppm. Generation of NO_x will be less than O_3, but dilution to about 25 ppm for nitrous oxide (NO) and 5 ppm for NO_2 will be required. These levels will be rapidly diluted further in the atmosphere to much lower levels. Because of the generally good baseline air quality in Hilo and the climatic factors that suppress photochemical activity, these emissions are not expected to cause offsite exceedances of either the O_3 or NO_2 standards.

The only other substantial source of pollutant emissions associated with the operational irradiation plant will be the trucks hauling untreated fruit to the facility and treated fruit to port and air freight facilities in Hilo. The projected traffic components representing employee commuting and visitors to the irradiation facility (Section 4.7) are negligible from an air quality standpoint. Since the fruit is currently trucked from producers to the same Hilo shipping destinations without treatment, the trucking source of emissions already exists, and the effect of the project would largely be a slight shifting of traffic patterns to the streets adjacent to the selected site. In the worst case, there could also be a concentration of trucking activities at the irradiation facility, as described in Section 4.7.2.3. However, the number of trucks at any given location will at all times be too small to cause even short-term pollutant levels in excess of the air quality standards. Because of the insignificant nature of expected impacts, a quantitative analysis for evaluation of project-related traffic by means of air quality modeling was considered unnecessary.

4.8.3 Mitigation

The proposed facility can be designed in a manner that will minimize air quality impacts to levels well below the air quality standards. The most important design consideration in this regard will be sufficient ventilation capacity for rapid removal of toxic gases from the irradiation room and for dilution of these gases to safe levels before they are discharged to the atmosphere. Given the low baseline pollutant concentrations in the Hilo area, the favorable daytime meteorology for pollutant dispersion and the small number of vehicle trips that will be generated by the proposed facility, no mitigation measures to reduce impacts associated with these operational sources are considered necessary. If earth moving or other construction equipment operate during an anomalously dry period, excess dust could be controlled by application of water.

4.9 NOISE

4.9.1 Existing Conditions

4.9.1.1 Site A

Site A, located in the southwestern corner of the existing General Lyman Field Airport Industrial Area, is surrounded entirely by industrial uses associated with the airport. As such, there are no sensitive receptors within the project vicinity. Primary noise sources would be aircraft operations and vehicle noise on roadways in proximity to the site. These roadways include the frontage road, main airport access road, and Kekuanaoa Avenue to the east and south. According to the FAR Part 150 Noise Compatibility Study being prepared for General Lyman Field, existing ambient noise levels (exclusive of aircraft noise) in the communities surrounding the airport range from 40 to 65 Ldn. Noise levels in excess of 65 Ldn exist along the rights-of-way of the major roadways which serve Hilo. Breaking waves (surf) produce noise levels in the 60 to 65 Ldn range along that portion of the Hilo shoreline that is unprotected by the breakwater.

4.9.1.2 Site B

Site B is located just north of the existing air cargo buildings near the old passenger terminal on the western side of General Lyman Field. The site is bordered on the south by the existing access road and air cargo and general aviation facilities. The eastern end of the site is paved and used as a parking lot. Other land surrounding the site is vacant. Noise conditions for this site are similar to Site A, although this site is located farther away (150 feet) from a major roadway (Kanoelehua Avenue).

4.9.1.3 Site C

Site C is currently vacant. It is located within an area that is zoned General Industrial. The land immediately surrounding the project on all sides is currently vacant. Land uses within the project vicinity include a lumber yard, asphalt batch plant, and HELCO's main Hilo electrical power generating plant. Existing noise conditions are similar to the sites discussed previously; however, ambient noise levels may be somewhat lower due to the vacant land surrounding the site. This would be especially true during the night hours.

4.9.2 Impacts

4.9.2.1 Site A

The siting of the facility at this location would have no significant noise impacts. The site is located in an industrial area in which ambient noise levels equal or exceed 65 Ldn. The project will introduce new traffic to the area (delivery trucks and employee vehicles); however, this amount of traffic is expected to be insignificant (see Section 4.7), and would not increase traffic noise levels. The majority of the truck traffic will occur between the hours of 6:30 a.m. and 4:30 p.m. In the event that a 2- or 3-shift operation is utilized, traffic may arrive throughout the day and night. The routes utilized by the trucks traveling to and from the packing plants are major roadways and, therefore, the noise generated by this traffic will not increase roadway noise levels and will not significantly affect any sensitive receptors.

The irradiation facility will not create an increase in ambient noise levels due to operations carried out within the facility. Loading and unloading operations may create some noise onsite, but this noise will be characteristic of all cargo operations in this industrial zone. As such, the project will be consistent with the zoning ordinance provision which requires that "no noise be emitted which causes a measurable nuisance beyond the property line."

4.9.2.2 Site B

Similar to Site A, this site is located with an industrial zone district. Noises generated by the facility and vehicular traffic will be consistent with other noise emissions generated in the vicinity. The air cargo and general aviation facilities located south of the site generate similar noises and will not be affected by this project. There are no other sensitive receptors around the site as the land is vacant. No noise impacts would occur if the facility is located at this site.

4.9.2.3 Site C

No noise impacts would occur at this site. There are no sensitive receptors in this area and the zoning ordinance provides assurance that any future development located in this area would not be sensitive to noise generated by this facility.

4.9.3 Mitigation Measures

No mitigation measures are necessary.

4.10 LAND USE

4.10.1. Existing Conditions

4.10.1.1 Site A

Site A is located in the southwestern corner of the existing General Lyman Field Airport Industrial Area. This industrial area is located near the center of the airport and was developed by the DOT for use by airport-related activities. Currently, the tenants of the area include the U.S. Postal Service, the Federal Aviation Administration airport control tower, and a fuel storage and loading facility operated by Lockheed Air Terminal, Inc. Activity at the airport has not grown as rapidly as expected when the industrial area was developed in the mid-1970s. Consequently, less than one-quarter of the available space is now occupied or committed. All of these lots are served by roads, electrical power, water, and telephone lines that were installed when the property was subdivided.

The airport master plan is currently being updated by the DOT. While the plan has not yet been finalized, it is expected that it will provide for moving the air cargo facilities from the western side of the airport to the perimeter of the industrial area. The first increment is likely to be near Site A at the eastern end of the industrial area.

4.10.1.2 Site B

The majority of Site B is currently vacant. The exception is a small portion of its eastern end which is paved for past use as a parking lot. The parking area was constructed to support the main passenger terminal that was formerly located in this corner of the airport. Now that the terminal has been moved to the southern side of the field, it is used only by a few employees who work across the street in the existing air cargo facilities. The land adjacent to the internal airport road that provides access to the site is either vacant or devoted to airport uses such as general aviation hangars, radio communication facilities, air cargo warehouses, and maintenance facilities. The only exceptions are a county-operated swimming pool approximately 500 feet east of Site B and a firm located the same distance to the north which sells small boats and fresh fish.

The land in this part of the airport, including Site B, has recently been transferred from the DOT to the DLNR. The area southeast of the access road which serves the irradiator will continue to be used for airport purposes for the foreseeable future. The DLNR has not formulated any long-term plans for redevelopment of the vacant area, but preliminary indications are that it will remain in industrial use consistent with its existing zoning (ML-20, Limited Industrial). The county has indicated it may seek to have a portion of the area near Site B designated as a foreign trade zone, but this has yet to be done.

4.10.1.3 Site C

Site C is currently vacant. It is located within a large, industrially-zoned area. Surrounding land uses include a lumber yard, asphalt batch plant, and HELCO's main Hilo electrical generating plant. The zoning of the site and nearby land (MG-1a, General Industrial, 1-acre minimum lot size) ensures that future development will be similar in nature. Th site is managed by the Department of Hawaiian Home Lands (DHHL) and is subject to DHHL policies and decisions in support and to the benefit of native Hawaiians.

4.10.2 Impacts

4.10.2.1 Site A

The land adjacent to Site A is currently vacant. It is expected that this will change over time as the airport industrial area becomes more fully developed. New air cargo facilities are the most likely neighbors on the north and east, while the frontage road, main airport access road (Kekuanaoa Street), and Keakaha Military Reservation will continue to bound it on the south. The property to the west is also designated for airport-related industrial uses.

The existing county zoning of the airport industrial area (ML-20, Limited Industrial with a 20,000 square-foot minimum lot size) limits uses to such things as manufacturing, processing, and research activities. The proposed irradiator will comply with the zoning code provision which requires that "no odor, dust, smoke, gas, noise, vibration, or radiation [emphasis added] be emitted which causes a measurable nuisance beyond the property line" (see Section 5.1). Hence, no direct impact on surrounding uses is anticipated during normal operation of the irradiator (possible abnormal incidents are discussed in Section 4.12.2).

Access to the site is via the main entrance road to General Lyman Field. The road has a wide right-of-way and there are no sensitive residential or institutional uses nearby. Truck traffic associated with the operation of the irradiator would increase traffic volumes on the entrance road only marginally (see Section 4.7), and then only to the extent that treated fruit is shipped via surface transport (barge and ship) rather than air.

In appearance and operating profile, the proposed facility will closely resemble existing papaya packaging houses in Hilo and elsewhere. These have proven good neighbors, and there is no evidence of lowered property value near them. The presence of radio-isotopes will distinguish the irradiator from these other facilities, but there will be no external evidence of their presence; the vast majority of people passing the facility will remain unaware that they are there.

During preparation of this EIS, members of the public expressed concern that the presence of the irradiator could depress the value of nearby properties. No detailed analysis of this possible effect was carried out for this report. Nonetheless, for reasons discussed below, construction of the irradiator on Site A is unlikely to have this effect.

First, and most importantly, the existing and planned land uses surrounding the site are industrial. Most are planned for air cargo facilities and all are reserved for activities which are directly related to the airport. The irradiator is generally compatible with all of these uses.

Even if a potential occupant of the airport industrial area might prefer (other things being equal) to avoid a site in proximity to an irradiator facility, there are virtually no opportunities available to act on that preference. Airport land is scarce, and the DOT's policy is to fully utilize the existing subdivision before developing additional land. Hence, users who wish to avail themselves of the advantages conveyed by an on-airport site will have no alternative but to accept the parcels that DOT is offering.

It is unlikely that potential users of the airport industrial area would reject that location if an irradiator is constructed there, the presence of a successful irradiation facility (i.e., one that continues commercial operation past the end of the 3-year demonstration period) may actually attract other uses (such as packing houses) which could benefit from proximity to it. If this occurs, the state may be able to increase utilization of developed airport property which is currently vacant.

4.10.2.2 Site B

As indicated above, construction and operation of the proposed irradiator is generally compatible with the industrial land use that is permitted in the area under the existing zoning. Compliance with the zoning code requirements relative to noise, odor, and radiation emissions should ensure that the facility does not have a noticeable adverse impact with respect to these parameters.

It is possible that some potential users of adjacent land may believe that there is risk associated with proximity to the proposed irradiator. If they do, the market value of the land could be affected to the extent that the area adjacent to the irradiator site is developed for a special purpose (such as a foreign trade zone). Potential users may have no viable alternative to locating there. On the other hand, concerns over the presence of an irradiator may make it more difficult to market the property to general users. As with Site A, the presence of the irradiator could attract packing houses, shippers, and others who could benefit from proximity to it. The net effect of these conflicting forces cannot be quantified at this time. But the factors discussed above and experience with properly sited irradiators elsewhere in the country (see CH2M Hill 1987) suggest that the impact will be minimal.

4.10.2.3 Site C

The proposed irradiator is consistent with the existing zoning of Site C. Its operation would not adversely affect the existing industrial uses in the area or preclude or diminish opportunities of parcels that are vacant or underutilized at the present time. In fact, packers could find it advantageous to construct or relocate their facilities to sites near the irradiator; if this occurs, it will encourage the planned industrial use of the area.

As with Site B, it is possible that some potential users of adjacent areas could avoid the area out of concern over perceived danger from the presence of radio-isotopes on the site. If so, this might partly or wholly offset the increase in demand that could be generated by spin-off from the irradiator. Given the low profile of the facility and the likelihood that continued safe operation of the facility over the years will allay most concerns, it appears unlikely that the irradiator will have a long-term negative effect on property values or the ability to use adjacent property as now planned.

4.10.3 Mitigation Measures

The proposed facility is compatible with existing land uses in the area. Hence, there is no reason why its presence should adversely affect surrounding land uses. Public concern may be best addressed through an informational program designed to make neighbors aware of the activities that take place at the irradiator and of the precautionary measures that are taken to prevent radiation leakage to the surrounding environment.

For Site B, DBED should work closely with DLNR to ensure that plans for redevelopment of the remainder of the old terminal area take the irradiator into account by providing space for potential spin-off activities such as packing houses and shipping agents.

4.11 PUBLIC SERVICES

4.11.1 Fire Protection

4.11.1.1 Existing Conditions

Fire protection services are provided by the Hawaii County Fire Department. The department has four stations in Hilo:

Primary Station	Distance to Sites Services to Site	A (miles)	B (miles)	C (miles)	Equipment at Station
Central Station	---	4.0	2.0	3.5	1-2 Engine Trucks
Waiakea Station	A and B	2.0	3.5	2.5	1 Engine, 1 Rescue, and 1 Helicopter
Kawailani Station	C	4.0	3.5	2.5	1 Engine Truck
Kaumana Station	---	6.0	4.0	5.5	1 Engine and 1 Tanker

4.11.1.2 Impacts

The proposed commodities irradiation facility does not involve the use of solvents, petroleum products, or other chemicals which constitute a significant fire hazard. The irradiation process itself does not require the use of high-voltage power or large mechanical or electrical equipment which is particularly susceptible to fire. In view of this, the fire hazard is considered low.

In the unlikely event that a fire should occur, initial fire-fighting services would be provided by the Hawaii County Fire Department.

Based on the distances that are involved, it is apparent that a unit from the nearest station could reach any of the potential irradiator sites within 5 minutes or less. A fire department representative stated that in the case of fires in industrial areas, additional units are automatically sent to back up the primary service station. Because of the relatively short distances that are involved, at least one back-up unit could be on the scene less than 10 minutes from the time the alarm is received.

Given its concrete construction, the fact that the radio-isotope is stored in a deep pool of water which effectively absorbs the gamma radiation, and the absence of substantial amounts of flammable materials in the radiation processing area, it is extremely unlikely that a fire would originate in proximity to radioactive materials. Hence, fire fighting would involve only the normal procedures used to fight structural fires; fire fighters would not normally be exposed to radioactive materials. Impacts associated with extremely unusual events are discussed in the risk assessment summarized in Section 4.12.

4.11.1.3 Mitigation Measures

No mitigation measures beyond those features already incorporated into facility design would be necessary.

4.11.2 Security/Police Protection

4.11.2.1 Existing Conditions

Police protection in Hilo, including all three of the alternative irradiator sites, is provided by the Hawaii County Police Department. Both the department headquarters and the county jail are located in Hilo, less than 3 miles from the potential irradiator sites. The police department regularly patrols all of the areas under consideration as potential irradiator sites. Several project-related security concerns have been identified during preparation of this report. These include the need to: 1) prevent theft of the products treated at the facility; 2) prevent unauthorized persons (such as youthful vandals) from entering the building and becoming accidentally exposed to harmful levels of radiation; 3) keep unauthorized personnel from gaining access to the radioactive source material and diverting it to illegal purposes; and 4) control access to the area in the event of an accident condition. These issues are discussed below in the impacts section.

4.11.2.2 Impacts

<u>Theft of Product</u>

In most respects, the security required for the proposed facility is the same as that needed for any warehousing and food processing operation: commodities stored onsite (processed and unprocessed) must be protected from theft and vandalism. A perimeter fence and entry-resistant locks will be provided on all exterior doors for this purpose.

None of the existing fruit packing operations or other industrial/warehousing facilities in the town have reported undue problems with theft, vandalism, or other criminal activity. Moreover, the relatively low unit value of the products that would be treated at the facility and the absence of an effective local market for this type of stolen property means that the commodities would not be attractive targets for thieves. In view of the foregoing, it is highly unlikely that substantial amounts of product will be illegally removed from the facility.

Prevention of Unauthorized Entry

During the demonstration phase of the project, the facility will be staffed for only one 8-hour shift, 5 days per week. To prevent unauthorized persons from entering the facility and being accidentally exposed to radiation, all outside entrances to the facility will be locked and a security alarm system will be activated whenever the facility is not in operation. Inside the facility, all entrances to the radiation area will be separately protected by locked doors and an alarm system. Finally, the radiation source will be stored in the water pool whenever the facility is not operating. This will reduce the amount of radiation in the treatment area to acceptable levels when the system is not operating, further reducing the risk of accidental exposure.

In view of the security measures that will be provided, it is extremely unlikely that unauthorized persons could gain access to the facility when it is closed. The interior safeguards that will be provided make it even less likely that an unauthorized entrant could approach the source. Even if vandals were able to penetrate the exterior security screens, there is virtually no way that vandals could damage the source or other equipment in such a way that radioactivity is released. In this respect, it is worth noting that the numerous similar mainland and international irradiation facilities have not suffered from vandalism.

Theft of Radioactive Source

The transport and use of radioactive material is so closely controlled that it is virtually impossible to sell any illegally acquired cobalt-60. This eliminates the major incentive for its theft and limits potential thieves to persons who intend to use the radioactive material for some type of blackmail or terrorist activity. Further, the rods of cobalt-60 that serve as the facility's radiation source are highly radioactive. As a result, their safe removal and transport is a complicated process involving heavy equipment and elaborate storage containers (see Appendix G for a discussion of source installation and removal). These containers are normally not stored on the island, which means that a potential thief would need to import them for this purpose. In view of the container's size, cost, and, most importantly, rarity, it is almost inconceivable that the source rods could be removed.

Access Control During an Accident

The design of the facility is such that there are no physical means by which radioactivity could spread beyond the radiation room in the event of an accident unless it were fractured. The steps that have been taken to ensure that this does not happen are outlined in the risk assessment contained in Section 4.12.2. Because of this, the same access controls that are used to secure the facility during normal operations will provide adequate protection during an accident. In addition, alternate access routes are available to all areas adjoining the sites under consideration for the irradiator, making it possible to close road access to the facility without isolating neighboring properties if this were even considered appropriate as a precautionary measure.

4.11.2.3 Mitigation Measures

No mitigation measures are required.

4.11.3 Effects on Public Health Facilities

4.11.3.1 Existing Conditions

There are no public health facilities in the immediate vicinity of any of the sites under consideration for the proposed commodities irradiator, and the facility would not increase the population requiring medical services. Hence, its impact on health care facilities would be limited to emergency situations. The existing health care facilities in Hilo and their ability to deal with normal industrial accidents and radiation exposure are discussed below.

Hilo Hospital, a full-service state hospital located on the north side of Hilo, is approximately 5 miles from the irradiator sites. This modern health care facility has an emergency room, intensive care unit, and 166 acute care beds (Ramos personal communication June 29, 1988). It is equipped to handle all normal industrial accidents. According to Ms. Donna Maiawa of the Emergency Medical Services Systems Branch, State Department of Health (June 29, 1988), the hospital has the facilities and personnel needed to treat individuals exposed to radiation.

In the unlikely event that a person was exposed to irradiation, normal procedures call for the person to be treated first at the irradiator site. Initially, aid would be rendered by other members of the irradiator staff at the direction of the site Radiation Safety Officer. They would be assisted by members of an emergency medical response team made up of fire department and ambulance personnel as soon as they arrive onsite. Treatment would consist largely of removing contaminated clothing and washing the exposed person. Once this has been done, the patient would be transported by ambulance to Hilo Hospital. Emergency room doctors trained to treat radiation exposure are on duty 24 hours a day at the hospital. In addition, procedures are in place which would allow those doctors to consult with specialists in Honolulu and on the mainland as necessary.

4.11.3.2 Impact of Normal Industrial Accidents

Operation of the facility involves the movement of produce to and from the site, and within the facility itself. This inevitably creates a potential for transportation and industrial accidents. This potential exists for all processing activities and is no different for the proposed irradiator than for any of the fruit packing operations already present in the Hilo area.

The staffing of the irradiator is low (4 to begin with; with peak onsite employment estimated at 7 persons in CH2M Hill 1987) and transportation accidents typically involve only a few people. Hence, existing health care facilities have adequate capacity to accommodate project-related health problems.

4.11.3.3 Impact of Accidents Involving Radiation

Because the cobalt-60 used as the radiation source for the project would be transported to and from the treatment facility in virtually impregnable casks (see Appendix G for a discussion), the only measurable risk of radiation exposure is limited to the one or two workers at the facility whose jobs take them into the irradiation area. The existing medical facilities described above are capable of accommodating this small number of patients.

4.11.3.4 Mitigation Measures

No mitigation is required beyond the design features already included in the project and the operational procedures required by the NRC and FDA.

4.12 HEALTH AND SAFETY

The assessment of health effects of the project has been divided into analyses of two issues: (1) the potential health effects of eating irradiated food; and (2) risks to the community associated with the facility's use of cobalt-60. A risk assessment on the safety of irradiated food and on the use of cobalt-60 is included in Appendix G to this EIS. A brief summary of its findings is given below.

4.12.1 Health Risks of Consuming Irradiated Food

4.12.1.1 Impacts

The safety of irradiated food has been extensively studied over the past 30 years. The focus of the research has been on the chemical changes (production of radiolytic products - see Appendix G) that occur in food as a result of irradiation, the potential for toxicity, and the effect on nutritional value.

As a result of irradiation, food molecules undergo various chemical reactions forming minute amounts of new compounds. Although many post-harvest chemical changes in food are unwelcome from a health perspective, a variety of processes that alter food are common. For example, a large percentage of food is cooked; the cooking process drastically alters the chemical composition and structure of food and also renders some foods edible that would otherwise not be; curing, culturing, and freezing also change the chemical composition.

Irradiation chemically changes food comparatively little compared to common post-harvesting food processes. The ions and/or free radicals produced in food as a result of irradiation undergo various reactions that cause chemical changes. Some of these alterations affect bacteria and mold on the surface of the foods, thereby eliminating their potential to attack the food product and extending its useful life. Other alterations occur to the food itself; one concern of food irradiation is that irradiation creates unwanted radiolytic products in food. Radiolytic products are not unique to irradiation; humans are exposed to radiolytic products through their intake of cooked and other processed food. The list of organic compounds that are present in human daily intakes have been identified and the potential concentrations from irradiation are orders of magnitude below recorded levels from other sources (Zurer 1986; Wierbicki et al. 1986). For example, benzene is present in many nonirradiated foods. There is about 2,000 times more benzene in a boiled egg than is produced by irradiation, this even for the high doses needed for sterilization. Also, hydrocarbons, aldehydes, ketones, polymerized fats, and free fatty acids are commonly produced in large quantities by cooking foods, whereas in irradiated foods they are found in trace amounts (Zurer 1986).

In the 30 years of research on the formation of radiolytic compounds in food from irradiation, no unique radiolytic products of toxicological concern have been found (Lubin 1985). The FDA has concluded, on the basis of low concentrations of unique radiolytic products, that there is no need for toxicological testing for food irradiated below 1000 Gy. Nevertheless, some argue that every unique radiolytic product should be proven not to be carcinogenic before food irradiation proceeds. Food chemists regard the term "unique" as a misnomer since these products are not unique or uncommon. They assert that claims that these products can cause toxic effects are unsupported and that there is no evidence that the products can survive normal digestive process.

Understanding the mechanisms by which radiation reacts with proteins, fats, carbohydrates, and other food components leads to the conclusion that there will not be any products formed during the proposed operations that are unique in a chemical sense (Merritt, in Zurer 1986). The types of compounds formed from irradiation have not been found to be toxic to humans. Fundamentally, the existence of these products is below levels of toxicological concern for the facility. No adverse health effects from eating irradiated food have been found in scientifically valid studies (51 FR 13384). The data uniformly negate the existence of significant potential adverse effects at the levels of ionizing radiation below 1000 Gy. The results from qualitative risk assessment also indicate that exposure of papaya to ionizing radiation is not likely to cause adverse health effects to humans if operated within the levels discussed and in the prescribed manner, as determined by the cognizant regulatory agencies. Each proposed facility alternative, regardless of radiation source employed, also presents no potential for inducing radioactivity in fruit.

Induced radioactivity in irradiated food will not occur. Just as normal exposure to medical x-rays does not induce residual radioactivity, such ionized energy levels do not make food radioactive. While some forms of ionizing radiation can induce radioactivity, they are excluded from use in treating foods. Neither of the FDA-approved gamma ray sources (cobalt-60 and cesium-137) induce detectable radioactivity in food at any dose. The FDA, in the *Final Rule on Irradiated Food,* has determined that "....irradiation of food does not cause the food to become radioactive..." and that "....the safety of food irradiation below 1 kGy (100 krad) has been established" (51 FR 13377). This limit is conservatively below the level of up to 30 kGy held to be safe by the International Consultative Group on Food Irradiation.

It is concluded, from a review of the available scientific evidence, that consuming food irradiated at the levels proposed for commercial operation presents no significant consequences to human health.

4.12.1.2 Mitigation Measures

No measures beyond the limits prescribed by law are necessary to protect consumers from consuming food processed in the proposed facility. Because some people are unconvinced of the safety of irradiated food, foods irradiated in this facility will, until April 18, 1990, be labeled so that individuals can recognize the food as irradiated and make the choice to consume the irradiated product.

4.12.2 Facility Risk Assessment

The proposed facility will involve transport and use of radioactive material, namely cobalt-60. An assessment of the potential risk to facility workers and the public from such activities is detailed in Appendix G. Disposal of the source is not included because at the end of its useful life at the food irradiator, the source is to be returned to the manufacturer for further use or disposal, as appropriate.

In this section, a brief discussion is given of the dose that everyone receives from natural background, and applicable standards for radiation workers, which may serve as perspective for what follows in the summary.

4.12.2.1 Introduction

The effects of radiation upon the body are a manifestation of the localized deposition of electromagnetic energy in the atoms along the path traveled by the radiation. The ionizations and excitations caused by this deposition can directly or indirectly alter both the chemical composition and equilibrium within the cells along the path. The effects of the radiation may be undetectable, or they may manifest themselves as acute physiological changes, carcinogenesis, or genetic effects, depending on the amount and type of incident radiation, type of cells irradiated, and time span over which irradiation occurs.

Mankind has always been exposed to naturally occurring radiation in the environment. This radiation comes from three sources: cosmic rays (highly energetic radiation from outer space), cosmogenic radionuclides (mainly produced through interaction of cosmic rays with target atoms in the atmosphere), and primordial radionuclides (with very long half-lives, some of which have remained since the formation of the earth).

Man is also exposed to radiation as a result of his activities, such as x-rays, air travel, or nuclear power generation. Scientists and government have attempted to identify the levels of additional exposure that are acceptable from a human health standpoint. The International Commission on Radiological Protection recommends limits of 50 millisieverts (mSv) per year for persons occupationally exposed to radiation and 5 mSv per year for others. To put these numbers in context, Table 4-6 lists the annual dose that is received from various natural and manmade sources. The U.S. EPA, NRC, and DOE have developed limitations on the use of radioactive materials to minimize the chance that excessive exposures will occur.

During normal operation, the irradiation facility would not result in emissions of radiation that could affect man. If an accidental release occurred, however, exposure could result. Consequently, the risk assessment in Appendix G identifies the types of accidents that could occur, estimates the probability of such accidents, and determines the worst-case exposure that could result. Such exposure levels can then be interpreted in light of potential health effects.

4.12.2.2 Risk from Facility Malfunction and Source Transportation

The risk assessment reviewed the facility operations and safeguards, most of which are discussed in Section 2. Further, the safety records of other facilities and of radioisotope transportation were evaluated. The analysis concluded that the design of the facility would minimize the chances of a significant release of radioactivity due to malfunction or operator error that could cause exposure to human beings and the environment. Likewise, the analysis concluded that transportation packaging and operations are sufficiently safe that no

Table 4-6

AVERAGE INDIVIDUAL RADIATION EXPOSURE

Natural Radiation Sources	Effective Dose Equivalent Per Year
From Natural Sources of Radiation in Areas of Normal Background	
Cosmic Rays at Sea Level	0.30 mSv
Radon (^{222}Rn and ^{222}Rn from ^{238}U and ^{232}Th, respectively)	1.37 mSv
Potassium (^{40}K)	0.30 mSv
Other	0.02 mSv
Total (rounded)	2.00 mSv
Manmade Radiation Sources	
From Medical Uses of Radiation (corresponds to about 20% of the annual exposure from natural background)	0.40 mSv
From Nuclear Explosives Testing (corresponds to about 1% of the annual exposure from natural background)	0.02 mSv
From Nuclear Power Production (corresponds to less than 0.1% of the annual exposure from natural background)	0.001 mSv

Source: CH2M Hill 1987

significant risk would occur; the U.S. transportation industry's safety record supports this conclusion.

4.12.2.3 Risk from Damage to the Facility by Outside Events

The facility's location near an airport and an active volcano has resulted in questions about a radiation release caused by outside events. The risk assessment screened many potential event scenarios associated with aircraft operations, natural phenomena (e.g., volcanism, flooding), and surrounding activities of man. It then assessed, in depth, the following types of events:

- Aircraft Crashes
- Industrial/Military Accidents
- Transportation Accidents
- Seismic Activity
- Volcanic Hazards

The aircraft crash analysis assessed the probable impacts of an accident involving four types of military and commercial aircraft that use, or can be expected to use, General Lyman Field. It also evaluated the effect on the facility if an airplane were carrying a bomb, which exploded at the facility. The results of structural damage, fire, and explosion were evaluated. In a worst-case scenario, health effects from exposure at the facility boundary could be significant; the probability of this scenario happening, however, appears very low. Subsequent to the risk analysis, the State of Hawaii Department of Defense was contacted. Under current military operations, munitions are not transported through Hilo airport (Hawaii Department of Defense - Lum consultation). Thus, this accident scenario would not occur under current military practices.

Accidents at nearby industrial and military facilities were assessed to determine their potential to damage the irradiation facility and cause a radiation leak. The worst-case scenario selected was an accident involving a 10,000-barrel low-pressure propane storage sphere at the propane storage facility located 1 to 1-1/2 miles from the irradiator site. If the contents of the sphere could be detonated, there is the potential (although it is extremely improbable) for an explosion with a high-explosive equivalent yield on the order of 2 kilotons. Although this would devastate nearby structures, the overpressures reaching the potential irradiator facility sites would be less than 4 psi, which would pose no threat to the irradiation facility structure or the contained cobalt source.

A variety of hazardous materials that could potentially be involved in a transportation accident, where the material or its effects could propagate to the site and cause damage, were evaluated. Of the transportation accidents identified, explosion of a propane tank truck near any of the sites has the most significant potential consequences. Propane, more energetic per unit mass than high-explosive, could potentially be released and ignited as the result of a tank truck accident in the vicinity of the site. The radiation safety-related construction quality of the walls and roof of the facility (6-foot-thick walls and roof, heavily reinforced concrete) preclude damage to the facility if a distance from the facility to the detonation site is greater than 10 feet. Thus, detonation occurring offsite will cause no damage to the facility or the contained cobalt source, although the metal-framed warehouse could be severely damaged and the operators could be injured by such an event.

A simplified, conservative analysis of the likelihood and consequences of earthquakes on the irradiator facility structure suggests that the facility, as currently envisioned, will provide adequate protection against earthquakes occurring with probabilities greater than once in a thousand years.

Worker and public exposure to radiation could occur if a large earthquake caused major structural damage to the facility and simultaneously made it impossible to lower the source into the shielding pool. The likelihood of an earthquake capable of causing such damage is believed to be low. The probability of pool failure is expected to be lower than that for the structure in general because the pool is embedded in the soil. In addition, the pool has a steel liner that will retain its integrity beyond the point at which the concrete pool wall begins to crack. It was concluded that the probability of leakage from the pool is also very low. The likelihood of a seismic event occurring at a time when a leaking pencil has contaminated the pool is even more remote. The small amount of cobalt-60 that might be released into the subsoil as a result of such a sequence of events would not produce any detectable health effects.

As discussed earlier in Section 4, the Island of Hawaii is an area of active volcanism. Hilo itself has been threatened or affected in historic times from flows originating from the northwest rift of Mauna Loa. Earlier lava flows from this rift zone have built a broad ridge that also trends toward Hilo. Recent work by the U.S. Army Corps of Engineers (1980) examined the risk of volcanism affecting the City of Hilo.

Preliminary discussions by CH2M Hill with the Geological Survey in Hawaii and with Sandia National Laboratories in New Mexico, indicate the very low probability that lava flows could cause a release of radioactivity from the sealed sources to the environment. Specifically:

- Lava flows are too viscous to enter the irradiation chamber through a labyrinth.
- The proposed design would prevent any movement of the facility due to the weight of a flow against the facility.
- The concrete shielding walls would not melt or crack due to either chemical or heat transfer attacks of the lava flows.
- The temperature rise inside the irradiation chamber, due to heat transfer through the concrete walls, would be insignificant due to the large thickness of the walls.

However, if in a given situation lava flows were perceived as a threat to facility safety, the source could be removed from the facility and transferred to a different location, prior to the lava reaching the facility (see Section 4.2).

4.12.2.4 Impacts

Based on the assessments discussed in Appendix G, the following can be concluded:

1. The risk of radiation exposure to workers or the public due to external events affecting the food irradiation facility are extremely low.
2. The massive structure of the facility is the key factor in reducing hazards associated with external events.
3. The only external events that threaten significant public exposure are aircraft crashes into the site. The probability of aircraft crash is in the range of 10^{-5} to

10^{-7} per year, depending on class of aircraft and site considered. The probability of exposure and health effect is far lower.

4. Direct exposure due to reduced or breached shielding is likely to be a more important contributor to public dose commitments than is the dispersal of radioactive material from the site.

4.12.2.5 Mitigation Measures

Emergency preparedness will be a critical element in controlling risk associated with loss of facility shielding integrity. Emergency plans must be in place and emergency response personnel thoroughly trained to deal with accidents that damage the facility structure or incapacitate the operators. These plans must be approved by the NRC prior to acceptance of the source onsite.

One objective (see Section 2.1) is to provide education on the irradiation process to the public. This program should educate the public on the risks associated with the facility and the measures that have been incorporated into the design and operation of the facility to protect public health and the environment. This education program should serve to minimize misperceptions about risk and radiation exposure.

4.13 AESTHETICS

4.13.1 Existing Conditions

As noted in other sections of this EIS, all three site areas and specific locations within those areas are currently industrial or airport areas. Consequently, surrounding uses reflect the character of the area. Site A is currently vacant but set aside for airport-related industrial uses. Site B is also currently vacant but appears to have once served as the site of airport-related activities. Site C is also vacant and once served as the site of a concrete batching and ready-mix plant.

4.13.2 Impacts

As a result of past land use patterns, the proposed irradiation facility, which will resemble any industrial type warehousing/processing facility, will blend in and be visually compatible with surrounding uses. It is expected that the plant will be a relatively low-rise structure consisting primarily of a metal warehouse for in/out storage of commodities, a refrigeration unit within the metal warehouse building, and an attached concrete-walled irradiation room. As indicated, the visual character of the facility will not distinctively distinguish the facility from surrounding buildings and/or facilities. The primary difference in the facility, depending on the site used and the particular siting constraints of the site, will be the traffic flow pattern for trucks entering and leaving the area. The facility will be landscaped in accordance with architectural drawings and county code requirements; chain-link security fencing will surround the perimeter of the facility.

4.13.3 Mitigation Measures

No mitigation measures are required.

4.14 ECONOMICS

4.14.1 Existing Conditions

All three alternative sites for the irradiation facility are located within industrial and/or commercial areas near General Lyman Field in Hilo, which is the governmental, commercial, and industrial center of the Big Island. Hilo has an estimated population of about 36,500 and at the last census in 1980, the civilian labor force of the Hilo area was about 17,500. Recent employment statistics indicate an unemployment rate of almost 5 percent versus a statewide rate of just under 3 percent.

Per capita income in the Hilo area was estimated at $6,900 in 1980, with the household median of about $18,000 and family median of about $20,500. The majority of the workforce is employed in nonagricultural jobs, with manufacturing, food processing, trade, services, and government being the principal industries. Agricultural workers comprise about 14 percent of the workforce.

In 1987, almost 4,000 acres were planted in papaya statewide, most of it in the Puna area of the Big Island. About 55.4 million pounds of the fruit were harvested, a 10-percent increase over the previous year. Although production did increase, it fell short of the original forecast of 66.5 million pounds, based on the reported high level of new plantings in 1986. Low levels of production were experienced in the first part of the year, but increased significantly during the second half of the year.

In 1987, 72 percent of the total crop was exported, 42 percent to the mainland U.S. By 1992, the Papaya Administrative Committee expects 85 percent of the papaya crop to be exported. The total value of production of fresh papaya in 1987 was $10.8 million, compared to $233.8 million for all crops in Hawaii. The average wholesale price of papaya on the mainland was $1.13 per pound in 1987, down from $1.30 in 1986.

The Hawaii Papaya Industry Association forecasts fresh papaya production of 65-million pounds in 1988, 75-million pounds in 1989, and 85-million pounds in 1990, assuming "that there will be no major production and/or distribution disruptions caused by both internal and external forces" (Production, Marketing, Income, and Industry Review, Robert A. Souza September 25, 1987). Most of the papaya in the state is grown on leased land and sold to one of eight processors for culling, treatment, packing, and shipment. All processors have facilities to provide double-dip treatment of fruit.

One of the processors, the Diamond Head Papaya Company, also operates a $1.7-million plant in Keeau which has the capacity to treat 30,000 to 40,000 pounds of fruit per day by vapor heat (Pacific Business News June 1, 1987). Hawaiian Host has opened a $5-million vapor-heat treatment plant in Hilo; at full capacity, the facility can process 80,000 pounds of fruit per day.

A recent development is the April 28, 1988, approval of the dry-heat method to meet APHIS requirements. Research indicates this method may also be effective in treating a variety of other fruits and vegetables.

4.14.2 Financial Feasibility

Since the federal government banned the use of the pesticide EDB, the papaya industry has used the double-dip method to control fruit fly infestation in papaya shipped to the mainland. This method has not proven to be entirely effective, as witnessed by a shipment of fruit-fly-infested papaya to California in spring 1987. Also, since the fruit must be picked at a low level of ripeness, there have been problems with fruit quality and taste which affect consumer acceptance and sales. To ensure the continued viability and growth of a $25-million industry which employs 600 persons (according to Mayor Carpenter, in

East West November 1987), as well as to explore the potential for treating and exporting other locally grown fruits, the irradiation demonstration program was proposed.

The economic and technical feasibility of the proposed irradiation facility was assessed in the *Feasibility Study for a Commodities Irradiation Facility in the State of Hawaii* by CH2M Hill. In summary, it was concluded that irradiation would be economically feasible if: 1) the resulting improvement in the quality of the fruit results in increased market prices or an increase in the volume of export, or 2) the double-hot-water-dip treatment proves unacceptable for whatever reason (poor quality of fruit, etc.). Irradiation was deemed to be cost competitive compared to the double-dip method at high volumes, but not at low volumes of export.

4.14.3 Analysis of Market Demand

The analysis of potential beneficial and adverse economic impacts is based on the assumption that a commodities irradiation facility would be constructed and operated to satisfy market demand for irradiated papaya and perhaps other irradiated fruit. Irradiated fruit has not been available in U.S. markets to any measurable extent and hence there are no significant sales data on the marketability of such products. The question of market demand is crucial in the analysis of potential impacts of a facility that may or may not be an economically viable venture.

The successful marketing of irradiated papaya and other fruit depends on consumer acceptance of the treated produce, i.e., their willingness to purchase the fruit, and on the availability of the fruit at the retail market level. Specific questions need to be addressed in estimating the demand for irradiated fruit:

- Are consumers familiar with the concept of food irradiation?
- What marketing efforts, including labeling, promotion, and education, would affect consumers' willingness to buy irradiated foods?
- Would consumers buy irradiated fruit if no alternative were available (the same fruit treated through a different method)?
- Would consumers buy irradiated fruit if there were alternatives?

- Are sectors of the industry (shippers, wholesalers, retailers, etc.) willing to market irradiated papaya and other fruit?

4.14.3.1 Demand Analysis for Irradiated Fruit

The CH2M Hill feasibility study contained an analysis of demand prepared by the E. Bruce Harrison Company. Three separate surveys were conducted: an industry survey, a consumer survey, and a community opinion survey. Results of the industry survey led the surveyors to the conclusion that food irradiation would be accepted by the food industry if American consumers are educated about the irradiation process.

In the consumer survey, over 1,000 interviews were conducted in eight key mainland markets. Almost 70 percent were very likely or somewhat likely to buy papayas, mangoes, avocadoes, or lychees, if they were irradiated. It should be noted that only 31 percent of the sample said they had heard of food irradiation. The study concludes that American consumers are not averse to food irradiation and are interested in learning more about how it works.

The third component, the community opinion survey, consisted of in-depth interviews with interested parties. Key findings included the following: both supporters and opponents agree that the irradiation issue will become important and be potentially quite devisive; an active anti-irradiation campaign has been started, alleging unresolved safety issues; and at the time of the survey, no Hawaii County business organizations had formally come out in favor of irradiation.

4.14.3.2 Consumer Acceptance Study of Irradiated Fruit

To assess the extent to which commodities treated at an irradiation facility would be accepted by consumers, a consumer acceptance study was prepared for this EIS (see Marketability of Irradiated Mangoes, Papayas, and Lichees, by Howard G. Schutz, in Appendix I of this EIS).

Schutz reviewed various studies and surveys on consumer response to, and acceptance of, irradiated foods; his findings are summarized below. He cautions that in almost all cases, discussion focuses on the evaluation of a concept rather than experience with a particular product, as few of those surveyed have actually tasted irradiated fruit. Indeed, although some of the studies focus on particular kinds of irradiated foods such as seafood and fruit, papaya in particular, most focus on consumer attitudes toward irradiated foods. Additionally, there is a strong possibility that among those who had not heard of irradiation, once informed of the process, a certain percentage would choose not to purchase irradiated products (Schutz personal communication June 24, 1988).

4.14.3.3 Awareness of Food Irradiation

Five studies examined by Schutz (including four that were nationwide) show that a high proportion of U.S. consumers is unfamiliar with the food irradiation process, with awareness (or degree of familiarity with the product) ranging from 23 to 66 percent of the population. Schutz sees an advantage in these statistics from the viewpoint of marketability, as there is potential for influencing those people who have not yet formed an opinion on food irradiation. A corollary disadvantage is that it will be necessary to provide a great deal of education, promotion, and advertising to inform potential consumers of the irradiation process.

Rather than asking about specific concerns and trying to estimate willingness to purchase, several of the studies elicited general comments from consumers. Positive perceptions of irradiated food included general safety and freshness of food, lessened danger of disease or sickness from food, elimination or reduction of chemicals, and a longer shelf life. Many of the negative concerns seemed to be derived from the association of irradiation with radioactivity and fear aroused by the term "irradiation."

4.14.3.4 Areas of Consumer Concern

Schutz identified seven general areas of concern expressed by organized groups opposing irradiation:

- Unproved safety of irradiated food;
- Concern that certain nutrients are lost in the irradiation process;
- Belief that the Department of Energy is using food irradiation to dispose of cesium-137 waste from nuclear power plants;
- Concern for safety of workers in plants and in transporting materials to and from plants;

- Concern that a change in labeling requirements would make the meaning of the Radura symbol unclear (association of the symbol with the statement "treated by irradiation" will no longer be required by 1990); and
- Belief that the radiation process would result in additional cost to the consumer.

Schutz concludes that the concerns identified above have to be dealt with if irradiated products are to be successfully marketed.

4.14.3.5 Levels of Consumer Concern: Irradiation Compared to Other Food Preservation Techniques

Schutz reviewed several studies which investigated consumer concerns regarding various food preparation techniques. He found that irradiation aroused less concern than the use of chemical sprays or food preservatives. In one study (Weise 1984) 38 percent of respondents voiced concern for irradiation, whereas 55 percent voiced concern for the use of chemical sprays, 50 percent for disease, 42 percent for preservatives, and 45 percent for wastes. (It should be noted that these results were for both respondents who had heard of irradiation and those who had not. Hence, they may not accurately reflect consumer response to a product that is being actively marketed.)

In a later study conducted for *Good Housekeeping* (McNutt 1985), food irradiation again appears to have aroused a lower level of concern among respondents than have chemical sprays (80 percent) or preservatives (75 percent). It is interesting to note that when irradiated foods were characterized as "foods treated with electro-magnetic energy/ionized," 41 percent of respondents voiced major concern, whereas only 19 percent voiced such concern when food was characterized as "irradiated to prevent spoilage." Schutz points out that this shows the importance of giving meaningful reasons to the consumer for the use of this food preservation technique rather than just indicating that the food irradiation process was used.

The importance of providing adequate information to consumers is also highlighted in two other studies (Harris 1985; McNutt 1985a). In the Harris study, for the total sample of consumers, there was no difference in preference for the use of either chemical preservatives or irradiation. Among those who had heard of irradiation, there was a higher level of preference for irradiation (39 percent) than chemical preservatives (24 percent). In the McNutt study, the number of those who indicated a preference for irradiation over preservatives was also greater than the opposite. However, 44 percent of the total sample did not know enough to judge, which points to the need for additional information for consumers to make more intelligent decisions regarding irradiated food.

4.14.3.6 Willingness to Buy Irradiated Food

The results of six studies which tested the willingness of respondents to buy irradiated food show a low of 32 percent likely to buy irradiated pork to 69 percent likely to buy irradiated fruit, including papaya. (Questions were formulated differently in each study and the type of information available before questions were asked varied; hence, results are not entirely comparable.)

In a Canadian study, the process of irradiation was not described as such, so that those surveyed did not realize that they were being questioned about an irradiated product. Schutz concludes that this could have contributed to the increased willingness to buy the irradiated product (3 to 1 positive intent to purchase when a non-irradiation name was used).

Schutz notes that "although there are many food treatment techniques which arouse higher levels of concern than irradiated foods, products with such treatment nevertheless are purchased in the marketplace." This leads to his assumption that were there no other alternatives to certain irradiated food products, consumers would buy these products in the same way that they purchase foods containing preservatives or treated with insecticides. A caveat from Schutz is that this is hypothetical; the U.S. consumer has not yet been faced with a decision about whether or not to make an irradiated food purchase. Presently, such items are not sold in the U.S. marketplace.

4.14.3.7 Reaction of Retail Markets to Irradiated Foods

Only two North American studies involving the reaction of the retail trade to the concept of irradiated food items were found in Schutz's review. In a Canadian study conducted in 1986, retail trade respondents gave a generally negative response to questions about irradiated seafood products since consumers prefer fresh fish to fish that have been irradiated to prolong freshness. A second study focused on mangoes, papayas, and lichee nuts (Harrison 1987). In that study, there were reservations about consumer acceptance.

Researchers felt that concerns about irradiation would have to be answered, and the process promoted, before the technology could be accepted.

Schutz points to an example of the importance of public opinion, or at least a vocal segment of the public: "Illustrative of the sensitivity of producers to public opinion concerning labeling and irradiation was the recent withdrawal from the marketplace of a rice mixture which contained a minor unlabeled irradiated mushroom." The situation was made public by a group opposed to food irradiation.

4.14.3.8 Influence of Information/Education on Food Irradiation Attitudes

Research conducted by the Brand Group in 1986 led to its conclusion that, as to educational efficacy, there are three groups of consumers: rejecters, who constitute an estimated 5 to 10 percent of the population, whose attitude will not be affected by education; undecided, an estimated 55 to 65 percent who have concerns, are confused by technology, and to whom education and promotion are important; and acceptors, representing an estimated 25 to 30 percent who believe they understand technology and have positive attitudes which could be shaken by exposure to the concerns of others and, therefore, for whom education is important. Education would thus be beneficial to all but the rejecter group, a minority, in increasing willingness to buy irradiated products.

Other studies also seem to illustrate the importance of the role of information in increasing willingness to try irradiated food products.

4.14.3.9 Label and Positioning Influences on Food Irradiation Attitudes

Four research studies involving label and positioning variables have been conducted, with results showing that:

- Consumers want irradiated food products to be labeled.
- Irradiation as the description for irradiated products fares poorly relative to alternative descriptions of the process.
- Radura, as the symbol chosen to denote an irradiated product, did not receive as positive a response as other symbols, particularly the "Sun" label.

- Label statements which promoted specific aspects of irradiation did not produce increased willingness to purchase.

Although it is uncertain how irradiated products should be labeled, consumers do support labeling requirements for such products.

4.14.3.10 Marketing Efforts

As mentioned earlier, most studies surveyed focused on the concept of irradiated food products rather than on the products themselves. This was due to the unavailability of irradiated foods, a deficiency proposed for resolution by the irradiation demonstration program. Schutz uncovered three marketing efforts for irradiated food, one of which was long-term and two demonstrations.

The first study was conducted in South Africa where potatoes, mangoes, papayas, and strawberries were marketed with special promotional activities during an 8-month period in 1978 (Webb 1983). Leaflets, newspapers, television and radio ads, and in-store advice were used, as was the help of consumer organizations. Products were identified by the Radura symbol and other labeling. The result was 90 percent consumer acceptance and general retailer satisfaction. This study seems to demonstrate the important role of a major promotional and advertising effort in the successful marketing of a product. However, Schutz gives two reasons why the South Africa experience may not be repeated in the United States. First, the product tested in South Africa may have been of a much higher quality than the one it replaced, a situation that may not be true in the United States. Second, organized opposition to irradiation in South Africa apparently did not exist to the degree that it does in the United States.

Of the two demonstration studies, one focused on mangoes sold in Puerto Rico for a short period after first being irradiated in the United States. Because of the nature of the study and its brevity, results cannot be generalized to apply to the long term in other areas of the country.

The other study in Orange County was a more carefully conducted demonstration in two upper-middle-class supermarkets where both double-dip papaya and irradiated papaya from Hawaii were marketed with in-store promotion, including taste tests with volunteer consumers. Significantly more of the irradiated papaya was sold than the double-dip product, 150 pounds versus 13 pounds during the one-day test. Also, consumers who tested the product preferred the irradiated fruit for appearance and taste over the double-dip papaya. It should be noted that responses came from those who volunteered to taste both the double-dip and irradiated products; therefore, results cannot be generalized to the total population. Nevertheless, Schutz asserts that this demonstration does show that irradiated papaya and other tropical fruit would not automatically be rejected by portions of the consuming population.

4.14.3.11 Overcoming Barriers to the Marketing of Tropical Produce

Schutz concludes that successful marketing of tropical produce is dependent on resolving several unknowns:

- The problems of consumer resistance to the siting of radiation facilities must be overcome.

- A major effort must be undertaken to educate consumers to the advantages of irradiated food and to dispel inappropriate beliefs about the safety of the product and the process of irradiation, through private and public efforts.

- The irradiated product must be of the highest quality possible.

- The retail trade will require a major education effort.

- Sharing plans and information with opponents to irradiation is preferable.

In the case of tropical fruits such as papayas and mangoes, Schutz estimates that 70 to 80 percent of the persons now purchasing those products would be willing to purchase irradiated versions if non-irradiated fruit were not available, and if an appropriate information and education program were to be carried out as part of the marketing effort. It is Schutz's belief that the market share of these fruits that can be captured by irradiated tropical fruits will be substantially lower (in the 50 to 70 percent range) if non-irradiated versions of the same fruits continue to be sold. He notes that this estimate applies to the market's initial reaction, and that it could change over time.

Finally, Schutz states that the success of irradiated tropical produce could lead to greater consumer acceptance of other irradiated food products such as other produce, pork, chicken, and seafood products.

4.14.3.12 Conclusions on Marketability

Specific surveys and studies show that the majority of U.S. consumers are unfamiliar with the concept of food irradiation. Consumers, as well as retailers, are interested in learning more about irradiation and would benefit from a wide-ranging educational and promotional effort. Retailers are willing to carry irradiated products if their customers are well informed about irradiation. Schutz does caution that boycotts and picketing would have an impact on retailers' willingness to carry irradiated food products, but has no evidence of long-term impact (Schutz personal communication June 1, 1988).

Given no alternative, Schutz estimates that 70 to 80 percent of those who normally purchase such fruit would buy papaya, mango, or lychee that had been irradiated, but that only 50 to 70 percent would be willing to buy irradiated fruit if non-irradiated fruit was also available.

4.14.4 Potential Economic Impacts

The proposed commodities irradiation facility is a 3-year demonstration project to be supported, in part, by federal and state funds. Economic effects will be empirically determined during the life of the project. The DBED is currently in the process of soliciting proposals from interested parties to design, construct, and license an irradiation facility which would be leased for exclusive use by the government during the 3-year demonstration period. It is expected that the economic impacts can be more realistically projected after selection of an operator.

Long-term impacts are contingent upon the outcome of the 3-year demonstration, whether there is a demand for irradiated fruit, the cost-effectiveness of using irradiation as a method of disinfestation given certain levels of demand, and the availability of alternate cost-effective methods of disinfestation, and the potential for irradiation to result in increased or new demand for Hawaii export produce. Impacts would be incremental and reflect the difference between the existing and proposed facilities, and between the existing and projected levels of production for fresh papaya and other fruit for export.

Also, a successful produce irradiation facility demonstration program would have a positive long-term impact on the agricultural sector of the Hawaii economy. If the irradiation process were to be found economically feasible and acceptable to consumers, crops which at present cannot be exported would have the potential to become export crops and contribute toward the growth of Hawaii's agricultural industry.

Following is a review of the potential positive and negative economic factors associated with the proposed irradiation facility, addressing economic concerns raised in the responses to the EIS Preparation Notice and at public scoping meetings.

4.14.4.1 Costs of Construction and Operation

The cost to design, construct, and operate the irradiation facility will be determined by the successful contractor responding the DBED's request for proposal. The preliminary cost estimate for the 3-year demonstration program is $5.5 million, with the U.S. Department of Energy providing $4 million, and the State of Hawaii providing $1 million for planning and construction. Should the facility be decommissioned after the demonstration period, the contractor will be responsible for paying decommissioning costs.

During the operational period, the state intends to lease the facility from the operator, who will operate the facility with its own personnel. Reimbursement for these services will include an annual lease amount and periodic payments for operations. The operator will be responsible for purchasing and maintaining comprehensive general liability insurance and other insurance, as required. All revenues received from the commercial treatment of fruit during the demonstration period will be retained by the state.

Robert Souza, Manager of the Papaya Administrative Committee, expects that existing double-hot-water-dip and vapor-heat-treatment facilities at the seven packing houses identified in Section 2.2 will not be dismantled if the commodities irradiation facility is built. To date, packers have not committed their fruit to the irradiation facility and will retain the double-dip facilities for potential reuse should irradiation treatment not prove viable. Souza believes that most of the double-dip facilities have been fully depreciated and that packers would have no incentive to dismantle them. Since these facilities would remain intact, there would be no costs associated with dismantling.

The CH2M Hill feasibility study contains the following cost comparison for alternative processing methods:

Process	Unit Cost (¢/Pound)
EDB	1.3 to 1.8
Vapor-heat	12 to 35
Double-hot-water-heat	2 to 5.5
Irradiation	1 to 3 (for large volumes)

Other estimates of irradiation unit cost range from 1¢/lb at very large volumes to 4¢/lb. In *Economies of Scale in Single Purpose Food Irradiators* by R.M. Morrison (1985), the per unit cost (including annualized fix costs and variable costs) is estimated to be 4.2¢/lb at 12-million pounds of throughput a year and 2.3¢/lb at 24-million pounds. Two other Hawaii sources in 1986 estimated costs of 2.5¢/lb and 4¢/lb (College of Tropical and Human Resources and Department of Food Science and Human Nutrition).

4.14.4.2 Employment

For the demonstration period, DBED estimates that employment will be seven people. For commercial-scale operation of three shifts, the CH2M Hill feasibility study estimates an annual salary cost of $350,000 for 14 employees:

	Position	Salary Cost ($)
1.	Factory manager	50,000
2	Plant operator	40,000
1	Maintenance man who is also a trained operator	32,000
2	Utility man	28,000
1	Laboratory technician	28,000
5	Product handlers	16.000
1	Office clerk	24,000

Personnel would be chosen from applicants who are high school graduates with appropriate high school course work. Successful candidates would undergo a training program before starting work at the facility; training programs are currently available in California, Canada, and France.

According to Robert Souza of the Papaya Administrative Committee, no statistics are available on the numbers of persons now employed by the packers in the double-dip treatment facilities. Presumably, the seven double-dip facilities which use a more labor-intensive batch method of treatment employ more persons than would one continuous-flow irradiation facility.

Although some of the employees who would be laid off if the double-dip facilities were to be idled might become employees at the irradiation facility, there would most likely be a net loss of jobs in the treatment segment of the papaya industry. This loss would result from commercial operation; the 3-year demonstration program is not expected to have a significant effect on double-dip employment.

4.14.4.3. Potential Impact on the Hawaii Papaya Industry

The irradiation method of disinfestation as opposed to the double-dip method now used would provide: 1) a high quality of papaya which taste tests show consumers to prefer; and 2) a more reliable process which would reduce the probability of shipping improperly treated fruit to the mainland U.S., thereby jeopardizing future exports of papaya.

Although it is unknown whether sales of double-dip-treated papaya would decrease significantly due to consumer rejection of the resulting lesser quality fruit, it can be assumed that a higher quality product (irradiated papaya) sold at a comparable price would contribute to the industry being able to attain projected production and sales if irradiation is an acceptable form of treatment for the majority of consumers and if the product is readily available at the retail level.

If demand for irradiated papaya increases, production would increase, contributing to higher value of production and potentially more jobs industry-wide, with most new jobs in production. However, employment in the treatment segment would probably decrease. Industry sources state that land for increased production is available.

4.14.4.4 Potential Impact on Agriculture in Hawaii

A successful commodities irradiation facility demonstration project would have a positive effect on the papaya industry, but according to Souza (PAC), it would be of greater importance to the fresh fruit industry as a whole. Mango, in particular, could become a viable new export crop to the mainland U.S. Currently, the United States receives about 90 percent of its mango from Mexico and Haiti, according to Souza.

According to PAC, the production value of the fresh papaya crop exported to the U.S. mainland in 1987 was about $8.2 million and successfully treated and marked mango could eventually reach similar levels of export. At an average, wholesale mainland price of $1.13 a pound for papaya, the wholesale retail value of papaya exported to the mainland was $26.7 million.

4.14.4.5 Other Areas of Potential Impact

During public meetings and in responses to the EIS Preparation Notice, concerns were raised as to the impact of the irradiation facility on other sectors of the Hawaii economy, tourism in particular, and on the surrounding neighborhood and the City of Hilo. Some surmised that tourists would not want to visit an island where an irradiation facility was operating, thereby adversely affecting a major statewide industry. Others questioned whether property values of land in the vicinity of the irradiation facility would decrease due to the location of an undesirable use. These concerns may be valid; however, there is no empirical evidence that they are. Many of the economic concerns cannot reasonably be estimated until the demonstration project is underway.

4.14.5 Conclusions

Irradiation has the potential to beneficially affect the local and state economy by supporting and fostering the ongoing viability of the state's agricultural export sector. However, costs and consumer acceptance are uncertain. The irradiation demonstration program is intended to identify these economic factors.

The demonstration program is not expected to have a significant employment effect. Future commercial operation could result in a net loss of jobs as labor-intensive treatment methods are phased out. The lack of current employment data from the packers precludes quantification of this effect, although it is not expected to be significant.

4.14.6 Mitigation Measures

The facility operator should use locally-available labor to meet as much of the facility's staffing requirements as possible . The operator should participate with the packers to the extent practical to assist in identifying new job opportunities for employees displaced if ongoing commercial operation occurs and if this results in job displacement.

SECTION 5
TOPICAL ISSUES

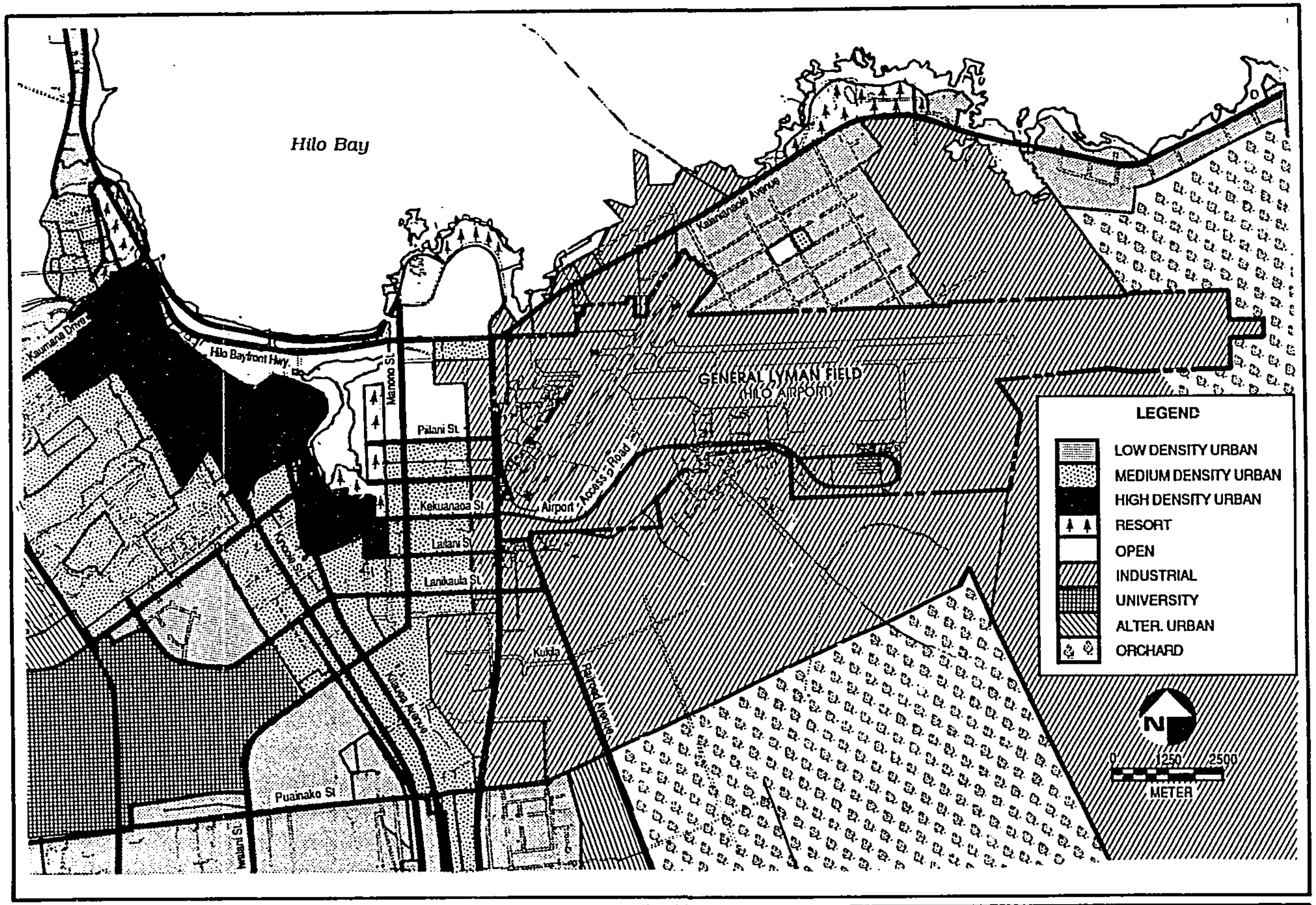
5.1 RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS OF THE PROPOSED ACTION FOR THE AFFECTED AREA

The applicable governmental land use policies, goals, and controls affecting the proposed project property are the Hawaii State Plan, the State Agriculture Functional Plan, the Hawaii County General Plan (see Figure 5-1), and the Hawaii County Zoning Code (see Figure 5-2). The proposed project's relationship to these and other land use plans and controls is described blow.

5.1.1 The Hawaii State Plan - General

The Hawaii State Plan - Revised (Chapter 226, Hawaii Revised Statutes) shall "serve as a guide for the future long-range development of the state; identify the goals, objectives, policies, and priorities for the State of Hawaii; provide a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improve coordination of state and county plans, policies, programs, projects, and regulatory activities; and establish a system for plan formulation and program coordination to provide for an integration of all major state and county activities."

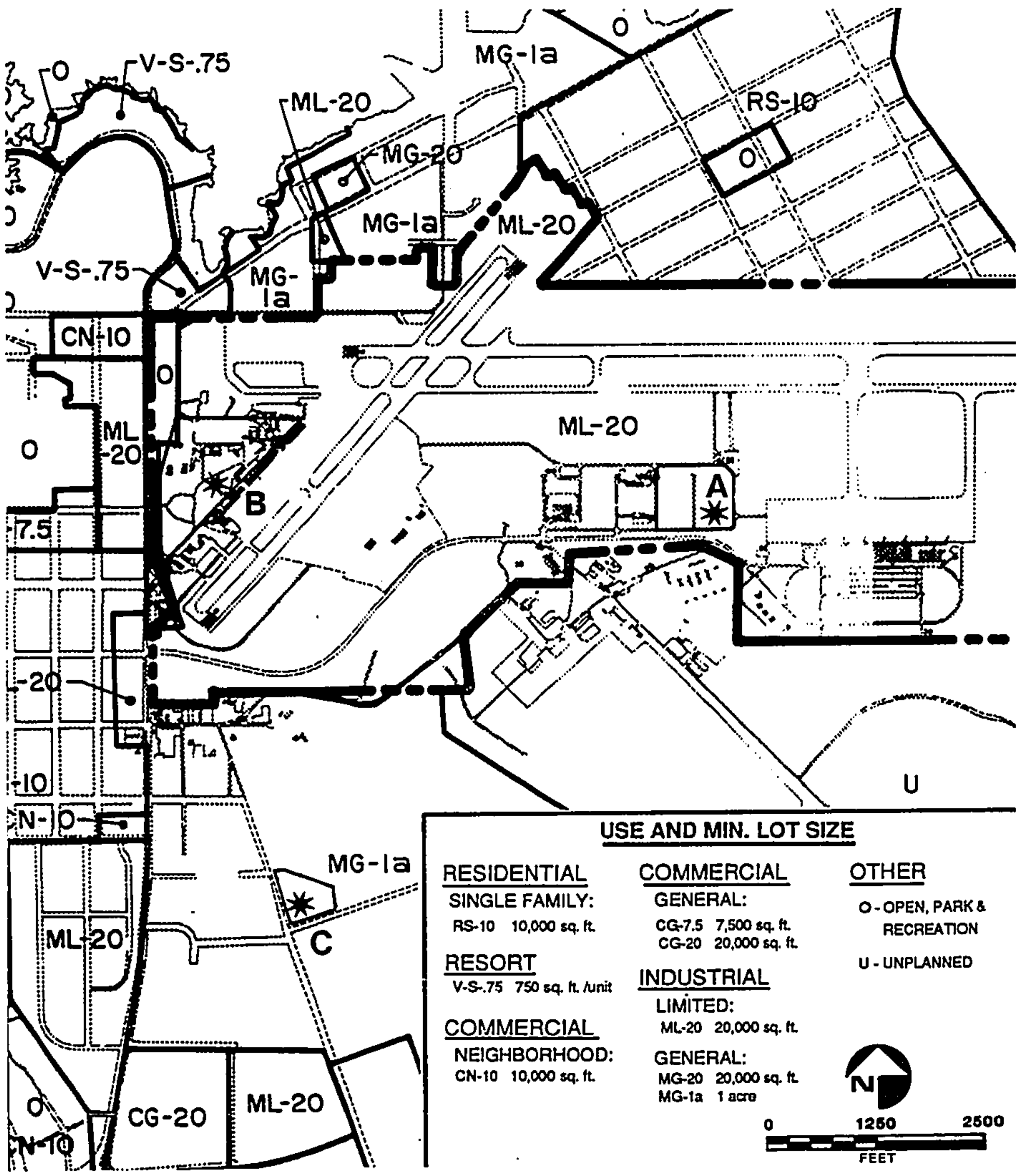
Among the plan's stated goals, objectives, and policies is a clear statement of intent to support the economy in general, the economy with regard to agriculture, and the agricultural industry as a major element of steady growth of the state. Policies related to the development of the agriculture industry emphasize the need for cooperation between the public and private sectors to assure a viable industry that is responsive to the economic, social, and environmental values of the community as a whole. In general, the proposed Hawaii Commodities Irradiation Facility project is consistent with the overall intent of the Hawaii State Plan - Revised. Specific objectives, policies, and priority actions contained in the state plan most relevant to the proposed project are discussed below.



Hawaii County General Plan

FIGURE 5-1

WESTEC Services, Inc.



County Zoning

FIGURE 5-2

Section 226-6, Objectives and policies for the economy - in general.

(a) "Planning for the state's economy in general shall be directed toward achievement of the following objectives."

(a) (1) "Increased and diversified employment opportunities to achieve full employment, increased income, and job choice and improved living standards for Hawaii's people."

(a) (2) "A steadily growing and diversified economic base that is not overly dependent upon a few industries."

(b) "To achieve the general economic objectives, it shall be the policy of this state to:

(b) (1) "Expand Hawaii's national and international marketing, communication, and organizational ties, to increase the state's capacity to adjust to and capitalize upon economic changes and opportunities occurring outside the state."

(b) (3) "Seek broader outlets for new or expanded Hawaii business investments."

(b) (4) "Expand existing markets and penetrate new markets for Hawaii's products and services."

(b) (9) "Foster greater cooperation and coordination between the public and private sectors in developing Hawaii's employment and economic growth opportunities."

Section 226-7, Objectives and policies for the economy - agriculture.

(a) "Planning for the state's economy with regard to agriculture shall be directed toward achievement of the following objectives."

(a) (2) "Continued growth and development of diversified agriculture throughout the state."

(b) "To achieve the agriculture objectives, it shall be the policy of this state to:

(b) (1) "Foster increased public awareness and understanding of the contributions and benefits of agriculture as a major sector of Hawaii's economy."

(b) (3) "Strengthen diversified agriculture by developing an effective promotion, marketing, and distribution system between Hawaii's producers and consumer markets locally, on the continental United States and internationally."

(b) (4) "Support research and development activities that provide greater efficiency and economic productivity in agriculture."

(b) (5) "Enhance agricultural growth by providing public incentives and encouraging private initiatives.

(b) (8) "Expand Hawaii's agricultural base by promoting growth and development of flowers, tropical fruits and plants, livestock, feed grains, forestry, food crops, aquaculture, and other potential enterprises."

(b) (9) "Promote economically, competitive activities that increase Hawaii's agricultural self-sufficiency."

<u>Discussion</u>: At a time when employment opportunities are decreasing in some segments of the agricultural sector of Hawaii's economy (primarily sugar and pineapple), opportunities are or could be increasing in the other segments of the industry. Permanent operational employment opportunities at the irradiation facility would directly add to increased and diversified employment opportunities, and indirectly add to those product and service industries supporting the agriculture industry on the island of Hawaii in particular and throughout the state. As such, the objective of achieving a steadily growing and diversified

economic base would be assisted. Further, the irradiation facility has been proposed to assist in expanding Hawaii's agricultural commodities markets and assist in fostering greater cooperation and coordination between the public and private sectors in developing employment and economic growth.

As noted in Section 2, one of the primary purposes and objectives of the proposed project is to conduct irradiation research on papayas and other Hawaiian grown commodities. This will assist in the continued growth and diversification of the state's agricultural activities. As such, the proposed project is in concert with the specific state plan economy objectives and policies regarding agriculture and the support of research and development activities; enhancement of agricultural growth by providing public incentives which will encourage private initiatives; expanding the agricultural base by promoting the growth of the tropical fruit portion of the industry; and promoting a treatment method that could be competitive with and complement other treatment methods.

5.1.2 The Hawaii State Plan - Priority Guidelines

The Hawaii State Plan - Priority Guidelines establish overall priority guidelines to address areas of state-wide concern. The overall direction, established by the Hawaii State Plan - Priority Guidelines is to assure that the state strives to improve the quality of life for Hawaii's present and future population through the pursuit of desirable courses of action in five major areas of state-wide concern which merit priority attention: economic development; population growth and land resource management; affordable housing; crime and criminal justice; and quality education. Those specific sections of the law that are applicable to the proposed irradiation facility are listed and discussed below.

Section 226-103

(a) "Stimulate economic growth and encourage business expansion and development to provide needed jobs for Hawaii's people and achieve a stable and diversified economy."

(a) (1) "Seek a variety of means to increase the availability of investment capital for new and expanding enterprises."

(a) (2) "Encourage the expansion of technological research to assist industry development and support the development and commercialization of technological advancements."

(a) (8) "Provide public incentives and encourage private initiative to develop and attract industries which promise long-term growth potentials and which have the following characteristics:

A) "An industry that can take advantage of Hawaii's unique location and available physical and human resources."

(B) "A clean industry that would have minimal adverse effects on Hawaii's environment.

(C) "An industry that is willing to hire and train Hawaii's people to meet the industry's labor needs."

(D) "An industry that would provide reasonable income and steady employment.

(a) (10) "Enhance the quality of Hawaii's labor force and develop and maintain career opportunities for Hawaii's people through the following actions:

(A) "Expand vocational training in diversified agriculture, aquaculture, and other areas where growth is desired and feasible."

(d) "Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

(d) (7) "Encourage the development and expansion of agricultural and aquacultural activities which offer long-term economic growth potential and employment opportunities."

Discussion: One of the primary purposes of the proposed irradiation facility is to determine the technical and economic viability of treating papayas and other Hawaiian food commodities for export. Positive results from the tests to be conducted are expected to stimulate the private sector into continued operation of the irradiation facility and investing in other similar treatment facilities. Similarly, positive results from the experiments and testing to be performed at the irradiation facility are expected to provide the incentives that will encourage private initiative to further develop the treatment industry for long-term growth. In this manner, the industry would take advantage of Hawaii's location and physical and human resources; be a clean industry that would have minimal adverse effects on Hawaii's environment; be an industry willing to hire and train Hawaii's people; and be an industry that would provide reasonable and steady employment. Further, the irradiation facility, through employment of local labor forces in all areas of operation, would be expanding and maintaining career opportunities through vocational training in diversified agriculture. To attain this objective, the use of public funds for technological research is in keeping with the state's economic priority guidelines to stimulate economic growth and encourage business expansion and development to provide needed jobs for Hawaii's people. Additionally, the pursuit of the irradiation facility is in keeping with the priority guidelines of promoting the growth and development of diversified agriculture and encouraging the development and expansion of agricultural activities that offer long-term economic growth potential and employment opportunities.

5.1.3 State Functional Plans

The Hawaii State Plan mandated the creation of 12 functional plans to provide detailed guidelines to implement its broad range of planning objectives. Ten of these plans, which function as guidelines and are not as law or statutory mandate, were adopted by the 1984 legislature; the remaining two were adopted in 1985. The 12 functional plans have been developed to act in concert and coordination with the county general and development plans. The functional plan pertinent to the proposed irradiation facility project is the agriculture plan as discussed below.

Although the functional plans work as the primary guide posts for implementation of the state plan, at times competing policy interests are found within the functional plans and county general and development plans and/or segments of Hawaii's population. For example, one of the objectives of the State Agriculture Functional Plan is the continued growth and development of diversified agriculture throughout the state. Methods of effecting this objective are the development of new crops or expansion of acreage of existing crops. Expanding existing crops, such as papayas, requires new or expanded markets, which can only be developed if new or better insect disinfestation treatment methods are developed to supply those new or expanded markets. That is, at present, existing treatment methods are either too costly, not totally effective, and/or not fully acceptable either to the industry or the market place. The proposed irradiation facility has been designed to answer some of the market and treatment efficacy questions that presently exist. The following are the specific objectives, policies, and implementing actions of the State Agriculture Functional Plan applicable to the irradiation facility.

Government Support

A. Objective: Achievement of Maximum Public Benefit from Allocation of Resources to Assist Agriculture.

Existing government programs in support of agriculture tend to focus more specifically on problems such as cultural practices, pest and disease control, handling and processing, and marketing. Identified needs relating to government support of agricultural activities include pests and diseases; cooperatives, associations, and marketing; agricultural industry analyses; and public resources allocation. The federal, state, and private interests and responsibilities identified include providing for fruit fly eradication and improved agricultural pest and disease control by the federal and state governments; the study of agricultural marketing systems by the state and private groups; and the setting of priorities for assisting agricultural industries and implementing the State Agriculture Functional Plan by the state. To effect the government support objective of the State Agriculture Functional Plan the following policies are applicable to the irradiator facility.

A (1) Policy: "Encourage and support pest and disease controls to increase agricultural production and economic growth."

A (2) Policy: "Encourage the development of agricultural cooperatives and associations and promote effective marketing of agricultural commodities."

Discussion: Federal and state government support for the irradiation facility and the purposes of the irradiation facility are in keeping with the above stated policies of encouraging and supporting pest and disease controls to increase agricultural production and economic growth and the promotion of effective marketing of agricultural commodities. As noted in this EIS, one of the purposes of the irradiation facility is to determine the technical and economic viability of using irradiation to disinfest papaya and other Hawaiian commodities subject to fruit flies. Additionally, a key element of the state and the U.S. Department of Energy cooperative agreement that funds the irradiation facility is marketability and consumer acceptance testing.

5.1.4 State and Land Use Law

The State Land Use Commission (LUC) regulates land use throughout Hawaii under the provisions of Chapter 205, Hawaii Revised Statutes (HRS). Four land use districts (Urban, Agriculture, Conservation, and Rural) and categories of uses permissible in each district have been established by the commission. All three irradiation facility site locations under consideration lie within the Urban District. As such, only county land use regulations are applicable. Section 15-15-24 of the LUC regulations states that "Any and all uses permitted by the counties...shall be allowed within this district...[unless more restrictive] [are] imposed by the commission pursuant to Section 205-4, HRS." No such conditions have been imposed on the facility site locations under consideration.

5.1.5 Hawaii County General Plan

The Hawaii County General Plan contains policies and land use maps showing the location and nature of desired land uses for the island. All three facility site locations under consideration are designated "Industrial" use (refer to Figure 5-1). The General Plan defines industrial use as those involving manufacturing and processing, wholesaling, large storage and transportation facilities, power generation, and government base yards. The following General Plan "Standards" for industrial uses are relevant to the proposed irradiation facility:

- Industrial developments shall be located in areas adequately served by transportation, utilities, and other amenities.
- Industrial development shall maintain or improve the quality of the present environment.
- Topography of industrial land shall be reasonably level.

- Industrial development shall be conveniently located to its labor source.
- Buffer zones shall be established between industrial and adjacent noncompatible land uses.

Discussion: All three sites under consideration for the irradiation facility have adequate road access and utility services. Other amenities, such as food services and support services, are available nearby. The proposed irradiation facility is in keeping with the visual character of all three sites; the topography of all three sites is generally flat (between 1 and 2 percent slopes); the sites are located in Hilo, the largest urban center on the island wherein skilled and unskilled labor are available; and the irradiation facility would be compatible with adjacent industrial and airport land uses.

In addition to the general standards discussed above, the General Plan also contains "Courses of Action" for the South Hilo District. The course of action that is most relevant to the proposed irradiation facility directs the county, through its zoning powers, to encourage the centralization of industrial activities in the Kanoelehua Industrial Area and to direct noxious industries away from residential and related areas. General Lyman Field (Sites A and B) is located immediately adjacent to Kanoelehua Industrial Area, and, as indicated by its "Industrial" zoning designation, represents a continuation of that land use. Site C is located within the Kanoelehua Industrial Area.

5.1.6 County Zoning

Areas A and B of the three site locations under consideration are zoned ML-20 (Limited Industrial, 20,000 square-foot minimum lot size) by the County of Hawaii. The land area directly south of Area A is zoned MG-1a (General Industrial, 1-acre minimum lot size), with more permissive uses allowed than under the ML-20 designation (refer to Figure 5-2). Limited Industrial districts are intended for businesses and industrial uses that are generally in support of, but not necessarily compatible with, uses in surrounding districts. Permitted uses include manufacturing, processing, assembling, research, laboratory, bottling, packaging, and others that are conducted in a building and from which there is no odor, dust, smoke, gas, noise, vibration, radiation, or other effect which has measurable nuisance qualities beyond the property line (Hawaii County Zoning Code, Section 25-216). Because the irradiation facility constitutes a "processing" activity and radiation from the facility would be confined to the irradiation room, the proposed facility is a permitted use in Area A.

The maximum allowable building height in the MG-1a zone is 45 feet, considerably higher than that required for the irradiation facility. Plan approval from the County Planning Director will be required for development of the facility within this district.

As noted above, Area B is also zoned ML-20 by the county and requires plan approval. The land area between Area B and Kanoelehua Avenue (Highway 11) is zoned "O" (Open, Park, and Recreation). The area west of Highway 11 is zoned for commercial and residential use and RS-10 (Single Family Residential, 10,000-square-foot minimum lot size).

Area C and its environs are zoned MG-1a, General Industrial, 1-acre minimum lot size. Activities allowed in this district include all of those permitted under Limited Industrial plus heavier industrial uses such as manufacturing and processing plants, quarries, feedlots, sawmills, sugar mills or refineries, and public dumps. The maximum allowable buildout height in the area is 50 feet, or 100 feet if determined to be functionally necessary. Plan approval from the County Planning Director is required for all development within this district.

5.1.7 Coastal Zone Management Act (Chapter 205-A HRS)

All three sites are outside the special management area (SMA) as established by the county under the Coastal Zone Management Act.

5.2 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

No significant short-term exploitation of resources that will have negative long-term consequences has been identified.

The principal long-term benefits of the proposed irradiation facility project include the productive use of a man-made isotope, an economical and efficient disinfestation treatment method, and the production of a product better than that which can be produced using present governmental agency accepted treatment methods. Increased economic opportunities would also be provided for all socioeconomic levels along with increased public awareness and education regarding the use of radioactive materials and the potential benefits that can be derived therefrom as well as the precautions that would be taken to protect the environment. The proposed project would be located in proximity to fruit packers and growers, thereby assisting in moving products from the field to the marketplace quickly and efficiently. The treatment process offers the advantage of requiring less time than other treatment methods, thereby aiding in the processing of product more efficiently than present treatment methods allow.

The irradiator will potentially provide socioeconomic benefits to the community by supporting important agricultural components of the state and regional economy. This support of on-going agricultural production will have benefits that ripple through the regional and island economy. Indirect, induced employment will be supported in both the short and long term in those industries and services that cater to the food products and agriculture service-related businesses in the proposed project area. Public revenues from excise and personal taxes are expected to more than offset any expenses associated with the expansion of public services to meet the requirements of the proposed project development.

The proposed facility would require the creation and use of the man-made isotope cobalt-60, a radioactive material. Cobalt-60 decays or disintegrates at a constant rate with a half life of approximately 5 years. This introduces into the environment a potential risk (as discussed in Section 4) which will last from the time cobalt-60 is created until its radioactivity has decayed to a level that is safe in an uncontrolled environment. The monitoring and control of the cobalt-60 during this period will require a commitment of personnel and financial resources.

5.3 Irreversible and Irretrievable Commitments of Resources

The development of the proposed irradiator facility would result in the irreversible and irretrievable commitment of certain natural and fiscal resources. The commitment of resources required to accomplish the project includes building materials and labor, both of which are generally nonrenewable and irretrievable. Construction, operation, and transportation to or from the project by researchers, operators, and suppliers would require the consumption of petroleum products and petroleum-generated electricity. The production of cobalt-60 requires the irreversible commitment of mineral, energy, and human resources.

Aside from costs incurred as a result of the legislatively-mandated demonstration program, the proposed project does not call for a substantial commitment of government supplied services or facilities that would not be required without the proposed project. The project would add to the commercial and industrial treatment facilities available to the growers and packers of the project area and state in general.

5.4 CONSIDERATION OF OFFSETTING GOVERNMENTAL POLICIES

By the very existence of a complex system of policies, plans, goals, objectives, and controls at both the state and county levels of government, development proposals that involve novel (to the state or county) processes and/or those that require rethinking traditional practices are often faced with inherent apparent conflicts within the regulatory system. As such, the proposed irradiator project must be reconciled against those planned elements that most appropriately apply. As indicated in Section 5.1, the proposed project is generally consistent with the applicable state plan goals, policies, and standards relating to the future growth of the state and the State Agriculture Functional Plan relating to the expansion, diversification, and growth of the agriculture industry. Proceeding as proposed would enable the project to meet initial objectives, as well as provide the advice and guidance necessary to determine a future course of action regarding the use of irradiation as a treatment method. The decision to proceed must be balanced against the risk of environmental effect should one or more of the built-in safeguards against such damage fail. Given the relatively accident-free record of irradiation facilities throughout the world, and the safeguards that would be inherent in the proposed facility, it would appear that a decision to proceed would be safe and prudent and allow the planned demonstration of the efficacy of irradiation as a treatment method to be determined.

5.5 UNRESOLVED ISSUES

Most environmental issues associated with the proposed project have been resolved in Section 4. The primary outstanding issue is uncertainty about the economic effect of the project. The project could have a significant positive economic effect; there is concern, however, that irradiated fruit would be less marketable than non-irradiated fruit, and a negative economic effect would result. Employment consequences of commercial operation are also unquantifiable. As discussed in Section 2, resolution of this issue is a primary objective of the demonstration project.

Concern has been raised that irradiation alters fruit in ways that could cause adverse health effects in those who eat the fruit. As discussed in Section 4 and Appendix G, however, the preponderance of available evidence indicates that no such effect is expected to exist.

SECTION 6
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This environmental impact statement was prepared for the Department of Business and Economic Development by WESTEC Services. Members of the WESTEC professional staff and subconsultants contributing to the development of this document are listed below:

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APPENDIX A

REFERENCES & CONSULTATIONS

APPENDIX A

A.1 REFERENCES AND BIBLIOGRAPHY

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A.2.1 Consultation

A.2.1.1 Public Representatives

State Legislature

Representative Andrew Levin
Senator Richard Matsuura

A.2.1.2 Federal Agencies

Department of Agriculture

Animal and Plant Health Inspection Service - James Fons
Edward Vyeda

Agricultural Research Service - Dr. Jack Armstrong
Dr. Jerry Gaffney

Department of Energy - Richard Chitwood
Gary Rosenwald

Federal Aviation Administration - David Welhouse

Geological Survey - Ellen White

Nuclear Regulatory Commission - Beth Riedlinger
Leonard Gordon

A.2.1.3 State of Hawaii

Department of Hawaiian Home Lands - Darell Yagodich

Department of Transportation - Dean Nakagawa
Wally Hishimoto
Frank Kamahele, Hilo Airport Manager
Larry Balbarino

Hawaii County - Albert Lono Lyman
Minoro Shintani
Tim Lui Kwan

Motor Vehicle Safety Office

Office of Environmental Quality Control - Marvin Miura
Dr. James Moy

University of Hawaii at Manoa - Dr. Robert Paull

A.2.1.4 Businesses and Organizations

Aloha Airlines - Fred Spencer
Tag Taguden

American Airlines - Steve Anderson

Amfac Tropical Products - Charlie Wallis

Battelle Pacific Northwest Laboratories - Dr. Jim Jarrett

Continental Airlines - Dorothy Zeno

Del Monte - Lily Arakawa

Delta Airlines - Craig Drum

Diamond Head Papaya Company - Roy Pokuyama

East Hawaii Coalition to Stop Food Irradiation

Hawaiian Airlines

Hawaiian Host - Stanley Fujiyama

Matson Shipping Services - Francis Shigemitsu

Ono Pac - Richard Sakanashi

Pacific Paradise - Aaron Hagerfeldt

Pacific Tropical Products - Meade Kirkpatrick

Papaya Administrative Committee - Robert Souza

United Airlines - Marta Chipi

Young Brothers Limited - Stephanie Char

A.2.2 Correspondence

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APPENDIX B

GLOSSARY

APPENDIX B
GLOSSARY OF ABBREVIATIONS AND TERMS

Accelerator. In commodity irradiation, a device for producing beams of high-energy electrons. The electron gun in a TV tube is also an accelerator.

AECL. Atomic Energy of Canada Limited.

Alpha particle. A positively charged particle emitted from a nucleus and composed of two protons and two neutrons. It is identical in all measured properties with the nucleus of a helium atom.

APHIS. The U.S. Department of Agriculture Animal and Plant Health Inspection Services.

Aqueous electron. The hydrated electron, a radiolythic product of water.

Becquerel (Bq). A unit of activity of a radioactive substance. It is equal to one disintegration per second.

Beta particle. A charged particle emitted from the nucleus during radioactive decay and having a mass and charge equal in magnitude to those of the electron. A negatively charged beta particle is physically identical to the electron.

Caldera. A large crater formed by volcanic explosion or the collapse of a volcanic cone.

Carcinogen. A substance or agent producing or inciting cancer.

Cathode ray. A stream of electrons emitted by the cathode of a gas-discharge tube or by a hot filament in a vacuum tube. The electron beams used in food irradiation generated by accelerators are cathode rays.

Cesium-137. A by-product of nuclear reactor operation; a gamma ray source which may be used in place of cobalt-60.

CFR. Code of Federal Regulations.

Chemiclearance. Regulatory clearance of a particular use of ionizing energy on a particular food on the basis of knowledge of the radiolytic products produced and an evaluation of the effect of these products on the safety of the food for human consumption.

Cobalt-60. A radioactive isotope of cobalt with mass number 60.

Communicable disease. A disease capable of being transmitted.

Curie (Ci). A basic unit of radioactivity. One curie equals that quantity of any radioactive nuclide having 37 Bq.

DBED. State of Hawaii Department of Business and Economic Development.

Decimal reduction (D_{10}). The ionizing energy dose in grays needed to reduce a population (e.g., of bacteria) by a factor of 10, or one log cycle, leaving as survivors 10% of the original population.

Disinfestation. In food irradiation, the inactivation of food-borne insects or parasites.

DHHN. State Department of Hawaii Home Lands.

DLNR. State of Hawaii Department of Land and Natural Resources.

Dose. The amount of ionizing radiation absorbed in a specified quantity of material. The units commonly used to measure absorbed does are the "gray" or the "rad". One gray equals 100 rads.

Dosimeter. A device for measuring radiation dose.

Dosimetry. The process of estimating exposure dose.

DOT. State of Hawaii Department of Transportation.

Double-hot-water dip. The method currently used for the majority of papayas grown for export. The method consists of treating the fruit with two hot water baths to kill fruit flies.

Dry-heat treatment. An experimental treatment which involves slowly raising the internal temperature of the fruit to 47°C over a period of about 7 hours.

EISPN. Environmental Impact Statement Preparation Notice.

EIS. Environmental Impact Statement.

EDB. Ethylene dibromide, a chemical fumigant banned by the U.S. EPA in 1984.

Electrons. Negatively charged particles that are constituents of all atoms.

Electron beam. A narrow stream or a bunched group of electrons moving in the same direction with approximately the same speed.

Electron volt (eV). A unit of energy. One electron volt is equivalent to the amount of kinetic energy gained by an electron accelerated through an electric potential difference of one volt. One million electron volts (MeV) is equal to 1.6×10^{-13} joules.

Encapsulation. Isolation of an isotope in a sealed (welded), leak tested and environmentally secure capsule, usually of stainless steel.

EPA. U.S. Environmental Protection Agency.

Epidemiology. Branch of medical science which is concerned with the study of disease as it appears in its natural surroundings, and as it affects a community of people rather than a single individual.

FEMA. Federal Emergency Management Agency.

FDA. U.S. Food and Drug Administration.

Free radical (•) An electrically neutral molecule with an unpaired electron in the outer orbit. The • placed in this manner, as in OH•, designates a free radical.

G value. Number of molecules changed per 100 electron volts of energy transferred to the system.

Gamma ray. High-frequency, short-wavelength electromagnetic radiation produced when an unstable atomic nucleus spontaneously disintegrates and releases energy to gain stability.

Gray (Gy). International System (SI) unit for absorbed dose. One gray is equal to the energy imparted by ionizing radiation to a mass of material corresponding to one joule per kilogram.

Half-life. The average time required for the decay of one-half the atoms of a quantity of radioactive substance.

Hertz (Hz). For electromagnetic radiation, frequency, or cycles per second.

High dose. In food irradiation, doses of 10 kGy (1 Mrad) or more.

Histopathology. The science that deals with the minute structure of disease in living organisms and considers the special forms of cells and their association in tissues and organs.

Induced radioactivity. Nuclear reactions in which exposure to radiation results in the production of unstable nuclei, which through spontaneous disintegrations give off radiation.

Infectious disease. A disease capable of being transmitted by infection without actual contact.

Ion. An atom or molecule that has a net negative or positive electric charge due to the loss or gain of one or more electrons. The term also refers to isolated electrons or other charged subatomic particles.

Ionization. Any process by which a neutral atom or molecule loses or gains electrons, thereby acquiring a net charge and becoming an ion.

Ionizing energy. In food processing, high-speed electrons from medicine sources or radiant energy from x-rays or gamma rays. The standard gamma ray sources are cobalt-60 and cesium-137.

Irradiate. To apply radiation to a material.

Irradiation. The process of applying ionization.

Irradiator efficiency. The percentage of the total energy emitted by the irradiator source that is absorbed by the product being processed.

Isotope. Atoms of the same chemical element having the same atomic number but different atomic weights, or those with nuclei having the same number of protons but different numbers of neutrons.

Joule (J). The absolute meter-kilogram-second unit of work or energy, equal to 10 ergs or approximately 0.7375 foot-pound.

Ldn

Low dose. In food irradiation, ionizing energy doses less than 1 kilogray (see also medium dose).

MBr. Methyl Bromide, an approved fumigant for citrus fruits.

Medium dose. In food irradiation, ionizing energy doses between 1 kilogray and 10 kilograys. In earlier literature this dose range (substerilizing) was included in the low-dose range. The recent division of the substerilizing-dose range into low and medium is a result of FDA's notice in the Federal Register on March 27, 1981, of its proposed intent to approve without further wholesomeness testing all fruits, cereals, and vegetables exposed to doses up to one kilogray.

MeV. One million electron volts. One electron volt is equivalent to the amount of kinetic energy gained by an electron accelerated through an electric potential difference of one volt. One MeV is equal to 1.6×10^{-13} joules.

Morbidity. Death resulting from disease.

Mutagen. An agent that changes a gene resulting in an alter effect of its expression (mutation).

Mutagenicity. The capacity to induce mutations or heritable genetic changes.

Nephropathy. An abnormal state of the kidney.

NERZ. Northeast Rift Zone.

Nitrosamines. Any of various neutral compounds characterized by the grouping NNO, some of which are powerful carcinogens.

Nonirradiated. Not irradiated. This is the correct term; unirradiated is incorrect.

OEQC. State of Hawaii Office of Environmental Quality Control.

Organoleptic. Affecting or employing one or more of the human senses in the evaluation of foods.

Photon. One unit or quantum of radiant energy.

Phytotoxicity. Poisonous to plants.

Polymerize. To undergo a chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecule.

Polyploid. Having or being a chromosome number that is a multiple greater than two of the monoploid number.

Positron. A positively charged particle having the same mass and magnitude of charge as the electron and constituting the antiparticle of the electron.

Probit 9. As used by USDA/APHIS, not more than 32 survivors per million insects treated.

Protein efficiency ratio. The gain in weight per unit weight of protein consumed. The measurement usually is made with male rats under standard conditions of a 4-week assay period with diets containing 10% protein and adequate amounts of other nutrients. Casein (the milk protein), used as the reference, has an efficiency ratio of about 2.5.

Pulses. Edible seeds of leguminous crops; such as peas, beans, or lentils.

Rad. A superseded term that is an acronym for radiation absorbed dose. One rad is equal to 0.01 joules per kilogram, or 0.01 gray.

Radappertization. Treatment of food with a dose of ionizing radiation sufficient to reduce the number and/or activity of viable microorganisms to such a level that very few, if any are detectable by any recognized bacteriological or mycological testing method applied to the treated food. This treatment must be used so that no spoilage or toxicity of microbial origin is detectable no matter how long or under what conditions the food is stored after treatment, provided it is not recontaminated.

Radiation. Radiant energy, or the emission and propagation of waves transmitting energy through space or some medium. In food irradiation, the term is limited to gamma rays, x-rays, and electron beams.

Radiation absorbed dose (rad). See "rad" above.

Radiolytic. Related to chemical decomposition as a result of exposure to radiation.

Radiolysis. Chemical decomposition by the action of radiation.

Radionuclide. An unstable isotope that decays, disintegrates, or transforms spontaneously, emitting particles or electromagnetic energy in the process.

Radurization. Treatment of food with a dose of ionizing radiation sufficient to enhance its keeping quality by causing a substantial reduction in the numbers of viable specific spoilage microorganisms.

Ripening. Plant tissue approaching or coming to full development and becoming usable as food.

Roentgen (R). The dose of gamma or x-radiation that produces ions carrying one electrostatic unit of charge per cm^3 of standard air surrounded by air at 0°C and 766 mmHg. It equals 88 ergs per gram of air.

Roentgen equivalent man (rem). A superseded unit of dose equivalence, now replaced by the Sievert. One Sv equals 100 rems.

Roentgen equivalent physical (rep). A superseded term for radiation dose in equivalent physical material other than air. It equals 93 ergs per gram.

SCS. U.S. Department of Agriculture Soils Conservation Service.

SERZ. Southeast Rift Zone.

Sievert (Sv). The unit of dose equivalent. It replaces the older term rem. If the dose is in Gy, 1 Sv equals 100 rem.

Senescense. The phase of plant growth from full maturity to death characterized by an accumulation of metabolic products, increase in respiratory rate, and a loss in dry weight, especially in fruit and leaves.

Shipping cask. A cask for the shipment of isotopes that has adequate strength and mass to withstand environmental insult and absorb the prescribed level of irradiation emitted by the isotope being shipped.

Teratogenicity. The ability to cause developmental malformations and monstrosities in the progeny of the exposed individual.

Teratology. The study of malformations or serious deviations from the normal type of organism.

Toxicology.

Unit prefixes. pico (p) = 10^{-12}
nano (n) = 10^{-9}
micro (u) = 10^{-6}
milli (m) = 10^{-3}
kilo (k) = 10^{3}
mega (M) = 10^{6}

U.S. DOE. U.S. Department of Energy.

Vapor heat treatment. The use of hot-water vapor for disinfestation of tropical fruits.

Wholesomeness. Foods processed with ionizing energy are generally considered wholesome when harmful microorganisms and microbial toxins are absent, when the ionizing energy has produced no measurable toxic effects or radioactivity, and when the food presents no significant nutritional deficiency relative to the same food that has not been processed with ionizing energy or has been processed by conventional methods.

X-ray. High-frequency, short-wavelength electromagnetic radiation emitted when electrons are accelerated to a high velocity and then impinged on a suitable target material. The interaction effects of x-rays are similar to gamma rays.

APPENDIX C

PUBLIC PARTICIPATION

C.1 EIS Preparation Notice
C.2 Public Meetings
C.3 Comments, Responses, and Letters

APPENDIX C
PUBLIC PARTICIPATION

Public participation is an important and ongoing part of preparing an EIS. Appendix C is organized into three parts to correspond to distinct facets of public participation. Section C.1 contains the documents used to provide notice to the public that the preparation of an EIS is occurring and to solicit public participation. Section C.2 includes public meeting agendas, summarized oral testimony, and any written documents that were provided by the public to be included as testimony. Section C.3 contains all comment letters received from the public as well as the EIS preparers' written responses to those comments.

C.1 EIS PREPARATION NOTICE

ENVIRONMENTAL ASSESSMENT AND NOTICE OF PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT FOR FOOD COMMODITIES IRRADIATION FACILITY

I. PROPOSING AGENCY

State of Hawaii
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813
Attention: Mr. M. Kaya

CONSULTANT

WESTEC Services, Inc./ERCI
3049 Ualena Street, Suite 1217
Honolulu, HI 96819
808/836-3036
Attention: Mr. James Frolich, Sr. Project Manager

II. ACCEPTING AUTHORITY

State of Hawaii
Office of the Governor
State Capitol Building
Honolulu, Hawaii 96813

III. CLASS OF ACTION

Use of State funds for planning. Possible use of State Lands. Baseline Information - Programmatic EIS.

IV. PLANNED PUBLIC INFORMATION MEETINGS

Meetings to provide the public with an opportunity to identify issues to be considered in the EIS will be held on:

May 3rd, Honolulu
May 4th, Hilo

V. PURPOSE OF EIS

In accordance with the provisions of Section 281 of Act 216 of the Fourteenth Hawaii State Legislature, Chapter 343 Hawaii Revised Statutes (HRS) and Title 11, Department of Health, Chapter 200, Environmental Impact Statement (EIS) Rules, an EIS identifying and discussing the potential environmental impacts of a food commodities irradiation facility and the measures proposed to mitigate potential adverse impacts will be prepared. The EIS will evaluate the proposed facility as a three-year demonstration project and the possibility of continued commercial operation or decommissioning. Three sites will be evaluated in the EIS. The document will be prepared to provide the public and governmental agencies an analysis of the potential environmental impacts from such a facility. The details of the conceptual irradiation facility under consideration are drawn from the State's Irradiator Feasibility Study prepared by CH2M Hill dated April, 1987.

VI. PROJECT DESCRIPTION

A. LOCATION AND PROPERTY OWNERSHIP

Site selection process was based on the site analysis by CH2M Hill which established feasible locations according to fruit production areas, transportation routes, land availability, costs and environmental issues. Hilo and Honolulu were determined logical locations since most packers are located in the Hilo area and since overseas transportation currently begins in Honolulu. Although both cities were ranked nearly equal in terms of desirability, the Hilo area was selected because of land availability, desire to encourage local packer participation in the demonstration project, and governmental policy considerations. Consequently, the conceptually proposed commodities irradiation facility, based on preliminary site studies, is planned to be located at one of three possible sites in the vicinity of General Lyman Field, Hilo, Hawaii (Hilo Airport). The preliminary investigations have identified the three sites as appropriate locations for the proposed facility because they (1) provide suitable access to the airport and seaport for inter-island or overseas transport; (2) have or could readily be provided with necessary infrastructure (water, power, sewer, roads, etc.); (3) consist of available vacant land; and (4) are under the jurisdiction of the State of Hawaii. All three sites are zoned and/or have land use designations to allow for construction and operation of the proposed irradiation facility. Tax Map Key (TMK) numbers for the three areas are: Site A, TMK 2-1-12; 106; Site B, TMK 2-1-12; POR 34-86; and Site C, TMK 2-1-25; 86. The regional and specific locations of the three possible sites are illustrated in Figures 1 and 2.

B. PHYSICAL DESCRIPTION OF THE FACILITY

The proposed facility would consist of a warehouse building housing the irradiator and ancillary operations. The irradiator equipment would be located inside a concrete block and concrete walled room (Figure 3). Ancillary facilities would consist of office space, dosimetry laboratory, storage space for treated and untreated fruit, and employee lockers and restrooms. The project site would be equipped with truck loading and unloading ramps to the warehouse, and truck and employee parking areas. The entire facility would be fenced for security, with access via a secured gate. The proposed site would be one to three acres and the warehouse building would be approximately 15,000 square feet.

Facility personnel would be comprised of employees to handle irradiator operations and employees to handle support activities. The total number of employees would depend on actual annual throughput of products. It is planned that the plant would operate 24 hours a day for five to six days a week for fifty weeks of the year. Two weeks in the year the plant would be shutdown for scheduled annual maintenance, with general maintenance occurring the one or two days a week when the plant is not in operation.

C. OPERATIONAL CHARACTERISTICS OF THE FACILITY

The proposed commodities irradiation facility would be used to treat papaya, mangoes, lychee, and other fruit or agricultural products which are transported outside the state of Hawaii and are susceptible to fruit fly or other insect infestations, and therefore subject to U.S. or foreign agricultural quarantine requirements. The proposed source of radiation would be gamma rays emitted from the decay of the man-made isotope, Cobalt 60, as approved by the U.S. Food and Drug Administration (FDA).

Operational characteristics of the proposed facility are as follows: Fresh picked fruit will be packaged and sealed in boxes and the boxes stacked onto pallets at the off site packing house, with average pallet loads of 1400 pounds. The pallets will be delivered by truck to the irradiation facility, where the they will be unloaded onto an automatic conveying system; this system will move the pallets through the irradiation chamber, exposing the fruit as uniformly as possible to the gamma ray emissions. The conveyer begins near or in the incoming product preparation area and delivers the processed product without further

handling to the processed product holding area. Total radiation dosage given the fruit would not exceed 1kGy (International System unit for absorbed dose of radiation), as required by the FDA. After processing, dosimetry examination, recording and certification will take place, according to FDA and NRC requirements. The processed fruit will then be ready for loading onto refrigerated trucks or air cargo shipping containers, and delivered to shippers for transport to overseas markets, either directly or through Honolulu.

D. SAFETY OF THE FACILITY

At no time during plant operation will people be in direct contact with the radiation source or be in the irradiator room during treatment. The radiation source (Cobalt 60) would be stored in a water bath or casing within the irradiation room when not in use. All Nuclear Regulatory Commission and Occupational Health and Safety Administration rules, regulations, and safety precautions would be observed at all times. Employees must be given initial and periodic safety and operational training programs to maintain that operating procedures are up to date with current recommendations. Constant monitoring procedures for employees will be exercised to assure that radiation exposure levels do not exceed safe limits.

VII. <u>DESCRIPTION OF THE AFFECTED ENVIRONMENT</u>

A. SETTING

The three study sites are located within industrial and/or commercial areas on or near General Lyman Field. All three sites have been disturbed by man's activities. Previous land uses of the sites include airfield activities on site A, air passenger terminal use on Site B, and gravel and concrete operations on site C (Figure 2).

Site A is located in the airport industrial area adjacent to the airport access road and on land presently under the jurisdiction of the Hawaii State Department of Transportation, Airports Division. Site A land was originally master planned for airport related industrial activities. Site B, located at the old air terminal, also under Department of Transportation jurisdiction or the State Department of Lands and Natural Resources (depending on the part of site B on which the plant would be located), is within or next to the airport boundaries. Currently, site B is used for air cargo operations. Site C is located on Railroad Avenue approximately one-half mile from the airport (under the jurisdiction of the Department of Hawaiian Home Lands) and is presently vacant. The site was previously ɪed for concrete mixing and for a sand and gravel plant. Nearby land uses include the Hilo airport, HELCO Power Plant, and other industrial activities. All three sites are zoned industrial.

B. PHYSICAL ENVIRONMENT

The three sites are located within the Hilo, Hawaii area which is underlain by pre-historic lava flows from the Mauna Kea and Mauna Loa volcanos. All three sites are located in Uniform Building Code (UBC) seismic zone 3. Sites A and B are both at an elevation of approximately 27 feet Mean Sea Level (MSL), and Site C is at an elevation of approximately 50 feet MSL. Research indicates that each site is above historical tsunami and flood high water levels. At each site, the water table is approximately at sea level. Annual rainfall for the area is an average of 127 inches, and average annual temperatures range from 71 to 76 degrees Fahrenheit.

C. BIOLOGICAL ENVIRONMENT

The flora and fauna of the three sites are typical for disturbed areas around the airport. Preliminary site surveys found introduced plant species to dominate. The floral and faunal characteristics of each site are discussed below.

Site A - Control Tower. The flora consists of cut/mowed grasses and weeds. Fauna includes mynas, doves, probably golden plover, cardinals, and finches. No protected species were identified.

Site B - Old Terminal. Flora consists of Koa haole, mango, bamboo, grasses and weeds, banyan and other introduced ornamentals. Fauna are doves, finches, cardinals, Japanese white-eye, mynas, and possible golden plover; small Indian mongoose, feral/domestic cats and dogs, mice, and rats. No protected species were identified.

Site C - Railroad Avenue. Flora includes grasses and weeds, wild orchids, banyan, bamboo, Koa haole, mango, and other introduced ornamentals. Fauna consists of Japanese white-eye, cardinal, finches, doves, and mynas; small Indian mongoose, feral/domestic cats and dogs, mice, and rats. No protected species were identified.

A complete botanical and zoological survey of each site will be conducted as part of the field investigations for the EIS. Findings will be used to examine the potential impacts of

the proposed irradiation facility on plant and animal life of the project site and surrounding areas.

D. HISTORICAL/ARCHAEOLOGICAL RESOURCES

Due to the disturbed nature of the three sites, it does not appear likely that historical and/or archaeological resources exist on the three sites. There is no known documentation which records historical and archaeological resources for the area. A complete archaeological reconnaissance survey will be conducted as part of the field investigations for the EIS.

E. SOCIOECONOMIC ENVIRONMENT

Given that the three sites are located in Hilo, Hawaii, they are part of the socioeconomic environment of the city. Hilo is the governmental, commercial, and industrial center of the island and has an estimated population of about 36, '0. The 1980 civilian labor force of the Hilo area was about 17,500, of which ove 16,000 were employed. Recent employment statistics indicate an unemployment rate of over 5%, compared to a statewide average of about 3.8%. Per capita income in the Hilo area was estimated at $6900 in 1980 with the household median of about $18,000 and family median of about $20,500. The majority of the workforce is employed in non-agricultural jobs with manufacturing, food processing, trade, services (including hotel services) and government being the principal industries. Agricultural workers comprise about 14% of the workforce.

Socioeconomic effects of the proposed irradiation facility may be positive and/or negative. Positive factors would be expected to accrue from the treatment process offered at the proposed facility. Negative factors could result from objections by the public to use irradiation as a treatment method. Economic effects would be empirically determined during a three year demonstration period of the proposed project. The potential positive and negative social and economic factors associated with the proposed irradiation facility will be examined in the EIS.

C-4

F. OTHER ISSUES

The overall scope of the EIS for the proposed Hawaii Commodities Irradiation Facility includes, but is not limited to, the parameters discussed above. Analysis of existing conditions and the potential impacts will also be discussed in the EIS for the following issues: radiological dose and risk assessment; water resources/water quality; air quality; geology; transportation; land use; noise; commodity wholesomeness; alternative methods of disinfestation; visual resources; and the short term vs. long term effects associated with the proposed project.

VIII. SUMMARY OF MAJOR IMPACTS AND MITIGATION MEASURES

Construction and/or operation of the proposed commodities irradiation facility at any of the three sites under consideration will involve vegetation removal, greater stormwater run-off, construction noise, and other changes typically associated with urban development. Operation of the facility could also generate significant amounts of vehicular traffic. Finally, some members of the public have expressed concern over hazards associated with the presence of radioactive materials and the safety and marketability of irradiated foods.

Results of the preliminary studies conducted to date indicate that significant adverse impacts can be avoided or mitigated by:

Adhering to all applicable Federal, State, and County building design and construction codes and standards;

Operating the facility in compliance with Federal and State environmental health regulations; and

Insuring that all personnel are properly trained in operational and safety techniques.

Further studies are required to confirm these preliminary findings.

IX. DETERMINATION OF SIGNIFICANCE

Construction and operation of the proposed project will involve the use of State funds, land, and other resources. Because of this, it is subject to the provisions of Chapter 343, Hawaii Revised Statutes.

The assessment of potential impacts presented above was prepared pursuant to the State Department of Health's Environmental Impact Statement Rules (Title 11, Chapter 200). Based on a review of the findings and the significance criteria contained in Section 11-220-12(b), the State Department of Business and Economic Development has concluded that the project is of a controversial nature and could, if adequate measures are not incorporated into the facility design and operation, potentially result in significant adverse impacts with respect to water quality, public health, property values, and economic and social welfare. For these reasons, it has been determined that an Environmental Impact Statement should be prepared.

X. PARTIES TO BE CONSULTED FOR THE PREPARATION OF THE EIS

Federal Agencies

U.S. Department of Army Corps of Engineers, Pacific Ocean Division
Department of Agriculture, Animal Plant Health Inspection Service
Department of Agriculture, Soil Conservation Service
Department of Energy
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of Interior, Fish and Wildlife Service
Department of Interior, Geological Survey, Water Resources Division
Department of Labor, Occupational Safety and Health Administration
Department of Transportation, Federal Aviation Administration
Food and Drug Administration
Environmental Protection Agency

State Agencies

Department of Accounting and General Services
Department of Agriculture
Department of Budget and Finance
Department of Defense
Department of Education
Department of Hawaiian Home Lands
Department of Health
Department of Labor and Industrial Relations
Department of Land and Natural Resources
Department of Social Services and Housing
Department of Taxation
Department of Transportation
Office of Environmental Quality Control
Office of the Governor
Office of Hawaiian Affairs
Office of State Planning

University of Hawaii Environmental Center
University of Hawaii, College of Tropical Agriculture and Human Resources
Governor's Agriculture Coordinating Committee

Congressional Representatives

Senator Daniel K. Inouye
Senator Spark M. Matsunaga
Representative Daniel K. Akaka
Representative Patricia Saiki

State Legislators

Senator Richard S. H. Wong
Senator Richard M. Matsuura
Senator Malama Solomon
Senator Anthony K.U. Chang
Senator Mamoru Yamasaki
Senator Robert N. Herkes
Representative Daniel J. Kihano
Representative Virginia Isbell
Representative Andrew Levin
Representative Michael O'Kieffe
Representative Wayne Metcalf
Representative Joseph M. Souki
Representative Harvey Tajiri
Representative Dwight Takamine

Hawaii County

Office of the Mayor
Planning Department
Department of Public Works
Department of Parks and Recreation
Department of Water Supply
Department of Research and Development
Fire Department

Police Department
Office of Housing and Community Development
Safety Coordinator
Civil Defense Agency
Finance Department
Hawaii Redevelopment Agency

Hawaii County Council

James K. Dahlberg
Frank De Luz, III
Takashi Domingo
Lorraine Jitchaku-Inouye
Russel Kokubun
Merle K. Lai
Spencer Kalani Schutte
Stephen K. Yamashiro

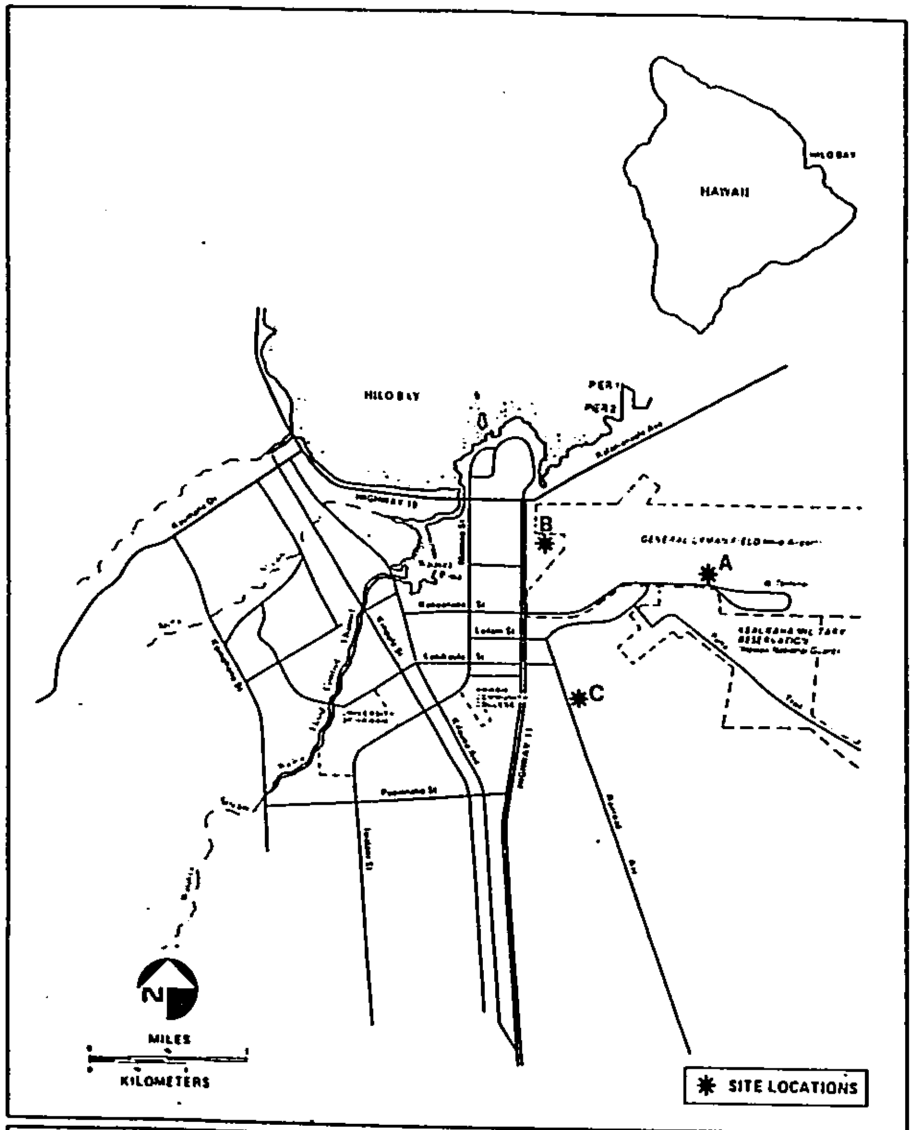
Public Utilities

Hawaii Electric Light Company
Hawaiian Telephone Company
Gasco., Inc., Hawaii Division

Community Organizations and other Public Interest Groups

Alu Like
Audubon Society - Hawaii Chapter
Big Island Business Council
Big Island Chamber of Commerce
Board of Realtors - Island of Hawaii
Hawaii Visitors Bureau - Big Island Chapter
Hilo Hawaii Visitor Industry Association
ILWU
Japanese Chamber of Commerce
Kohala Chamber of Commerce
Kona Chamber of Commerce

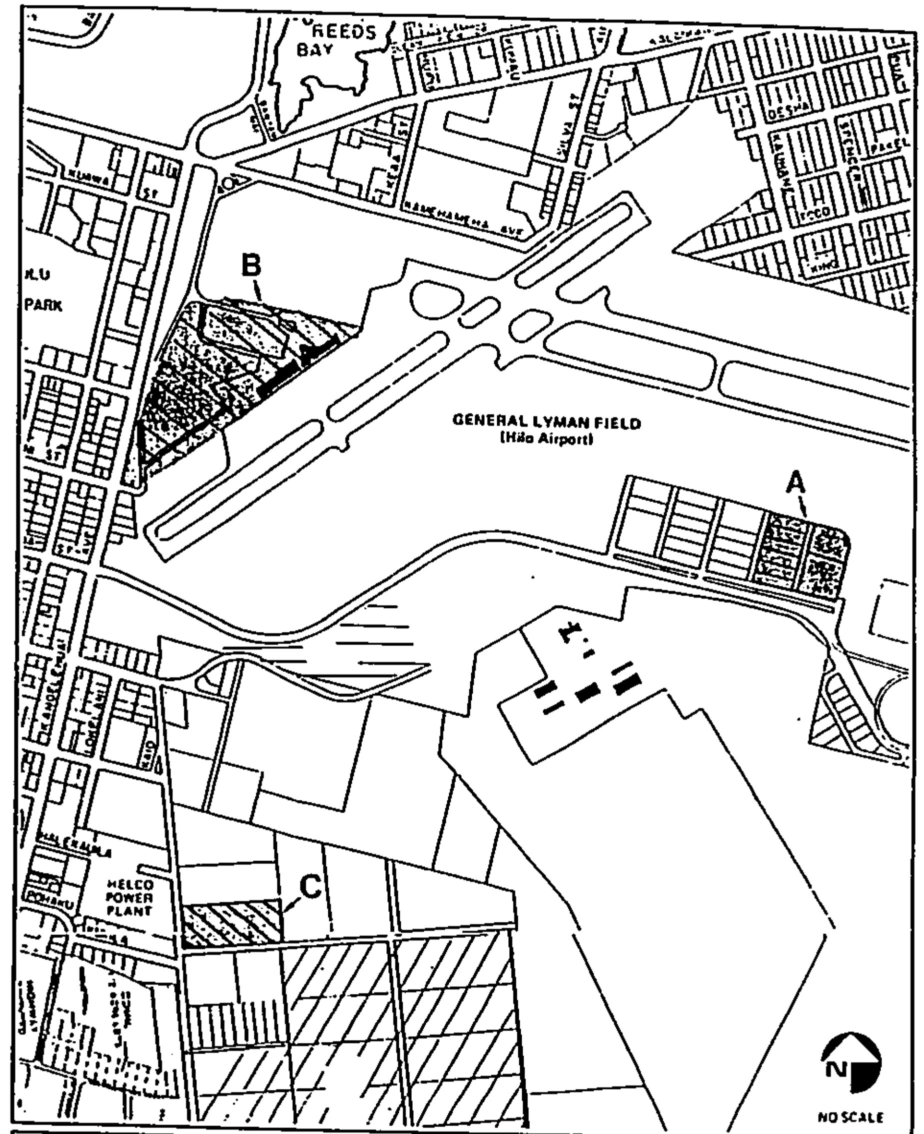
Life of the Land
Moku Loa Group, Hawaii Chapter Sierra Club
Portuguese Chamber of Commerce
Papaya Growers Association
East Hawaii Coalition to Stop Food Irradiation
Hawaii Island Technical Council
Hawaii Farm Bureau Federation



Regional Location

FIGURE 1

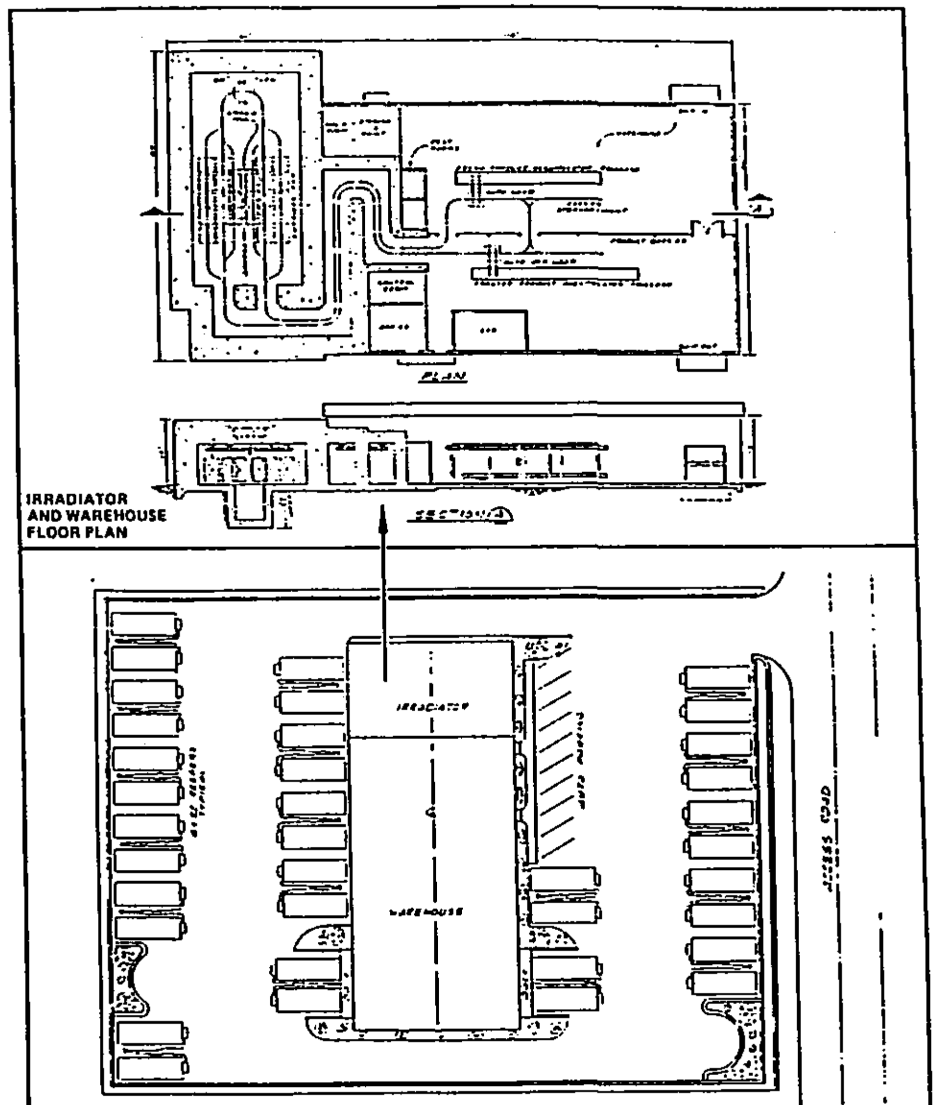
WESTEC Services, Inc



Site Areas A, B and C

FIGURE 2

WESTEC Services, Inc



SOURCE CH2M Hill, April 1987

Generic Facility Plot Plan

FIGURE 3

WESTEC Services, Inc

APR 21 1988

IN THE MATTER OF

NOTICE OF PUBLIC MEETING

NOTICE OF PUBLIC INFORMATION MEETING IRRADIATION FACILITY EIS

NOTICE IS HEREBY GIVEN that the Department of Business and Economic Development and their consultant WESTEC Services, Inc., will hold public information meetings relating to an Environmental Impact Statement for a Hawaii Commodities Irradiation Facility being considered for Hilo, Hawaii.

The meetings will be held in the auditorium of the State Capitol Building, Honolulu, at 7:00 p.m. on May 3, 1988 and at the Hawaii Naniloa Hotel, 93 Banyan Drive, Hilo, Hawaii, at 6:30 p.m. on May 4, 1988.

Roger A. Ulveling
Director of Business and Economic Development
State of Hawaii

(Hon. Adv.: Apr. 13, 1988) [illegible]

NOTICE OF PUBLIC INFORMATION MEETING IRRADIATION FACILITY EIS

NOTICE IS HEREBY GIVEN that the Department of Business and Economic Development and their consultant WESTEC Services, Inc., will hold public information meetings relating to an Environmental Impact Statement for a Hawaii Commodities Irradiation Facility being considered for Hilo, Hawaii.

The meetings will be held in the auditorium of the State Capitol Building, Honolulu, at 7:00 p.m. on May 3, 1988 and at the Hawaii Naniloa Hotel, 93 Banyan Drive, Hilo, Hawaii, at 6:30 p.m. on May 4, 1988.

ROGER A. ULVELING
Director of Business and Economic Development
State of Hawaii

(Hon. S.B.: Apr. 13, 1988) [illegible]

AFFIDAVIT OF PUBLICATION

STATE OF HAWAII,
City and County of Honolulu. } ss.

........Miyako Fujimoto........, *being duly sworn, deposes and says that she is a clerk, duly authorized to execute this affidavit, of the HAWAII NEWSPAPER AGENCY, INC., agent for HONOLULU ADVERTISER, INC., publisher of THE HONOLULU ADVERTISER and SUNDAY STAR-BULLETIN & ADVERTISER, and agent for GANNETT PACIFIC CORPORATION, publisher of HONOLULU STAR-BULLETIN; that said newspapers are newspapers of general circulation in the state of Hawaii; that the attached notice is a true notice as was published in the afore-referenced newspapers as follows: The Honolulu Advertiser* ..one...... *times, on*

........April 13, 1988........

Honolulu Star-Bulletin: ..one.. *times, on* ....

........April 13, 1988........

Sunday Star-Bulletin & Advertiser: .... *times, on* ....

and that affiant is not a party to or in any way interested in the above entitled matter.

........[signature]........

Subscribed and sworn to before me this 13th *day of* April *A.D. 19*88...

........[signature: Elaine A. Maruyama]........
Notary Public of the First Judicial Circuit
State of Hawaii
My commission expires March 7, 1992

AFFIDAVIT OF PUBLICATION

State of Hawaii } SS:
County of Hawaii }

LEILANI K. R. HIGAKI, being first duly sworn, deposes and says:

1. That she is the BUSINESS MANAGER of HAWAII TRIBUNE-HERALD, LTD., a newspaper published in the City of HILO, State of Hawaii.

2. That the "NOTICE OF PUBLIC INFORMATION MEETING IRRADIATION FACILITY EIS- NOTICE IS HEREBY GIVEN that the Department of Business and Economic Development and their consultant WESTEC Services, Inc., will hold public information meetings relating to an Environmental Impact Statement for a Hawaii Commodities Irradiation Facility, etc., ", of which a clipping from the newspaper as published is attached hereto, was published in said newspaper on the following date(s) April 13, 19 88 (etc.).

Subscribed and sworn to before me

this 20th day of April, 19 88

[signature]
Notary Public, Third Circuit,
State of Hawaii

My commission expires October 9, 1988

IPH

The purpose of the meeting is to gather from the community the issues and interests that should be addressed in an Environmental Impact Statement (EIS). The meeting will be conducted in the following manner:

> The meeting will start with a description of the proposed project and a description of the EIS process and schedule. Person wishing to present community interest and concerns which should be addressed in the EIS must sign up. Comments will be limited to 3 minutess per speaker, initially. Any speaker wishing to sign up again after his or her initial 3 minute comment period may do so. The project team will stay until all speakers have finished commenting. The project team has chosen to enforce a 3 minute time limit, with the opportunity to comment a second time, in the interest of hearing from as many persons as possible. The project team would ask that commenters honor this time limit as a courtesy to those who are waiting to testify. It is the project teams hope that a wide variety of issues that need to be addressed in the EIS for this project can be brought forward in a courteous and productive manner.

REQUEST TO SPEAK

Envision Hawaii! dbed

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

I would like the opportunity to express my suggestions on the issues to be addressed in the Hawaii Irradiation Facility EIS.

Name (please print): ______________________
Address: ______________________
____
Telephone: ______________________
Representing: ______________________

WESTEC Services, Inc.

AGENDA

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting
May 3, 1988
Honolulu

6:30 p.m.	Facility Open, Sign-in
7:00 p.m.	Introductions and Meeting Purpose
7:10 p.m.	Description of Proposed Project
7:30 p.m.	Description of EIS Process and Schedule
7:45 p.m.	Break, Sign-in
8:00 p.m.	Public Comments
9:30 p.m.	Adjourn

AGENDA

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting
May 4, 1988
Hilo

6:00 p.m.	Facility Open, Sign-in
6:30 p.m.	Introductions and Meeting Purpose
6:40 p.m.	Description of Proposed Project
7:00 p.m.	Description of EIS Process and Schedule
7:15 p.m.	Break, Sign-in
7:30 p.m.	Public Comments
9:30 p.m.	Adjourn

465 SOUTH KING STREET · KEKUANAOA BUILDING, #104 · HONOLULU, HAWAII 96813 · TELEPHONE (808) 548-6915

OEQC BULLETIN

OFFICE OF ENVIRONMENTAL QUALITY CONTROL

JOHN WAIHEE
GOVERNOR

MARVIN T. MIURA, Ph.D.
DIRECTOR

Volume V | March 23, 1988 | No. 6

REGISTER OF CHAPTER 343, HRS DOCUMENTS

****

All Chapter 343, HRS documents submitted for publication in the OEQC Bulletin must be addressed to the Office of Environmental Quality Control, 465 South King Street, Room 104, Honolulu, Hawaii 96813. Documents addressed otherwise will not be considered for publication.

****

EIS PREPARATION NOTICES

The following proposed actions have been determined to require an environmental impact statement. Anyone can be consulted in the preparation of the EIS by writing to the listed contacts. 30 days are allowed for requests to be a consulted party.

HAWAII FOOD COMMODITIES IRRADIATION FACILITY, GENERAL LYMAN FIELD, HILO AIRPORT, HILO, HAWAII, Energy Division, Dept. of Business and Economic Development

The Dept. of Business and Economic Development's proposed facility would be used to treat papaya, mangoes, lychee, and other fruit or agricultural products which are transported outside the state of Hawaii and are susceptible to fruit fly or other insect infestations, and therefore subject to U.S. or foreign agricultural quarantine requirements. The proposed source of radiation would be gamma rays emitted from the decay of the man-made isotope, Cobalt 60, as approved by the U.S. Food and Drug Administration (FDA).

At no time during plant operation will people be in direct contact with the radiation source or be in the irradiator room during treatment. The radiation source (Cobalt 60) would be stored in a water bath or casing within the irradiation room when not in use. All Nuclear Regulatory Commission and Occupational Health and Safety Administration rules, regulations, and safety precautions would be observed at all times.

The proposed facility would consist of a warehouse building housing the irradiator and ancillary operations. The irradiator equipment would be located inside a concrete block and concrete walled room. Ancillary facilities would consist of office space, dosimetry laboratory, storage space for treated and untreated fruit, and employee lockers and restrooms. The project site would be equipped with truck loading and unloading ramps to the warehouse, and truck and employee parking areas. The entire facility would be fenced for security, with access via a secured gate. The proposed site would be one to three acres and the warehouse building would be

approx. 15,000 sq. ft.

The three sites are located within industrial and/or commercial areas on or near General Lyman Field. Site A is located in the airport industrial area adjacent to the airport access road and on land presently under the jurisdiction of the Hawaii State Dept. of Transportation, Airports Division. Site A land was originally master planned for airport related industrial activities. Site B, located at the old air terminal, also under Dept. of Transportation jurisdiction or the State Dept. of Lands and Natural Resources (depending on the part of Site B on which the plant would be located), is within or next to the airport boundaries. Currently, Site B is used for air cargo operations. Site C is located on Railroad Ave. approx. one-half mile from the airport (under the jurisdiction of the Dept. of Hawaiian Home Lands) and is presently vacant. The site was previously used for concrete mixing and for a sand and gravel plant. Nearby land uses include the Hilo Airport, HELCO Power Plant, and other industrial activities. All three sites are zoned and/or have land use designations to allow for construction and operation of the proposed irradiation facility. TMKs: Site A, TMK:2-1-12: 106; Site B, TMK 2-1-12: por. 34-86; and Site C, TMK:2-1-25: 86.

Contact: Mr. M. Kaya
State of Hawaii
Dept. of Business and Economic Development
Energy Division
335 Merchant St., Rm 110
Honolulu, HI 96813

Deadline: April 22, 1988.

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF A VERY LONG BASELINE ARRAY (VLBA) ANTENNA FACILITY WITHIN THE MAUNA KEA SCIENCE RESERVE, MAUNA KEA, HAMAKUA, HAWAII, Institute for Astronomy, University of Hawaii

A supplement to the Final EIS for the Mauna Kea Science Reserve Compl. Development Plan, which was accepted b. the Governor in January 1983, will be prepared for the proposed project.

The purpose of the Very Long Baseline Array (VLBA) is to provide high-quality radio images of remote astronomical objects at the highest angular resolution that can be achieved by a ground-based instrument. The design objectives of the array would be met by placing the easternmost and westernmost antennas in the U.S. Virgin Islands and Hawaii, respectively, with the remaining antennas at suitably located sites on the mainland U.S.

The National Radio Astronomy Observatory (NRAO) has asked the University of Hawaii, Institute for Astronomy, for permission to locate the Hawaii-based VLBA antenna within the Mauna Kea Science Reserve. The proposed antenna facility site is located below the summit area, between the 12,200- and 12,400-ft elevation of Mauna Kea, approx. 2,600 ft. northeast of the Mauna Kea Observatory Access Rd. The antenna facility, which would not have a dome, would be identical in both operational characteristics and appearance to the other 9 antennas which make up the VLBA.

An area of approx. 2 acres will be delineated for the use; approx. 1 acre o the site will be enclosed by a 7-ft. high chain link fence, painted to blend into the surrounding environment. An additional 2.5 acres, more or less, will be required for a road connecting the VLBA site with the MKO Access Road.

The VLBA antenna, a control building, an emergency generator, a LPG fuel tank, a tower with weather instruments and miscellaneous concrete pads for equipment will be constructed within the fenced area. The antenna will be a wheel and track, elevation over azimuth configuration with a 25-meter (82-foot) diameter solid surface reflector, carried by a wheel and track mounting to permit pointing in any direction. It will rest on a circular concrete, 50-ft.-diameter ring with concrete spokes, spaced at 90

C.2 PUBLIC MEETINGS

The purpose of the meeting is to gather from the community the issues and interests that should be addressed in an environmental impact statement (EIS). The meeting will be conducted in the following manner:

> The meeting will start with a description of the proposed project and a description of the EIS process and schedule. Persons wishing to present community interest and concerns which should be addressed in the EIS must sign up. Comments will be limited to 3 minutes per speaker, initially. Any speaker wishing to sign up again after his or her initial 3-minute comment period may do so. The project team will stay until all speakers have finished commenting. The project team has chose to enforce a 3-minute time limit, with the opportunity to comment a second time, in the interest of hearing from as many persons as possible. The project team would ask that commentors honor this time limit as a courtesy to those who are waiting to testify. It is the project team's hope that a wide variety of issues that need to be addressed in the EIS for this project can be brought forward in a courteous and productive manner.

CONTACTS FOR
COMMODITIES IRRADIATION FACILITY
ENVIRONMENTAL IMPACT STATEMENT

Maurice Kaya
State of Hawaii
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Telephone: 548-4150

Howard J. Mimaki
State of Hawaii
Department of Business and Economic Development
General Lyman Field
Hilo, Hawaii 96720

Telephone: 935-9741

AGENDA

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting
May 4, 1988
Hilo

6:00 p.m.	Facility Open, Sign-in
6:30 p.m.	Introductions and Meeting Purpose
6:40 p.m.	Description of Proposed Project
7:00 p.m.	Description of EIS Process and Schedule
7:15 p.m.	Break, Sign-in
7:30 p.m.	Public Comments
9:30 p.m.	Adjourn

AGENDA

Hawaii Commodities Irradiation Facility
Environmental Impact St ement
Public Meeting
May 3, 1988
Honolulu

6:30 p.m.	Facility Open, Sign-in
7:00 p.m.	Introductions and Meeting Purpose
7:10 p.m.	Description of Proposed Project
7:30 p.m.	Description of EIS Process and Schedule
7:45 p.m.	Break, Sign-in
8:00 p.m.	Public Comments
9:30 p.m.	Adjourn

1/1

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Pubic Meeting

May 3, 1988 - Honolulu

Name	Address and Telephone	Representing
Christine Rosavia	Hawaii Agricultural Alliance 99193 Aiea Hts. Dr. #120 Aiea, 96701	486-5338
James H. Moy	Food Tech Bldg. UHM Hon., HI 96822	UHM
Robert W. Hall	Hawaii Institute for Biosocial Res. 545-2800	
	P.O. Box 4124 Honolulu 96812	
Myron Isherwood	Dept Agriculture 548 5550	
Richard Sakanashi	100 Kukila St. Hilo, Hi 96720	OnoPac Corp
Kenneth Martin	P.O. Box 463 Kilauea, Hi 96754	Haw. Trop. Ind. Ass 828-1030
Dennis Mason	P.O. Box 210 Kealau Hi 96749	[illegible] Tropical Products
Charles T. Wallis	P.O. Box 325 " " "	" "
Robert A. Souza	1100 Ward Ave Rm 860 Honolulu, HI 96814 (533-3844)	PAC
Darrell Yagodich	Dept. of Hawn Home Lands Po 1879 Hon. 96805	
Wendell Koga	HFBF - 293 Kalihi St. 96819	
Anthony K.H. Chang	State Capitol, Rm 229	State Senate

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Pubic Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Ken Mann	1100 Ward Street LWL	HAA
Brad Lewis	RR2 Box 4774 Pahoa, Hi 96778	AINA
Richard Sakanashi	100 Kukila St. Hilo	Ono Pac Corp.
Adriana E. Dicker	99 Honolii Pl., Hilo, Hi.	self + family
Kathleen Brown	Box 691 Volcano, HI 96785	self
Abbie Napeahi	213 Todd Ave. Hilo Hi 96720	Leleiwi Assoc.
Helen Napeahi	119 W. Lanikaula St. #[illegible] Hilo Hi 96720	Keaukaha Panaewa Assoc.
Karen & Michael Clark	PO Box 1546 Keaau HI 96749	family
Helga & James Costello	Star Rt. 5277 Kea'au, Hi 96749	family
Annie Napeahi	213 Todd ave Hilo Hi 96720	
Ann Mau	121 Lokoaka Hilo 96720	Leleiwi Comm. Ass.
W.J. Saltzer	RR2 Box 3700 Pahoa HI 96778	
Ginny Aste	15-272 Puni [illegible] Pahoa HI 96778	
G.H. Souder	Box 1264 Pahoa	SELF
Kathleen Ing	Box 545 Volcano, Hi 96785	family
Stuart Marks	Box 616 Kurtistown, Hi 96760	Family
Thomas Bearden	2405 Kalanianaole Ave [illegible] Hilo 96720	
Lewis Goldenberg	Bx 1061 Pahoa Hi 96778	
Art McCormick	Box 6159 Capt. Cook 96704	
Roger Evans	Po Box 5024 Hilo H. 96720	
Virginia Spencer	RR-Box 4018 Pahoa 96778	
Vince Shank	P.O. Box 848 Pahoa	
Mr. & Mrs. John Dela Cruz	696-A8 Railroad Ave.	

2

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Russell Ruderman	P.O. 1410 Pahoa, 96778	SELF
Deborah Hay	P.O. Box 761 Keaau 96749	self
Frank Jelvatek	P.O. Box 1857 Pahoa 96778	"
Walt Southward	94 [illegible] Hilo 96720	HICA.
Elliot Pulham	1088 Bishop St. #1227	SELF
Kenneth Martin	P.O. Box 463 Kilauea, Hi 96754	President Haw Pap Inst.
Shigeko Chang	18 [illegible] St Hi 96720	[illegible]
Terri Scott	Box 943 Kurtistown 96760	self
Sc.		
Barbara Hogan	S.R. 5859 Keaau Hi 96749	self
Judith & John Howe	P.O. Box 208 Laupahoehoe 96764	
Mr & Mrs Joseph Chun	408 Todd Ave, Hilo, Hi 96720	
Myrl Finley	33 Kiola St. Hilo 96720	
James Finley	— — — 9	
John Wegner - SR6233 - Keaau, Hi 96749 -		
Milton Papineau	S.R. 6210 Keaau Hi 96749	
Olivia Cockcroft	POBX 1035 Kurtistown Hi 96760	
Jennifer Weinert	PO BX 388 Kurtistown HI 96760	
[illegible] Hamilton	POBOX 125 Kurtistown Hi 96760	
James R. Talick	1045 Oli Oli Way Hilo	Self
Bonnie Bator	PO Box 565 Kurtistown HI 96760	
Rebecca Burke	PO Box 1265 Keaau HI 96749	
Sherry Burris	1875 Kalanianaole Ave #705 Hilo 96720	

3

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Darrell Yagodich	PO Box 1879 Honokaa 96305	Hawn Home Lands
Melvin Nishina	875 Komohana St. Hilo 96720	CES - Hi County
Ellen Takeyama	P.O. Box 540 Papaikou	
~~[illegible]~~	~~Box 475 P Hilo.~~	
~~[illegible]~~	~~25 [illegible] St. Hilo~~	Self
Vern Inoue	1212 Kilauea Pl Hilo	Self
D Hayashi	225 Nani alii St	
Greg Ferrin	P.O. Box 943, Kurtistown 96760	
Keola Kalauli, Pres.	226 King Ave 961-6239	Keaukaha-Panaewa Comm Assoc.
Glen M.K.K. Kalua	226 King Ave	Keaukaha Panaewa Farm Assoc.
Dawn [illegible] Hawthorn	PO 1536 Keaau, Hi	
Steven Beardsley	967 Awa St Hilo 96720.	
Peter McClaran	P.O. Box 50144, Hon, HI 96850	
Alfred Tong	104 Alae St. Hilo 96720	
Oppenheim	P.O. Box 714 Hilo, HI 96721	
Fix Bradford S.	P.O. Box 214 Hilo, HI 96721	
Calina	PO B 541 Pahoa Hi 96778	
Julie Hedgecock-Jacobson	PO Box 900 Kurtistown HI 96760	
Rob Jacobson	PO Box 900 Kurtistown HI 96760	
Donna Licata	P.O. Box 1569 Pahoa, Hi 96760	
Mr. & Mrs. Marvin Knoff	P.O. Box 554 Keaau, Hi 96749	
Diane Furgene	S.R. 5643 Keaau Hi 96749.	
[illegible] Dunn	Box 324 Kurtistown 96760	

4

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Joseph A. Calvino	POB 541 Pahoa 965-9029	
THOMAS K Cook	1970 KALANIANAOLE Av Hilo	Keleiwi Com. Assn
Irene Okada	282 Mohe Pl	Hilo Church of Holy Cross
Dorothy Dowden	181 S. Wilder Rd.	" "
CHAS. H. AULD	101 AUPUNI #907	Hilo —
Ralph L. Yost	15-2712 Hoe St. N Pahoa, Hi. 96778	
J. J. Ricard	2036 KALANIANAOLE, HILO 96720	
AL LEIGHTON	PO Box 1259 KEAAU 966-8544	BIG ISLAND EARTH WORKS
GENE NIST	2705 KAL-UNIT 506	Orchid Ind. 935-1827
Ted Erhard	P.O. Box 1915 Pahoa Hi 96778	
Laurel Dekker	PO Box 577 Kurtistown, HI 96760	myself
Nellie Rodriguez	PO Box 5 Ninole HI 96773	—
Donna Licata	P.O. BOX 1591 Pahoa HI	
Jay Benson	1923 Kalanianaole, Hilo, HI, 96720	
JAY SASAN	888 Kalanianaole Hi 96720	
Michael F. Greenlaw	SR 11000 Keaau HI. 966-8701	
Kay Roach	PO BOX 2115 Pahoa Hi. 96778	

C-17

5

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Dianne C. Clarke	P.O. BOX 1365	Human Kind
Vince J McCallum	P.O. Box 1183 Keaau Hi 96749	
Kendra Dabney	P.O. Box 10588 Hilo H. 96721	
Ole' Fulks	SR 5664 Keaau 49 Hi.	No Phone
Patricia M Ivy	P.O Box 612	Self
Richard West	P.O. Box 71124 Hilo Hi 96721	
Dr. Jacqueline Brittain	1923 Kalanianaole Hi 96720 935-6297	
[illegible] Snyder	1439 Railroad Ave 959-8776	BINFZC
Alan Cay	Box 1244 Pahoa	
Nora Kuitz	" "	
Victoria L. Tenbrink	322 Ohai St #17 Hilo, HI 96720	myself
Mrs. Tammie Keown	RR1 Box 172 Pahoa HI	NO PHONE
M. V. Tobin	POB 536 Pahoa Hi 96778	
Linda Haynes	151 Kapaa St Hilo	
Roxie Karahn	190C Kaumana Dr. Hilo Hi 96720	myself
TAMMY EZZO	430 W. KAWILI ST. 4B HILO, HI. 96720 959-3094	
CLIVE CHEETHAM	P.O. Box 1513, PAHOA, Hi 96778	Kona Community Assoc.
Jack Funes	194 MAKAALA St Hi 96720	Western Pacific Interior
Cynthia Hathaway	P.O. Box 599 Keaau, HI 96749	opposing irradiation
Lucinda Reed	1510 Kilikina St Hilo 96720	
Christine Reed	382-A Kaiwiki Rd. Hilo 96720	opposing
David Zeigler	13-3586 Chelsea Ct. Pahoa 96778	opposing
Rory Habermayer	SR 6820 Keaau 966-6909	

6

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Colleen Wandab	Box 1946, Volcano	Volcano natural Groceries
Lisa Buza	149 Hale St. #7-D	Hilo High School
Kim Takazawa	P.O. Box 396 Pepeekeo HI 96783	" " "
Dave Brown	1039 Ainako Hilo	Self & Pacific Tropical Products
Dexter Cate	167 Lehaina St. Hilo	Self + Earthtrust
Dr. Jack Turner	50 Ululani Hilo	me
[illegible] 965-9449	RR 1 Box 4518 Pahoa Hi	[illegible]
Nilo Kristi	Box 1244 Pahoa HI 96778 966-6278	GAIA
Paul W. Dit[illegible]	P.O. Box 244 Volcano, HI	self
STEVEN KROWN	RR1 BOX 172 PAHOA HI 96778	
John Bancroft	61 E. Lanikaula St. Hilo 96720	
Holly Taylor	2353 Kinoole Hilo 96720	
Stephen Palmore	P.O. Box 162 Mt. View HI 96771 968-6140	Fern Acres Comm. Assoc.
EDWARD S. CLARK	400 HUALANI ST. #260 HILO, HI 96720	(SELF) (& WIFE)
Harriet Smith	P.O. Box 770, Kurtistown, Hi 967	
Randal Lee	P.O. Box 943 Pahoa Hi 96778	
R. Ainslie	PO Box 1158 Hilo HI 96720	Sane Citizens Against Nukes.
H. nakoolani Warrington	696 Railroad Ave #A-4 Hilo Hi 96720	(self)
Leslie Miki	90 Kamehameha Ave Hilo, HI 96720	
Steve Brothers	P.O. Box 884 Kurtistown Hi 96760	Abundant Life Natural Foods
Sue Clark	SR 6830 Keaau Hi 96749	
~~Kathy D~~		
Kathy Dorn	PO Box 1569 Pahoa 96778	

C-18

7

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
Cathy Chow	Box 758 Pahoa 96778	
David Larson	72-B Halaulani Pl Hilo 96720	
Kim Kerk	1334 WALUKU DR. 96720	
Harry Jay J. Akrey	Box 1073 Awalako Hi 96720	
Charlie Gumeson	Box 4968 Hilo 96720	(Candidate) 1st Dist
Dr. Mark Goodman	1396 Kinoole Hilo 96720	
Dr. Robert L. Lawyer	493 Ocean View Dr. Hilo	
Lawrence R. Test	1000 Kaiwiki Rd. Hilo	
Jeyes-Paku Turner & Family	194 Makaala	Western Pacific Interiors
Amos C Akeonee	PO Box 691 (967 7379)	Volcano 96785
Michael J. Kelly	167 Lahaina St. Hilo, Hi. 96720	
FRANK Coskie	P.O. 998 Kurtistown, Hi 96760	
Joe Pacal	SR 13008, KEAAU, HI 96749 966-8592	HAWAII CENTER FOR ECOLOGICAL LIVING
Lynn Pelletier	Box 317 Kurtistown, Hi 96760 966-7509	
JOANIE P. KEALOHA	696 RAILROAD AVE #A-8, HILO, Hi 96720	
PAUL SHAW	P.O. Box 1313 KEAAU, HI 96749	[illegible]
Bonnie Gold	POB 1597 Keaau Hi	
Frank Streeter	52 Femo St, Cambridge, Mass 02138	
Denver Leaman	PO Box 888 Pahoa 96778	
TERENCE SPENCER	SR 9534 KEAAU Hi 96749	
Sal Licata	P.O. Box 1519 Pahoa 96778	
ROBERT SEARIGHT	Bx 1223 PAHOA 96778 Hi.	
MARY E BALETTA	Bx 1591 KEAAU HI.	

8

ATTENDANCE RECORD

Hawaii Commodities Irradiation Facility
Environmental Impact Statement
Public Meeting

May 4, 1988 - Hilo

Name	Address and Telephone	Representing
CHARLES H. STEWART	4-4-2 Toyotamanaka Nerima-ku Tokyo 176 03(993)2193	
Jennifer S. Moore	Po box 10907 Hilo 96721	Simply's Joy
Robert S. Jastowski	SR 6846 Keaau 96749	Genaiaro's Exotics
Marge King	1875 Kalanianaole #205 935-2569	
Alex Carney	P.O. Box 11018 Hilo Hi. 961-5483	
JAY COSKIE	BOX 998 KURTISTOWN 96760 966 8875	
Kalei Jeanah Verdun	696 Railroad Ave #AB Hilo Hi 96720 959-2061	
Hoshimi WILKES	Dr 780 Kurtistown, 96760	
Helen Behrmann	P.O. Box 483 Naalehu Hi 96772 929-9635	
Thomas Watson	400 Hualani #352 Hilo HI 96720 961-4477	
HAWAII TRIBUNE-HERALD	P.O. BOX 767 HILO, HI 96721	
DOROTHY WALKER	P O BOX 162 HILO HI. 96721.	
PATRICIA OLIVER	POB 1902 HILO, HI 96721	
Laura Simmons	P.O. Box 750 Naalehu Hi 96772	
Robert A. Souza	1100 Ward Ave Ln 860 Honolulu 96814 - PR	
Christine Rosavia	Hawaii Agriculture Alliance 99-193 Aiea HTS DR. #120 Aiea 96701	
MAM ANDREW LEO	BOX 1675 PAHOA, Hi. 96778	
Kima Elkin	Box 1307 Keaau 96749 966-6484	
Karen Davis	RR2 Box 3906 Pahoa 96778	
Suzanne Hale	P.O. Box 687 Mt View 96771	

Irradiation Facility
State Capitol Auditorium
May 3, 1988

The meeting was convened at 7:00 p.m. by Dee Dee Letts of the Neighborhood Justice Center. Dee Dee explained about the Neighborhood Justice Center and her role as facilitator for the evening. She then went over the agenda for the evening with the attendees. It was explained that the purpose of the meeting was to help define and develop the issues needing to be addressed in an Environmental Impact Study (EIS) on the irradiator facility. There was an announcement that printed material about the project is available from:

Maurice Kaya State of Hawaii DBED Energy Division 335 Merchant St., #110 Honolulu, HI 96813 Tel: 548-4150	or	Howard Mimaki State of Hawaii DBED General Lyman Field Hilo, HI 96720 Tel: 935-9741

Participants were invited to share any printed material they may have outside the meeting hall so as not to disrupt the meeting. Participants were also invited to sign up legibly if they would like to receive a copy of the group memory for the evening.

Dee Dee then went over the ground rules for the evening. These included the meeting time 7:00 to 9:30 p.m., that courtesy among all the participants was important and that there would be a three minute limit on comments. She explained that the three minute time limit on concerns and issues for the EIS was to assure everyone who wanted to speak got a chance in a timely manner. It was pointed out that in the interest of time speakers should summarize and make their issues, questions and concerns clear and honor the time limits as a courtesy to those waiting to speak. It was recognized that the issue is a complex one and that it was not the intent of the time limit to restrict persons from raising the necessary issues. Any speaker needing more time was encouraged to sign up again for more time after everyone had been heard.

Dee Dee then went over the outcomes for the meeting:

- an understanding of the proposed project
- an understanding of the EIS process and schedule
- a list of questions and concerns that need to be addressed in the EIS

Dee Dee then introduced the project team.

Maurice Kaya - Energy Program Administrator, Irradiation Project Manager, DBED

Jerry Lesperance - Alternate Energy Specialist, DBED

Jim Frolich - EIS Project Manager, Westec

Perry White - Belt Collins & Associates, Environmental Sub Consultants

Gordon Chapman - Independent Environment Consultant from Honolulu

Dee Dee then introduced Jerry Lesperance who described the proposed project. When Jerry finished his presentation, Jim Frolich described the EIS process and schedule.

The meeting was then opened up for community concerns. What follows are the major points, concerns and issues the participants felt should be addressed in the EIS.

- Industry needs the facility
- Agriculture is a vital segment of the Hawaiian economy, keeping this facility from being built will make it more difficult for agriculture to compete against other land uses
- Concerned about integrity of construction in view of natural hazards
- Must balance benefits of agriculture against the risk of the processes needed to support it
- Need to insure site transportation of radioactive material
- Consider its use for other commodities in addition to papaya
- Look for back-ups to sugar and other existing crops
- Want the facility to be a <u>safe</u> alternative treatment method, thinks irradiation is that
- Farmers in general support the demonstration project
- Growers believe food irradiation has been proven safe
- EIS should present all available info, but recognize that demonstration project will provide even more

Assess risk factors

Dramatic increase in acute illnesses in State, concern about pesticides as possible cause

Scientific studies are "equivocal", but indicate there may be problems with irradiation

Concerned that there is no scientific basis for reassurance that there is no problem

- Past studies on toxic substances are inadequate
- Concerned about effects on immune system of agricultural and other chemicals
- Scientists are unwilling to oppose "popular" projects
- No tests anywhere that adequately define effects of toxic substances here
- There is good scientific evidence that irradiated food should be avoided

(See attached statements)

HAWAII COMMODITIES IRRADIATION FACILITY
ENVIRONMENTAL IMPACT STATEMENT
PUBLIC MEETING NOTES
Tuesday, May 3, 1988, 7:00 p.m.
State Capitol Auditorium
Honolulu, Hawaii

Meeting Purpose and Introductions - Dee Dee Letts, Facilitator

Ms. Letts summarized the purpose of the meeting, the meeting rules, and the agenda, and gave the names and addresses of the contact people. (See attached handouts 1 through 4.) She announced that those who had signed in will receive a copy of the meeting notes. The audience was advised that they could pass out information, but it should be done outside the hall. Ms. Letts also stated the desired outcomes of the meeting:

- that people understand the nature of commodities irradiation in general and the proposed Hilo demonstration project in particular;
- that they understand the EIS process; and
- that the authors of the EIS know the topics that people want the EIS to address.

Those who are working on the project were introduced: Maurice Kaya and Jerry Lesperance of the Department of Business and Economic Development (DBED), and consultants Jim Frolich (WESTEC Services, Inc.), Perry White (Belt Collins & Associates), and Gordon Chapman (independent consultant).

Description of the Proposed Project - Jerry Lesperance, Alternate Energy Specialist, Department of Business and Economic Development

Mr. Lesperance gave background information on the events that have led up to the cooperative agreement between the U.S. Department of Energy (DOE) and State DBED to develop an irradiation facility in Hawaii as a demonstration project. Key events included the ban of EDB and its impact on the papaya industry, establishment of a steering committee, completion of a feasibility study, appropriation of funds by the Legislature to construct an irradition facility (conditioned upon the Governor's acceptance of an EIS for the project), and WESTEC being retained to prepare the EIS. Mr. Lesperance summarized the provisos specified by t[illegible] Legislature to be followed in selection of the contractor. He explained the irradiation proc[illegible], described a typical facility and safety measures, and listed various facilities on the mainland. The proposed alternate sites in Hilo were pointed out on a map. Mr. Lesperance said that the RFP for design, construction, and operation of the facility is currently being prepared.

Description of EIS Process and Schedule - Jim Frolich, WESTEC Service, Inc.

Mr. Frolich explained that the EIS will examine thre[illegible] [illegible]lternate sites and that it is being prepared as an informational document to aid those who must weigh the environmental factors. DBED is the lead agency, and the Governor is the accepting authority. A risk assessment will be conducted, as well as a marketability study to determine the level of consumer acceptance.

Mr. Frolich reviewed the EIS process. Between 60-65 comment letters have been received in response to the environmental assessment and EIS preparation notice. The next steps are these public meetings to get further public input, followed by preparation of the draft EIS, which will be published in mid-August. The public will then have 45 days to review and comment on the DEIS; written responses will be sent to those who provide comments. The final EIS will be submitted to the Governor to be used as an information document so a decision can be made and as a basis for the final design.

Public Comments

Ms. Letts announced that since only four people had requested to speak, the time limit was extended to five minutes. Mr. Hall, who had signed up twice, was allowed ten minutes. The facilitator again emphasized that the project team was looking for questions and concerns that need to be covered in the EIS, and that the EIS is an informational document, not a decision document.

Christine Rosania, Hawaii Agricultural Alliance

Ms. Rosania explained that the Hawaii Agricultural Alliance is a statewide group of large and small crop growers that sees agriculture as a vital industry that must be preserved. The Alliance sees land use as the key issue; agricultural land is being converted to uses that may not be in the best interests of the state. It is believed that Hawaii can develop a strong agricultural export industry. Not building the irradiation facility would prevent this growth since the present process is not efficient enough. Ms. Rosania stated that the benefits must be balanced with the risks; she thinks that the benefits outweight the risks, which can be either minimized or eliminated. She would like to see a plant built that can withstand earthquakes.

Wendell Koga, Executive Director, Hawaii Farm Bureau Federation

Mr. Koga's organization, representing 1,400 members across the state, supports the facility. He requested that the EIS consider the economic impacts on farmers and the state, including the potential of other fruits and vegetables that could be exported out of state. Because irradication of the fruit fly is years away, Mr. Koga believes irradiation is the only viable alternative.

Kenneth Martin, President, Hawaii Papaya Industry Association

The Hawaii Papaya Industry Association represents 400 growers. Mr. Martin wants the community to have a safe facility and feels confident that the facility can stabilize and stimulate the industry. He feels that exports can be increased—not just papayas but other crops as well. Mr. Martin recognized that the EIS will not be able to answer all of the questions, but that only by proceeding with the demonstration project can some of those answers be found.

Robert W. Hall, Hawaii Institute for Biosocial Research

Mr. Hall expressed concern about increases in the incidence of acute conditions in Hawaii. He cited high rates of birth defects, sterility, cancer, and acute/chronic illnesses, and the heavy use of pesticides by farmers. He said that scientific studies show signs of toxic substances being created through irradiation, and that after reading the literature, he would not eat anything that had been irradiated. Mr. Hall also spoke about the problems of water supply contamination and the toxicity of flouride. Another concern was the lack of research on the effects of toxic chemicals on the immune system. Mr. Hall felt we are not paying attention to the scientists, and that we have not heard from those who have done the studies. He is concerned that UH scientists are not willing to speak up.

Irradiation Facility
Hilo, HI
May 4, 1988

The meeting was convened at 6:45 p.m. by Dee Dee Letts of the Neighborhood Justice Center. Dee Dee explained about the Neighborhood Justice Center and her role as facilitator for the evening. She then went over the agenda for the evening with the attendees. It was explained that the purpose of the meeting was to help define and develop the issues needing to be addressed in an Environmental Impact Study (EIS) on the irradiator facility. There was an announcement that printed material about the project is available from:

Maurice Kaya State of Hawaii DBED Energy Division 335 Merchant St., #110 Honolulu, HI 96813 Tel: 548-4150	or	Howard Mimaki State of Hawaii DBED General Lyman Field Hilo, HI 96720 Tel: 935-9741

Participants were invited to share any printed material they may have outside the meeting hall so as not to disrupt the meeting. Participants were also invited to sign up legibly if they would like to receive a copy of the group memory for the evening.

Dee Dee then went over the ground rules for the evening. These included the meeting time, 6:45 to 9:30 p.m., that courtesy among all the participants was important and that there would be a three minute limit on comments. She explained that the three minute time limit on concerns and issues for the EIS was to assure everyone who wanted to speak got a chance in a timely manner. It was pointed out that in the interest of time speakers should summarize and make their issues, questions and concerns clear and honor the time limits as a courtesy to those waiting to speak. It was recognized that the issue is a complex one and that it was not the intent of the time limit to restrict persons from raising the necessary issues. Any speaker needing more time was encouraged to sign up again for more time after everyone had been heard.

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Gordon Chapman - Independent Environment Consultant from Honolulu

Dee Dee then introduced Jerry Lesperance who described the proposed project. When Jerry finished his presentation, Jim Frolich described the EIS process and schedule.

The meeting was then opened up for community concerns. What follows are the major points, concerns and issues the participants felt should be addressed in the EIS.

- Government agencies have found irradiation to be safe
- Address natural hazards
- Concern about accidents causing release of radiation especially leading to water pollution
- Use of irradiation will make fruit unmarketable
- Demonstrate economic feasibility - cost versus benefits
- Who will operate and assume liabilities for accidents?
- Will packers use facility?
- What are the alternatives to irradiation?
- What happens if packers don't use the facility?
- Address transport system for nuclear components and risks/protective measures
- Discuss decommissioning of plant if it is not feasible over the long run
- Is irradiated fruit safe to eat? (adequacy of studies questioned)
- Provide a list of events that would cause the plant to be decommissioned
- What happened to the Honolulu plant?
- How many people are in the papaya industry?
- Why not build the plant in Honolulu
- If irradiation comes to Hawaii, where can the people go?
- More research is needed to prove irradiation is safe

- Address the possibility of ground water contamination - what precautions taken?
- What is worker exposure (Honolulu accident discussion)?
- Transportation safety and transport
- What is accident risk and how can residents be protected?
- Is it fair to risk many people's lives for the economic benefit of a few?
- Concern about presence of nuclear materials near populated areas. Are they really safe?
- Site selection process is flawed, need to address
- Irradiation treatment that may be safe for non-consumptive materials is not necessarily safe for people's food
- Existing regulations will <u>not</u> insure safety
- Regulators are too susceptible to economic influences. How will DOH effectively monitor safety?
- Have alternative methods been adequately explored?
- <u>Sure</u> we won't be a dump site or affected by accidents?
- Why/by what authority does the government pursue irradiation?
- Address the danger from terrorism/sabotage
- Cobalt 60 is in short supply and expensive. What is seen as the long-term fuel supply?
- How much shielding is needed at the facility?
- How come Westec is already giving conclusions about safety if the studies and design aren't done?
- The risks of eating irradiated food are not well known, can't inform consumers effectively through labeling
- Plant should be prohibited as part of the nuclear free zone that Hawaii has set up
- Pana'ewa papaya growers don't want the irradiation plant and won't use it
- What will happen if no irradiation facility is built? This scenario is only potentially bad for a few growers?

Page 4

- Denying papaya growers access to technology will damage the growth of the industry
- Examine accident records at other facilities
- Does this facility come under Price-Anderson Act (limited liability)?
- What is the role for county in this plant?
- When will education plan be implemented?
- To what extent will rejection of irradiation harm agriculture/promote other (urban) development
- Alternatives - should compare available technologies
- Pana'ewa site has better uses
- How can residents be assured of safety?
- Danger from natural hazards (tsunami, earthquake, lava flow)
- Local residents oppose plant as noted by DBED's own poll
- Why is state studying the safety of the Waimanalo plant if there are no safety problems?
- Will consuming states ban sale of irradiated fruit?
- Where will wastes be stored and disposed of?
- Why can't existing technology continue to be used?
- Prevention of water contamination during transport
- How will children be protected from accidents?
- Why is an irradiator allowed to emit more radiation and still be considered safe and operable than a power plant (regulations)
- What is basis for irradiation cost estimates?
- Is it appropriate for the Government to support the facility?
- Will growers use the facility? Is there a market?
- Threat from sub-atomic particles - high emissions from the facility
- Is recovery from accidents possible?
- How reliable are regulations?

Page 5

- Will labeling provide adequate protection?
- What is the reasonableness of FDA assumptions?
- Why is state considering irradiation despite public opposition?
- Who really benefits?
- The issue should be decided by vote
- How are wastes to be disposed of?
- Radiation levels are not low (what are radiation levels?)
- Will there be provisions for adequate labeling
- Assurance about the availability of fuel/cover alternative fuels and their side effects in the EIS
- The DBED poll of residents feelings - <u>clearly</u> show that they are not in favor
- Define acceptable "risk" and "response"
- Will this process kill/mutate enzymes?
- Treat alternatives equally in the EIS discussion
- Examine the effects on Indian children from eating irradiated meat
- Is this project just a way to get rid of nuclear wastes?
- History of other nuclear facilities of this type
- Is fruit nutritious?
- Look at alternative technology especially dry heat
- What are economic benefits to Hawaii (who makes money)?
- Concern about poisoning from nuclear wastes
- Can never stop irradiator once it is started. The issue needs a referendum
- What is safe level of radiation? Only <u>0</u> is ok
- What are the potential long-term health effects?
- What are the agriculture commodity losses if the facility is closed

Page 6

- How will the environment be protected? What is the liability and who holds it if the plant fails?
- We should look at ways to kill flies, not irradiate fruit
- When will there be a public hearing on the EIS?
- Decision on irradiation will actually be made in back room, not in the open
- Who will be hired to operate the plant?
- How does treatment affect the taste?
- What are the hazards associated with the manufacturing of Cobalt-60?
- What are the effects of this industry on other industries?
- What are the human error risks - especially at night?
- Where are the disposal sites and what are the dangers?
- The alternatives may provide more employment; EIS should compare
- How/who would treat emotional psychological trauma resulting from accident at the plant?
- What is the plant's effect on property values?
- Will food product be radioactive? (secondary/residual radiation)
- Why is the plant allowed greater radiation releases than a reactor?
- What are the possible litigation impacts of the plant?
- What are the photo-nuclear effects/ISO-meric and relationship to safety?
- Don't want people to eat irradiated food
- What is the social impact of having a plant <u>imposed</u> on them?
- Political alienation when elite doesn't listen
- Referendum is only way to stop project/people must get together
- Is the facility designed to solve the military's waste problem?
- How can project be halted?
- The impact of Cesium as an alternate powers source must to be studied

Page 7

- Who wants the plant near them/site availability
- It is known that radiation is unsafe - EIS should show public opposition
- People feel helpless to prevent use of irradiation
- Please send a copy of the tape of hearing to Senator Inouye
- Fuel transport accident - what would be its effect on the ocean and ocean resources
- What is the effect on tourism?
- What about labeling and who will monitor co pliance?
- Safety is <u>regional</u> issue
- EIS should look at costs/benefits/effectiveness
- What is the facility's location effect on businesses?
- How about biological control of fruit flies?
- What are the costs of decommissioning the facility
- Reputation of Hawaiian industries
- Radiation poisoning/sickness
- Need to do market tests
- Supply of Cobalt 60 - quantity, place of origin
- Numbers and types of jobs to be created
- Effectiveness of irradiation on mangos, lychee
- Potential for expansion of papaya industry
- Number of acres of virgin forest destroyed for papayas already
- Effectiveness of irradiation on orchids, etc.
- Should print EIS in Philippino language
- Transfer funds to other treatment methods

HAWAII CO..:MODITIES IRRADIATION FACILITY
ENVIRONMENTAL IMPACT STATEMENT
PUBLIC MEETING NOTES
Wednesday, May 4, 1988, 6:45 p.m.
Naniloa Hotel
Hilo, Hawaii

The purpose of these notes is to provide a record of the meeting, specifically the questions and concerns that the public feels should be addressed in the EIS being prepared for the irradiation facility. Although many subjects were brought up in the meeting, only those points relevant to the EIS were included in these notes.

Tape #1, Side A

Meeting Purpose and Introductions - Dee Dee Letts, Facilitator

Ms. Letts summarized the purpose of the meeting, the meeting rules, and the agenda, and gave the names and addresses of the contact people. (See attached handouts 1 through 4.) Ms. Letts also stated the desired outcomes of the meeting:

- that people understand the nature of commodities irradiation in general and the proposed Hilo demonstration project in particular;
- that they understand the EIS process; and
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The people working on the project were introduced: Maurice Kaya and Jerry Lesperance of the Department of Business and Economic Development (DBED), and consultants Jim Frolich (WESTEC Services, Inc.), Perry White (Belt Collins & Associates), and Gordon Chapman (independent consultant).

Description of the Proposed Project - Jerry Lesperance, Alternate Energy Specialist, Department of Business and Economic Development

Mr. Lesperance gave background information on the events that have led up to the cooperative agreement between the U.S. Department of Energy (DOE) and State DBED to develop an irradiation facility in Hawaii as a demonstration project. Key events included the ban of EDB and its impact on the papaya industry, establishment of a steering committee, completion of a feasibility study, appropriation of funds by the Legislature to construct an irradition facility (conditioned upon the Governor's acceptance of an EIS for the project), and WESTEC being retained to prepare the EIS. Mr. Lesperance summarized the provisos specified by the Legislature to be followed in selection of the contractor. He explained the irradiation process, described a typical facility and safety measures, and listed various facilities on the mainland. The proposed alternate sites in Hilo were pointed out on a map. Mr. Lesperance said that the RFP for design, construction, and operation of the facility is currently being prepared.

Description of EIS Process and Schedule - Jim Frolich, WESTEC Service, Inc.

Mr. Frolich explained that the EIS will examine three alternate sites and that it is being prepared as an informational document to aid those who must weigh the environmental factors. DBED is the lead agency, and the Governor is the accepting authority. A risk assessment will be conducted, as well as a marketability study to determine the level of consumer acceptance of irradiated fruit.

Mr. Frolich reviewed the EIS process. He said that between 60-70 comment letters have been received in response to the environmental assessment and EIS preparation notice. The next steps are these public meetings to get further public input, followed by preparation of the draft EIS, which will be published in mid-August. The public will then have 45 days to review and comment on the DEIS; written responses will be sent to those who comment on the report. The final EIS will be submitted to the Governor to be used as an information document so a decision can be made and as a basis for the final design for the facility.

Public Comments

Kenneth Martin, President, Hawaii Papaya Industry Association

Mr. Martin's organization, representing 400 papaya growers statewide, is in full support of the project. He testified that the project needs to be pursued in a safe manner, and that the impact of natural disasters such as earthquakes, lava flows, and hurricanes should be addressed.

Greg Owen

Mr. Owen expressed concern about pollution and the risk of an airplane crash due to the proximity of the proposed sites to the airport.

Brad Lewis

Mr. Lewis is concerned that irradiated papayas will be p[illegible]oned and will not be marketable.

Robert Duerr (representing Dan Lutkenhouse)

Mr. Duerr read Mr. Lutkenhouse's letter responding to the EIS prep notice:

- Requested an in-depth study of the overall economics including financial benefits to the County and the papaya industry, construction cost, r[illegible]enue, etc.
- Who will operate the facility?
- Will the facility be run as a business/for profit? Who will fund the losses?
- In case of an accident during transport or operation, who will assume legal liability? Are they insurable? Who will pay for clean-up? Who will assume liability for workers exposed to radiation?
- Which packers will use the facility? What percentage of papayas will be processed through the plant? Will this be sufficient to economically and efficiently operate the facility?

- Are the papaya growers and the Chamber of Commerce willing to be signed on as co-insured?

Nelson Ho

Mr. Ho asked that the following be addressed in the EIS:

- Discuss the existing alternatives to irradiation. What will the effects be on existing processing?
- Who will assume responsibility for the facility if a widespread boycott occurs and no one buys the irradiated papayas?
- What are the impacts on the papaya industry?
- Identify the transportation modes and routes and the possibility of transportation workers being exposed to radiation.
- Do police, fire, and other personnel have the training/capability to handle an emergency?
- What are the risks to Keaukaha and to postal workers?
- What is the cost of dismantling the facility? Who will pay for it?

Marge King

Ms. King wished to know whether irradiated papayas are safe to eat. She cited studies which indicate that irradiated foods cause illnesses and damage to organs and asked whether there are any studies on papayas.

Tape #1, Side B

Karen Clark

Ms. Clark requested a detailed list of what would cause the plant to be decommissioned and asked the following questions:

- What would happen in the event of a tsunami or earthquake?
- What happened at the Honolulu irradiation plant?
- How many people are actually involved in the papaya industry?
- What would happen if the plant is sabotaged or if there is an accident?

Rolf Salzer

Mr. Salzer spoke against building the plant.

Suzanne Hall

Ms. Hall expressed concern about accidents.

Helga Costello

Ms. Costello is primarily concerned with nuclear safety issues, including the risk of cancer and disposition of waste products. She said more research is needed before the facility is brought into the community.

Ginny Aste

A Puna resident, Ms. Aste spoke in opposition to the project; concerns included:

- Groundwater contamination. What method will be used to determine this? She was concerned about what happened with the Hawaii Development Irradiator (HDI) in 1969.
- Regarding levels of worker exposure in the 1969 HDI incident, have any longitudinal studies been done to determine if health problems developed? Will these effects be compared to those on the so called "atomic veterans" who were exposed during bomb tests in the Pacific?
- Will transporation routes pass through populated areas?

Jan Moon, Member and Director, Leleiwi Community Association

Ms. Moon testified that the facility should not be built on this island close to homes. The following questions/concerns were expressed:

- Location of the proposed sites: close to the airport and within tsunami and flood zones.
- What is the accident risk? Is there insurance coverage available in case of an accident?
- Will property values be affected?
- Concern that the neighborhood will be ruined to benefit a few.

Abbie Napeahi, Leleiwi and Keaukaha-Panaewa Community Associations

Ms. Napeahi is opposed to the project being located in and around the airport and requested community input in the site selection. She questioned the safety of cobalt 60 and cesium 137.

John Tan

Mr. Tan expressed concerns about safety and health.

Kathy Dorn, East Hawaii Coalition to Stop Food Irradiation

Ms. Dorn questioned the conclusion in the environmental assessment that significant impacts can be mitigated by following government regulations and by training personnel in safety techniques. She is concerned about the record of other plants and does not feel that government regulations are enough. The Legislative Auditor's report crit al of the Department of Health's environmental section was cited; she asked whether DOH is capable of monitoring the plant and handling emergencies. Ms. Dorn is concerned that DOH gives higher priority to fiscal health than public health.

Kathleen Ing

A Volcano resident, Ms. Ing is concerned about the potential hazards of eating irradiated food. She asked the following questions:

- Have alternate methods for treating fruit fly infestation been explored?
- Will we become a dump for nuclear wastes?
- What are the chances of accidents during storage and transport?
- What are the chances of accidents due to natural disaster or human error?
- What are the safety records of other irradiation plants?

Stuart Marks

Mr. Marks is concerned about sabotage and what would happen if we run out of cobalt 60. He feels government does not have the authority to go ahead with this project.

Lewis Goldenberg

Mr. Goldenberg asked how thick the concrete walls and ceiling should be to contain cobalt and cesium and how far escaped particles can cross town. He feels the outcome of the EIS is already determined.

Art McCornack

Mr. McCornack is concerned that the effects of irradiation are unknown. He is concerned about the cancer risk and feels irradiated food should be labeled.

Roger Evans

Mr. Evans stated that Hawaii County is a nuclear-free zone, except for the military, and that the residents have approved this in a vote. Therefore, he feels the proposed plant breaks the spirit if not the letter of the law. He believes that alternatives should be found to deal with the fruit fly infestation.

Lillian Dela Cruz, President, Aboriginal Native Hawaiian Association

Ms. Dela Cruz stated that she also represents the Panaewa area and the farmers who do not want an irradiation plant for their papayas. She asked what would happen if the plant is not built on the island and who would be hurt if it is not built. Will the 400 farmers be the only ones to benefit? She suggested that the plant be built on Kauai.

Walt Southward, Executive Director, Hawaii Island Contractors Association

Mr. Southward testified that his 400-member organization supports the project. He stated that the economy is very much a part of the environment and shared his concern that Hawaii has the highest unemployment rate in the state. He is concerned that agriculture's growth potential would

be denied. Mr. Southward asked that the safety records of irradiation facilities in the U.S. and other countries be carefully examined.

Steve Philips

Mr. Philips asked whether this facility would come under the Price Anderson Act regarding limited liability. He wondered why the private sector has not built it and why government should. He is concerned that the federal government is pushing the project. Mr. Phillips is also concerned about the cancer risk.

Tape #2, Side A

Ruth Bass (Kau resident)

She expressed concern about the social impacts of the proposed facility.

Lorraine Jitchaku-Inouye, Hawaii County Councilwoman

Ms. Jitchaku-Inouye was speaking as chair of the Council's Economic Development Committee. She asked that the following be addressed:

- Implications of the project in relation to Article 8 of the County Code which addresses nuclear energy.
- What government regulations would control the transport of hazardous materials?
- Would the County have a regulatory role? Would existing County rules, codes, or regulations need to be changed?
- As the operator, what are the County's responsibilities and liabilities?
- If the fruit fly is irradicated, would the need for the plant be eliminated?
- When will the education plan outlined in Attachment 3 be implemented?

Christine Rosania, Hawaii Agricultural Alliance

Ms. Rosania explained that the Alliance represents a wide spectrum of agricultural interests statewide. Her organization sees land use as the key issue; more land zoned in agriculture would promote the current life style. She testified that the irradiation facility would allow the industry to grow.

Lori Adolewsky

Ms. Adolewsky is concerned about safety and requested a comparison of the environmental impacts of irradiation versus steam/vapor heat processing.

Keola Kalauli, Keaukaha-Panaewa Community Association

Concerns were expressed about tidal wave hazards, the taking of Hawaiian Home Lands, and the chance of accidents.

Ruth Robison, Big Island Branch of the Women's International League for Peace and Freedom

Ms. Robison asked about natural disaster hazards (earthquake, tsunami, and lava flows).

Sam Burris, President, Leleiwi Community Association

Mr. Burris raised the following points:

- Concern that the growers will not use the facility and that there is no guarantee that the papayas can be sold.
- DBED poll showing that most of the poeple on the island are not in favor of the plant.
- Health effects on workers at the Waimanalo irradiation plant.
- Concern that the sale of irradiated food is banned in areas of the mainland.

Joseph Calvino

Mr. Calvino asked for proper research. He is concerned that irradiated foods will not be accepted. He would like to know where the cooling water waste and core will be stored.

Bonnie Bator

Ms. Bator raised the following questions/concerns:

- Cobalt 60 is expensive and in short supply, while cesium 137 is plentiful and available free as waste.
- How will accidental contamination of the ocean during transport be prevented? What is the plan to contain a spill?
- How will the community be protected in case of tsunami, earthquake, or lava flow?

Shama Bator

Mr. Bator asked what will be done to protect the children in case of an accident.

Donna Licata

Ms. Licata asked why emissions from a food irradiator are allowed to exceed that of a nuclear power plant.

Colleen Mandala, Pahoa Natural Groceries

Ms. Mandala raised the following questions/concerns and requested that an economic feasibility study be done.

- How was the cost of irradiating papayas (12 cents/lb.) arrived at?

- The Hawaiian Host facility can process the entire papaya crop on the island; why should government compete with private enterprise?
- Nobody has committed 100 percent of his/her crop to the proposed plant.
- Lack of public acceptance of irradiated products.

Anthony Almada, East Hawaii Coalition to Stop Food Irradiation

Mr. Almada's concerns are as follows:

- Risk of pollution by subatomic particles; risk of cancer, birth defects, and immune deficiencies due to radioactive contamination, to both residents and visitors.
- In the HDI case, the State was either lax or incompetent and covered up the incident. Likewise, the nuclear industry has a record of lies and cover-ups.
- Concern that Hawaii will be used as a nuclear waste dump site.
- Concern that no test exists to tell when food has been irradiated, so it is impossible to regulate the industry.

Jeanne Clarke

Ms. Clarke expressed concern about labeling. She asked how we can assume that irradiated food will only be a small part of our diet and what the consequences would be if it was a large part of our diet.

Earl Dunn

Mr. Dunn is concerned that irradiated papayas will not be accepted in Japan and California, the major markets for the fruit. He wants to know who will benefit economically from this facility.

Vincent McClellan

Mr. McClellan asked who will benefit from the irradiation facility. He is concerned that there is not enough cobalt 60 to support the industry and that cesium 137 will be used. Mr. McClellan feels the issue should be put to a vote by the people.

Dexter Cate

Mr. Cate wondered how a million curies could be considered "low level." Other concerns:

- That the labeling of irradiated food will be discontinued after a period of time.
- Effects of radiolithic products found in food that has been irradiated.
- That cesium 137 will be used. He requested that the EIS cover the hazards and impacts of using cesium 137.

It was suggested that a poll be taken islandwide or just in the Hilo area.

Tape #2, Side B

Rebecca Burke

Ms. Burke's questions/concerns:

- What is "acceptable risk"?
- What is "acceptable response"? Is it relocation?
- If irradiation mutates enzymes in food, does it kill the enzymes?
- Each alternative should be studied equally in depth to the proposed project itself.
- People who have been affected by radiation should be interviewed.
- Consider studies that have been done in India on children who were fed irradiated wheat and developed leukemia.
- How long has the oldest plant been operating and what is its record?

Ole Folks

Mr. Folks asked whether irradiated fruit is nutritious. He said that dry heat treatment is cheaper than irradiation and noncontroversial; in light of this, why is irradiation still being pushed? He wants to know who will be making money on this.

C-30

Joyce Folena, East Hawaii Coalition to Stop Food Irradiation

Ms. Folena cited the effect of low grade radiation on womens' periods and expressed concern about nuclear waste. She wants the right to vote on the issue.

Richard West

Mr. West recounted the experience in Maine whereby people were unable to have a nuclear power plant removed. He said that if the irradiator is allowed, residents will never get rid of it. He proposed a referendum.

Jim Snyder, Big Island Nuclear-Free Zone Committee

Mr. Snyder asked what a safe level of radiation is, and said that if this is not known, the irradiator should not be built.

Laurel Dekker (Farmer)

Ms. Dekker inquired about the economic and social impacts of the proposed facility.

- What are the long term health effects and their follow up treatment?

- Is irradiated food safe?
- What about agricultural commodity losses if the facility is closed down? Who will handle facility maintenance?
- How will the environment (people, water supply, insects, etc.) be protected in case of an accident due to human error or natural disaster?
- Who covers losses? Who is liable?

Ms. Decker requested a detailed cost analysis of alternate methods to deal with the fruit fly. She asked that alternative methods to market the papaya industry be addressed. In addition, she wanted to know when another hearing would be held so testimony from experts could be heard.

Alana Gay

Ms. Gay is concerned that the decision has already been made. She expressed concern about cancer.

Noa Kristi

Ms. Kristi said that she represented lesbians on the Big Island. Her questions/concerns included the following:

- Who will be hired to operate the plant—local or mainland people?
- What does irradiated fruit taste like? Is it nutritious? Safe?
- What are the air and water quality impacts? What would happen to the land and water if contamination occured?
- Who makes cobalt 60? What are the hazards to the people who make it? What are the effects on the environment?
- What would happen if a missile or rocket landed on the plant?
- What would the impact be on the tourist industry if contamination occurred?
- Is the facility going to be run 24 hours a day? Ms. Kristi noted that accidents have occurred when workers fell asleep on the job at night.
- Where will the waste be buried? In Hawaii? She is concerned about the impact of natural hazards on the waste sites.

Dr. Jacqueline Brittain (Psychologist)

Dr. Brittain asked how the massive emotional and psychological trauma that will occur in case of contamination will be handled; how will treatment be carried out and by whom? She indicated that the literature covers the physical impacts but little is known about the emotional impacts. As a Keaukaha landowner, Dr. Britten is also concerned about the impact on property values in Keaukaha with the irradiator close by.

Paul Dixon

Mr. Dixon expressed concern about residual secondary radiation in the fruit and the cumulative impact on consumers, especially children. He wants the photonuclear and isomeric effects addressed in the EIS. Other concerns included questions about liability and the possibility that Hawaii's image would be tarnished.

Dr. Noelle Rodriguez (Sociologist)

Dr. Rodriguez is concerned about the radiolithic byproducts of irradiation. She is also concerned about the social impact of having this type of plant imposed on people against their will. She said they will feel a sense of political alienation—that they are not living in a democracy and that their will is not being considered by the elites.

Jack Bancroft

Mr. Bancroft wants a referendum; he asked that those interested in organizing should stay after the meeting.

Venus Tobin

Ms. Tobin wanted to know how to stop the project.

Clive Cheetham, Koa'e Community Association

Mr. Cheetham requested that the EIS cover the impact of cesium 137 on the environment and on people.

Edward Clark

Mr. Clark voiced concern about the transport of nuclear matter, waste disposal, and free radical mutgens. He noted that the overwhelming majority of the public testimony was opposed to the facility.

Leslie Miki, Abundant Life Natural Foods

Ms. Miki said that Senator Inouye feels the decision should be made at the local level; she requested that a copy of the tape recording of this meeting be sent to Inouye.

The following concerns were expressed:

- Impact on fish and other marine life if nuclear material leaked while being transported to Hawaii.
- Contamination of water supply.
- Impact of tourism in case of contamination.
- Who will monitor the labeling? Will every store owner have the consciousness to inform the consumer?

Tape #3, Side A

Paul Shaw

Mr. Shaw said that dry heat treatment should be scrutinized as a viable alternative. He asked that animals not be used to test impacts.

Tape #4, Side A

Charlie Gumapac

Mr. Gumapac is concerned about the following:

- Impact on businesses within vicinity of the plant.
- Natural biological methods of fruit fly irradication should be addressed as alternatives.
- Proximity of the site to Hawaiian Home Lands.

Dr. Robert Lawyer, Professor of Economics

Dr. Lawyer's concerns are as follows:

- Disposition of nuclear waste.
- Cost of getting rid of the facility.
- Reputation of Hawaii's agriculture industry.
- Impact on the tourist industry.

Lani Ross

Ms. Ross stated that she is a victim of radiation poisoning inherited from her father, who died as a result of it. She spoke of indigenous people in the Pacific who have been exposed to radiation. She doubts that the government will be truthful.

David Zeisler

Mr. Zeisler spoke about the Diablo Canyon experience.

Rima Elkin (Keaau homeowner)

Ms. Elkin is concerned about nuclear accidents. She feels the emphasis should be on clean industries and that money should be invested to help farmers and agriculture.

Robert Jaslowski

Mr. Jaslowski noted that most of the new papaya farmers are from the Philippines and that they are being leased land and/or provided loans by the packing houses in exchange for agreements that their papayas be sold to the packing houses. He wants to know who has the ownership and control and the extent of it.

Jerry Chang

Mr. Chang feels the following issues should be addressed:

- Concern that most of the cobalt supply comes from South Africa, and in case of a shortage, priority would be given to facilities that sterilize medical equipment.
- The EIS should consider alternative methods such as dry heat treatment and the linear accelerator, which uses no radioactive materials and is under operation in Florida to treat citrus fruit.

Kathy Dorn

Ms. Dorn offered the following additional testimony:

- Requested that the EIS compare the number of jobs provided by a double dip facility and an irradiation facility.
- Expressed doubt that the irradiator could be used for mangos, lichees, foliage, and soil on plants. Pointed out that mangos are destroyed by the process, lichees can be treated with a single hot dip (which would be cheaper that irradiation), and the HDI experience showed that irradiation is useless for soil and foliage.
- Regarding expansion of the papaya industry, how much acreage would be needed? How many pounds of papayas would be needed to support the irradiator? How many acres of forest would have to be devastated?
- Can DOE funds be transferred to develop the dry heat process?
- Request that the EIS be printed in the Filipino dialects of Ilocano and Tagalog.

Brad Lewis

Mr. Lewis is also concerned about destruction of native forests to expand the papaya industry.

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COMMENTS RE: IRRADIATION PLANT ISSUES, STATE DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT HEARING, TUESDAY, 7:00 p.m., STATE CAPITOL AUDITORIUM, BY ROBERT W. HALL, PRESIDENT AND DIRECTOR

SCIENCE, POLITICS AND IRRADIATION

The irradiation of food holds the promise of improving the quality of our lives. The question from a scientific, and public health point of view involves the question of safety.

The Food and Drug Administration's approval of food irradiation of fresh fruits, vegetables and grains and the tripling of the dose currently used on spices, was purportedly based upon more than 30 years of scientific research. The FDA purportedly reviewed 441 toxicity studies in reaching a conclusion that irradiation caused no adverse health effects. In fact only 5 of the 441 studies were considered by FDA reviewers as being scientifically credible according to then current standards[5]. All of the 5 studies found no problem with irradiation. Many of the studies rejected, and others not considered by FDA researchers, have found a problem with food irradiation.

Irradiation involves conveying food items through low doses of gamma or x-ray exposure, in order to kill bacteria that cause spoilage, insects and other contaminants. Radioactive sources include cobalt 60 or cesium 137, waste products of the nuclear power industry. The use cesium 137 for food irradiation substantially reduces the cost nuclear industry waste disposal. The irradiation of pork is recommended primarily in order to kill trichinosis. In 1983, 45 cases of trichinosis were reported in the United States. The FDA has approved at various times the irradiation of 60 spices and seasonings, potatoes, and wheat. The FDA is considering the approval of the irradiation of fish and poultry.

Irradiation causes new chemicals known as "unique radiolytic particles" or URP's, to form in foods. URP's are formed as radiation violently realigns the chemical bonds in foods. Loosened electrons are known as "free radicals". These free electrons go on to interact with other molecules in food. These products include hazardous compounds such as benzene and formaldehyde. Irradiation also causes a breaking down of the molecules of the food itself. An estimated 10% of the radiolytic by-products produced by food irradiation are not common to other chemicals whose toxicity is understood and measurable. This completely unknown area is a cause for scientific concern.

Some vitamin and mineral or nutrient depletion occurs on irradiation, and occurs again if the food is cooked. The B vitamins particularly, including thiamine, are lost. Thiamine is important to the normal functioning of the central nervous system and helps release carbohydrate energy.

There is no residual radiation when food is irradiated and there is no serious scientific concern on that point. That particular point is usually raised by proponents as a straw issue in attempts to discredit opponents. A point that does cause scientific concern is that foods react differently to irradiation.

There are no long term epidemiological studies with regard to the safety of irradiated food. Short term studies are equivocal. Some studies suggest that irradiated food could cause cancer, kidney and liver disease, birth defects and other problems, while other studies suggest that irradiated foods are safe. Without long term studies, we simply do not have reliable data one way or the other.

In a 1986 New York Times article, Richard Ronk, deputy director of the FDA's Center for Food Safety and Applied Nutrition was quoted as admitting that there was no way to test the effects of irradiated foods in animal systems[2]. If that is true and harmful effects do occur, then we may have the makings of the proverbial perfect crime. The nuclear industry gets rid of its waste cesium 137. There is no known way to prove harm even though harm may occur.

The situation is similar to the current pesticide dilemma. With food irradiation we have the possibility of double trouble since irradiation does not eliminate the use of pesticides.

The purported scientific case for irradiation tends to give the impression that the last scientific word has been written with regard to adverse health effects. The truth is that adverse health effects if any, will be slow to develop. We will not know the health effects until some time in the future, perhaps 5 to 40 years in the future. That statement assumes that long term studies will be funded and we have no assurance that they will be funded. To the extent that we may err with irradiation, the issue has the potential to saddle future generations with enormous public health care and tort costs. In March 1987, the British Medical Association recommended a food irradiation ban on the basis that food irradiation could pose long-term health hazards.

Most of the studies that have been done to date are not up to modern standards of toxicological safety. A team of medical statisticians and epidemiologists led by Dr. Donald Luria of the New Jersey Medical School advised against food irradiation on the basis of a year long investigation that found the data used by the was to be full of flaws. The team called the approval of irradiated food using the FDA data as "absolutely irresponsible"[4].

A primary scientific research deficiency involves the failure to toxicologists to consider the effect of irradiated foods on the human immune system. Saying this another way, the work that has been done is too simplistic and does not give a true picture of the total effects of irradiated food on total human health, not simply cancer. Some of the work that has been done suggests a deleterious effect on laboratory animals and humans who have consumed various forms of irradiated foods.

When abnormal chromosomal patterns were researched in

malnourished children fed irradiated wheat, abnormal chromosome patterns were found. In follow-up studies, rats and mice fed diets containing wheat irradiated at 80K rad (the Hawaii papaya growers are proposing to use 100K) less than 20 days before consumption were found to have an increased number of polyploid (too many chromosome sets) cells in their bone marrow. The animals also showed evidence of dormant lethal mutation. Normal monkeys and malnourished children fed recently irradiated wheat also demonstrated increased polyploidy in circulating lymphocytes[3]. There is genuine scientific concern with regard to the mutation of future generations from irradiated food.

Cancer

The rate of the incidence of cancer in this country is already increasing at the rate of about 1% per year and the federal government does not know the cause of this hefty increase. One of the reasons is that long term studies to determine the increasing cancer incidence have not been properly designed or funded. If certain classes of pesticides or toxic chemicals in our food chain were the actual cause, the federal government does not have the information necessary to make a scientifically credible determination. We have no reason to believe that the situation would be any different with irradiation.

Every now and then, we come across an irradiation proponent's statement with regard to safety that appears to have been very carefully crafted. As an example, the statement "(I)n three decades, no injury or death has been attributable[1]" to irradiation material shipments. That, of course, does not mean that such incidents have not occurred. The statement means that the federal government has not attributed health risk to irradiation material shipments and nothing else. Such statements lack candor.

In order to have faith in proponents' statements, we must look to the federal government's past history and track record with regard to health assurances associated with the uses of pesticides, toxic chemicals, and nuclear radiation. If one is satisfied with the federal government's past record of accuracy, veracity and scientific accuracy since the end of WWII, then one may well be satisfied with federal government assurances of irradiation safety. The more careful among the scientific community will more likely retain a healthy skepticism and move very cautiously. The promise here is essentially the pot at the end of the rainbow. That alone dictates caution.

Rachel Carson's "Silent Spring" was just the beginning of the warnings that the federal government had made a terrible error with regard to pesticides. Since that time, officials from testing laboratories have gone to jail for simply lying to the federal government with regard to the results of scientific testing. Congress has ordered the EPA to reassess 50,000 active ingredients in more than 500,000 chemical compounds since earlier laboratory information was either scientifically worthless or outright fraudulent. That task will be completed sometime in the 21st century assuming the current schedule is kept. The federal government track

record with regard to environmental abuses to human health has been one of the best science that money can buy, fundamental scientific error, scien ific incompetence, or outright fraud. The result has been that public health decisions have not been made on basis of modern scientific evidence. Final decisions of th federal government have been made almost entirely on the basis of political considerations.

Current plans ignore potential health care and social costs in the event food irradiation is harmful to human health. Those costs must be added to the equation or the decision to proceed or not proceed will be flawed. No one will be able to opt out with regard to food irradiation. There is no known test enforcement officers could use to determine whether food had been irradiated or not, or more important the dose. We will all be completely dependent upon the word of food processors with regard to both the fact of irradiation and the dose. The knowledge of that fact is chilling indeed.

Contrary to popular belief, food irradiation does not sterilize food. Salmonella, viruses and other bacteria, especially in spore form, will survive differentially among species and with increasing dose. This is particularly true at current recommended dosages. The result will be a strong incentive to overdose. The other factor in food preservation is the post-treatment method of storage.

Food condemned because of bacterial contamination could be irradiated and pass health checks. Current standards are based upon live bacterial load. The industry calls this "renovation". The result could be food contaminated with botulin and aflatoxin in supermarkets that cannot be detected. With no means of detection, food can be tampered with at will regardless of protecting law.

Current food irradiation proposals call for testing irradiated food in the marketplace. That means testing irradiated food on humans without their informed consent. Such a plan is scientifically unethical. The jury is still out with regard to food irradiation.

References

1. Robinowitz, Mark. The F.D.A.'s game of 'genetic roulette'. The New York Times, June 1, 1986.
2. Burros, M. Is radiation the answer to spoiled food? The New York Times, April 16, 1986, p. 22.
3. Srikantia, S.G. Wholesomeness of irradiated wheat. MFI Bulletin, 7(3) 9 (1986).
4. Myer, J. Irradiation. Bacteria-killing process stirring up hope, controversy. The Sunday Star-Bulletin & Advertiser (UPI), July 5, 1987, p. C-2.
5. Federal Register, (51)75, April 18, 1986, p. 13,384.

GINNY ASTE
15-242 Puni makai Pahoa
96778

I am concerned about ground water contamination at the proposed Hilo site. (1) What method will be used to determine the possibility of ground water contamination of the same magnitude of radioactive water spill which occurred at the Hawaii Development Irradiator in 1969 when the radioactive source was lifted out of the holding pool, stuck in the "up" position & had to be lifted out through the roof?

I am concerned about levels of worker exposure due to equipment failure or human error. (2) What was the level of radioactive exposure to workers at HDI in 1969 who were present when the accident or spill occurred? Has any longitudinal study been done to determine whether any of these workers developed health problems or cancers traceable to that exposure almost 20 yrs ago?

(3) Will the EIS study compare the levels of exposure of HDI workers & subsequent health problems of those workers to the levels of exposure & subsequent health problems experienced by the so-called "atomic veterans" who have just been granted permission to petition the U.S. gov't for damages due to injury, cancer & death caused by exposure to radioactive materials during the atomic bomb testing in the Pacific 25 years ago?

(4) will the EIS specify transport routes & will those routes pass thru populated areas e.g. Kanoelehua Street, and Highway 11

(5) will the EIS specify liability and who bears the costs of damages due to worker exposure, accident & human error such as the accident which occurred at a N. Jersey plant when the safety locks were dismantled & a worker walked in the irradiation chamber when the radioactive source was in the "up" position (e.g. outside the holding pool)?

May 4, 1988 Virginia (Ginny) Aste

C-36

Bonnie Bator
PO Box 565
Kurtistown, HI 96760

Although the State legislature has specifically named cobalt-60 as the irradiation source; the belief persists that cesium-137 will be the eventual choice of irradiation material.[1]

Cobalt-60 is very expensive and in short supply. Cesium-137 has been offered free from the Department of Energy. There is a huge supply of cesium-137 locked into the high level waste generated by nuclear power plants.

In the Hawaii Commodities Irradiation Facility Environmental Impact Statement on behalf of myself, my children, and for those intimidated by this process, I request the question(s) of how the State (DBED) intends to speedily stop and contain accidental contamination of seawater during transportation of cesium-137 or cobalt-60.

In an accident occurring during transportation of cesium-137 or cobalt-60 from port to the proposed site of the facility, by what means does the State intend to rapidly stop, contain, and remove the radioactive spill?

During the event of Tsunami, how does the State intend to protect the Hilo, Keaukaha, and Panaewa areas from radioactive contamination?

What immediate action will be taken after a 6 point + earthquake that lasts 60 seconds? (Recall the fall of 1983 earthquake which damaged buildings in the Hilo area.) From where will the manpower manifest to concentrate efforts solely on containment of radioactive particles?

The threat of Lava flow should be adequately addressed. This concern MUST NOT be taken lightly.

Please THOROUGHLY address these valid concerns.

Thank you for this opportunity to answer our questions and concerns in the environmental impact statement.

1. Lagunas-Solar, Manuel C.; Matthews, Stephen M. - Comparative Economic Factors On The Use Of Radionuclide Or Electrical Sources For Food Processing With Ionizing Radiation; University of California, Lawrence Livermore Laboratory. (Available from DBED)

① what is ACCEPTABLE risk?
② what is ACCEPTABLE RESPONSE TO LEAK/ACCIDENT? Relocation?
③ Does irrad. mutate the enzymes in food?
④ " " kill " " " " ?
⑤ Want to see equally comprehensive and in depth study of alternatives as is being done for irrad.
⑥ Interview residents of Scandinavia/Europe/G.Brit. who were affected by Chernobyl, to gather data on "acceptable risk".
⑦ Use studies such as those from India - where children were fed irradiated wheat as large portion of diet - and found increase in childhood leukemia in determination.
⑧ I would like a transcript/and/or/copies of these proceedings?!!...

Rebecca Burke
PO Box 1265
Keaau, HI 96749
808 965-7618

East Hawaii Coalition To Stop Food Irradiation

A Non-Profit Citizen Action Group

May 4, 1988

TESTIMONY OF KATHY DORN , DIRECTOR,
ENVIRONMENTAL IMPACT STATEMENT HEARING ON THE PROPOSED
COMMODOTIES IRRADIATION FACILITY FOR THE CITY OF HILO
NANILOA RESORT HOTEL, MAY 4, 1988

The EHCSFI has already submitted a list of concerns in question form to Westec Services. However another area of major concern which was not addressed in those questions is the ability of the State Department of Health to monitor a nuclear facility in light of budget and staff shortages which already exist in the DOH.

The "Environmental Assessment and Notice of Preparation" already issued by Westec Sevices has made the disturbing conclusion that significant adverse impacts of the proposed irradiation facility can be avoided or mitigated by:

1) Adhering to applicable Federal, State, and County building design and construction code standards;

2) Operating the facility in compliance with Federal and State environmental health regulations; and

3) Insuring that all personnel are properly trained in operational and safety techniques.

It has been shown time and time again by the very bad track record of nuclear industries in general, that no amount of rules, regulations, codes, and/or training can insure the safety of either the workers in nuclear industries or the health and safety of the surrounding community.

P.O. BOX 1559 ■ PAHOA, HAWAII 96778 ■ (808) 965-7140

Please don't expect us to accept the safety of this irradiation facility on those grounds.

In February of 1987, the Legislative Auditor of the State of Hawaii presented the "Management and Program Audit of the Environmental Protection and Health Services Division (EPHSD) of the Department of Health"(DOH) to the Governor and the State of Hawaii. This report was highly critical of the performance of the EPHSD. Some of the criticisms of the EPHSD were:

1) The EPHSD is sorely lacking in leadership and direction;

2) The EPHSD does not see public health as the main issue for the environmental pollution programs and appears to almost equally concerned with the economic interests of the State.

3) The absence of a firm commitment to the role of public health protector has left EPHSD subject to pressures from outside interst groups especially the Department of Business and Economic Development. In other words fiscal health has been a higher priority than public health. In regards to the irradiation issue, this state of affairs does not seem to have changed.

4) In the area of air quality control, EPHSD has been wavering and inconsistent in their actions and actually shunned its role as public health protector;

5)In the area of water quality protection, EPHSD is especially fragmented in its administrative duties leading to ineffective enforcement of pollution controls and irreversible groundwater contamination;

6) In all areas of environmental health protection, the EPHSD was found to be understaffed.

It has only been 14 months since the release of this report which exposes the failure of the DOH to protect the health of the people of Hawaii from environmental hazards. I would like the EIS to address this critical area and inform us if the DOH's support of the irradiation project is but yet another example of the Department's bowing to pressure from the Department of Business and Economic Development which is the very enthusiastic promoter of the irradiation project.

What changes in the organization of the EPHSD have taken place to ensure that this department which has failed to monitor the air and water quality in Hawaii, is suddenly capable of monitoring a nuclear facility? How many staff members have been added to the department since the Legislative Auditor's report was released? How is the Radiation and Noise Branch of the EPHSD equipped to handle an emergency involving the release of radioactive contaminants? How many staff members make up the Noise and Radiation Branch? What has soil and water tests for radioactive contaminants revealed?

As I said in my opening statement, no amount of rules and regulations can insure the safe operation of a nuclear facility. Safety must be based on something more substantial than that. That is the lesson of history.

############

UH BS AG MS HORT

EARL DUNN

ECONOMIC FEASABILITY - IS IT NOT A

FACT - MORE THAN 90% OF EXPORT PAPAYA'S MUST GO THRU IRRADIATOR FOR IT TO BE ECONOMICALLY FEASIBLE,

FACT - MAJOR MARKETS FOR HI'S PAPAYA'S ARE JAPAN AND CALIFORNIA,

FACT - JAPANESE GOVERNMENT WILL NOT, AS A MATTER OF POLICY, ALLOW IRRADIATED FOOD INTO JAPAN,

FACT - MANY CALIFORNIA SUPERMARKETS (1200+) WILL NOT ACCEPT OR SELL IRRADIATED PAPAYAS,

FACT - CALIFORNIA CONSUMERS HAVE SHOWN A DECIDED BIAS AGAINST IRRADIATED PAPAYAS,

FACT - THE U.S. CONGRESS IS CONSIDERING LEGISLATION BANNING THE USE OF IRRADIATION ON FOODS,

FACT - MANY OF THE "FACTS" BEING GIVEN OUT BY DBED AND OTHER PROPONENTS OF IRRADIATION ARE, AT BEST, SUSPECT,

FACT - THE U.S. & HAWAII CONSTITUTIONS BOTH STATE EXPLICITY THAT GOVERNMENT IS THE SERVANT OF THE PEOPLE, NOT VICE VERSA, AND

FACT - MOST CITIZENS CONCERNED ENOUGH TO PARTICIPATE IN THE IRRADIATION DEBATE ARE, AS HAS BEEN OVERWHELMINGLY DEMONSTRATED

(2) EARL DUNN

TONIGHT, ARE OPPOSSED TO THE CONSTRUCTION OR USE OF IRRADIATION IN HAWAII.

GIVEN THESE FACTS, MY QUESTION IS, # WHY IS THE STATE OF HAWAII EVEN CONSIDERING IRRADIATION FOR HAWAII. # ~~[illegible]~~

~~SECOND, WHAT ARE THE SO-CALLED ECONOMIC BENEFITS # OF THIS FACILITY~~?
WHAT ARE THE REAL ECONOMIC BENEFITS?

ERB THEN AND NOW -

I'd like to speak about the need for intelligent evaluation of the facts at hand and the need for responsible handling of the conclusions. There is already too much breast beating and macho face saving rhetoric by proponents of this facility and it is important that their zeal not influence this report.

I would like this EIS to address the issue of how thick a concrete wall and ceiling is needed to contain Cobalt as compared to cesium & how far escaped particles can actually travel across town

Lewis Goldenberg

LORRAINE R. JITCHAKU-INOUYE
Councilwoman

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
25 Aupuni Street
Hilo, Hawaii 96720

May 4, 1988

TO: State of Hawaii Department of Business and Economic Development, Energy Division
WESTEC Services, Inc.

FROM: Lorraine R. Jitchaku-Inouye, Councilwoman
Chairperson, Committee on Economic Development
County of Hawaii

SUBJECT: EIS Consideration for Food Commodities Irradiation Facility

For several months now the Hawaii County Council's Committee on Economic Development has been receiving testimony from individuals and groups pertaining to the proposed Food Commodities Irradiation Facility. In the course of these deliberations, questions have surfaced relative to the County's role in establishing and maintaining this facility. As Chairperson of this Committee, I would like to recommend that the following concerns be addressed in your environmental assessment process.

1. Article 8 of the Hawaii County Code addresses Nuclear Energy. We would hope that implications on this Article are addressed in your assessment.

2. Concerns were raised relative to the transportation of the hazardous material to and from the facility. What Federal, State or County standards would govern this activity?

3. Questions were asked on what the County's role would be in the facility. Would it have a regulatory role? Would existing County codes, rules and regulations need changing? The County has been mentioned as the proposed operator of the facility. What are its responsibilities and liabilities in this role?

4. If what is proposed to be spent on this facility were diverted to the effort to eradicate the fruit fly, would this solve the problem and eliminate the need for the facility?

5. When do you intend to implement the education plan as outlined in attachment 3 of the Final Report Attachments?

Auduboners Take the Lea[d]

Arthur McCornack
P.O. Box 6189
Captain Cook, HI 96704

IRRADIATED GROCERIES

The Heart Association tell us that someone in America dies of a heart attack or stroke every thirty-two seconds. They also tell us that any intelligent person can avoid heart disease or at least arrest it. It is not necessary to dig an early grave with your teeth.

But methodical deals between the food industry and government makes it almost impossible to keep the number two killer, cancer, at a respectable distance. It follows that behind the scenes, many foods contain pesticides, food additives, preservatives, and now irradiation that may not be on the label. Therefore, begin each day by telling yourself, today I will eat some pesticide, irradiation, greed, cancer, and transgression.

They will not ... put the irradiation issue ... to ...

No matter! it is now clear that the food industry and our elected officials are working hard to choose irradiation for you./The fact is, many of the effects of food irradiation are still largely unknown and without giving us, the consumer, the full choice of buying nonirradiated food. If the present regulations stand, it will be nearly impossible to avoid foods that have been treated with radio active isotopes. If food is irradiated, don't you think it should be labeled?

Is this chaos purposeless and ungoverned or is there a reason beyond our grasp? Or is it simply human ignorance? No need to grumble, the false economy seems to be an evolution of a bigger Scheme. Think of the times you had an opportunity to change events, of which you have taken no advantage. By doing nothing you become coupled with the deception. So! Without your intervention wide spread undisclosed food irradiation will soon be imposed on every "free American". secret

The daily wearing away of life, with its ever-fearful reminder, need not be a pressing problem. Instead of being classed with rats and monkeys, you need only to revert to the teachings of your creed and trust in your reason. But then, we must acknowledge that "scientific facts" has never prevented greed from making numerous and absurd mistakes.

Maybe we should let greed take its course. Over population is the cause for the extermination of thousands of plant and animal species. It also degrades air and water quality, destroys forest and conservation lands, and declines marine life. It's all happening in our time and space.

Very truly yours,
[signature]
Arthur McCornack

Submitted at Hawaii Commodities Irradiation Facility Environmental Impact Statement Public Meeting, Hilo 5/4/88

It is primarily the papaya industry and other vested interests who are in favor of irradiation facilities. Cost-effectiveness is often cited by these interests although it is not clear that an irradiation facility would be cost-effective. These same vested interests choose to downplay the health and safety risks inherent in such a technology, whereas community opposition to the industry, based on these risk factors, is so widespread and well-organized (both here and in the primary markets in California) that it is certain to have an impact on the cost-effectiveness of the project, if not its viability. Note that this is true whether or not the technology is safe.

An irradiation plant must be operated 24 hours a day, 6 days a week, 50 weeks a year to make it economically feasible, and calls for massive amounts of commodities because of the very high cost of maintenance of the source material.

Inasmuch as the dry heat method of treating fruit has been extremely successful in eradicating fruit flies while at the same time preserving the quality of the fruit, I feel that this non-irradiative treatment should be scrutinized very closely, and considered as a viable alternative to irradiation. Currently the dry heat process is awaiting final approval by the USDA's Animal and Plant Health Inspection Service - Plant Protection and Quarantine Agency.

Finally, I have read that the FDA has waived its customary approval standards for animal testing when granting its approval of food irradiation plants. My understanding is that it is difficult to isolate the radiolytic products which are created in the irradiated foods. Standard experimental procedure is to isolate these products and then feed massive doses of them to animals. Apparently all of the radiolytic products which are created in the foods are not known. Although I disapprove of the FDA's granting approval of food irradiation plants, I wish to encourage them to continue not to test animals with massive doses of radiolytic products. I consider it to be extremely unethical to attempt to determine the safety of human-centered technologies by testing with lethal doses on non-human species. We do not have the right to misuse other species (or individuals within other species) simply because we have the ability to do so.

Please see enclosures: 1. Focus on agriculture, Hawaii Tribune-Herald, 2/28/88, re dry heat treatment.

2. Monkeys Go To War, reprint concerning irradiation experiments on primates.

Paul Shaw

Paul Shaw
PO Box 1313
Keaau, HI 96749

34—Hawaii Tribune - Herald, Sunday, February 28, 1988

Focus on agriculture

The long struggle to eradicate the Mediterranean fruit fly in Hawaii is showing progress as entomologist Jack Armstrong and his associates at the Hilo USDA Tropical Fruit and Vegetable Research Laboratory work toward tests that may prove the dry heat treatment as the ultimate solution, particularly since this treatment does not depend on the use of radioactive materials such as Cesium-137 or Cobalt-160 — or even X-rays.

Development of the dry heat treatment has not been easy. Early tests looked too good to be true and the results were continually questioned. "We just could not believe that this treatment wasn't going to damage the papaya," Armstrong said. "We kept waiting for the other shoe to drop, that some form of damage would finally show up." It didn't.

He added that progress in development of the new treatment was kept quiet for more than six months, just to keep from disseminating false hopes. The research personnel, working as a close knit team attacked each problem area again and again, and eventually arrived at the conclusion, beyond doubt, "The new dry heat treatment did indeed work."

The final development was a high temperature forced-air quarantine treatament using four different temperatures at the proper staging times — which would culminate in the death of any fruit fly infestation and at the same time preserve the quality of the fruit. They discovered the critical end-temperature point to be 117 degrees Fahrenheit at the center of the papaya, followed by hydrocooling to reduce the fruit center temperature to below 86 degrees F.

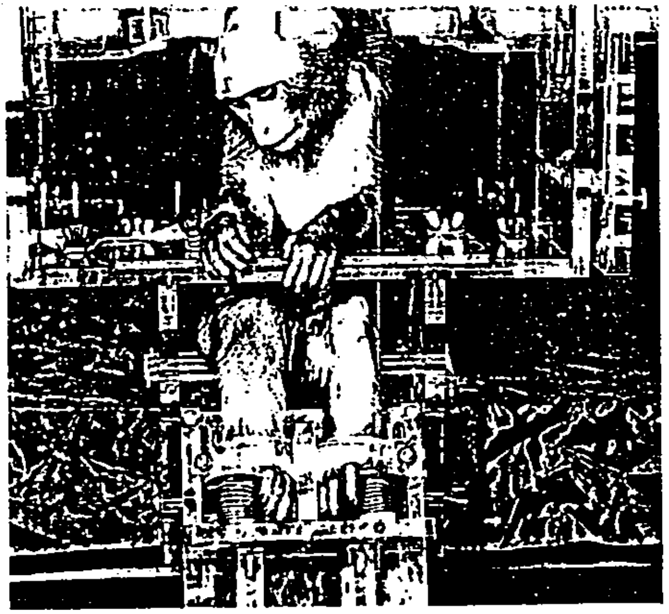
Armstrong said the major discovery was the hot air, transferring the heat into the fruit slower than does hot water or vapor heat, and still not damage the fruit. The discovery of this treatment was so novel that Armstrong and his associates have applied for a USDA patent on the new quarantine treatment technology. He also noted that while the current process works, the total treatment time is already under way. In this development process Armstrong and his associates tested more than 250,000 fruit fly eggs and larvae of each fruit fly species in infested papayas.

The next step will be final approval by the USDA's Animal and Plant Health Inspection Service-Plant Protection and Quarantine Agency, and the installation of the necessary commercial treatment equipment by the papaya industry in preparation for shipping to overseas export markets. Armstrong also says the USDA researchers will determine if the dry heat treatment will be applicable for other Hawaii grown fruits with export value.

"We will be looking at a wide variety of fruits," Armstrong said, "As we have information or preliminary data that indicates modification of the dry-heat treatment may be applicable to avocados, atemoya, starfruit, lychee, longan, rambutan, peppers, zucchini, squashes, eggplant and other island crops."

(Incidentally, when the staff associated with Jack Armstrong was listed in the first column in this series, the name of Ben Hu was inadvertently omitted. Ben is in charge of the Message Development and Liaison Office for the USDA and made a major contribution to the fight against the fruit fly).

C-43



MONKEYS GO TO WAR

by Shirley McGreal *Co-Chairwoman of the International Primate Protection League (IPPL)*

Thousands of monkeys have died in experiments designed to help prepare the United States for World War III. The animals, brought in from countries like India, Bangladesh, Malaysia, Indonesia, Kenya and Bolivia, have been used to study the effects of atomic blast and fallout, the effects of the radiation that a neutron bomb would produce, the effects of beams on the human body, and the toxicity of various chemical warfare agents.

Monkeys have been used in this type of experimentation because of their overall physiological and psychological resemblance to humans.

The first use of monkeys in military radiation experiments appears to have occurred in 1957-58. Dr. J.C. Pickering of the School of Aerospace Medicine, Brooks Air Force Base, San Antonio, Texas, informed me in the course of my August 1979 visit to the facility that monkeys were placed at atomic test sites in 1957-58, some as part of the Operation PLUMBBOB test series. Ten tubes, each containing eight monkeys, would be placed at varying distances from Ground Zero; some of the monkeys in the outer tubes survived, and were subsequently transferred to the Yerkes Primate Center, Atlanta, Georgia, where many have since developed various cancers.

The School of Aerospace Medicine has continued to perform radiation experiments on monkeys to the present day. Numbers of monkeys involved are unclear, but it is known that the School has killed over 4000 monkeys, although no breakdown of the deaths has been published. Some of the studies involved generalized radiation; others involved localized radiation. Some of the most painful experiments were performed by the Ocular Thermal Burns Section. A medical doctor who used to be involved in these experiments once contacted the International Primate Protection League to explain how cruel — and useless — these experiments were. The actual irradiation of the eyes did not hurt; it took 2 weeks for the monkeys' agony to start. Acute irritation and discomfort would last for several months. Eventually, cataracts and blindness would result.

Most of the radiation experiments at the School of Aerospace Medicine were concerned with the study of the effects of radiation on human performance, including that of irradiated, dying pilots. Monkeys would be taught to fly "Primate Equilibrium Platforms" to determine how an irradiated pilot would be able to fly a plane. After training, the monkey would be irradiated and tested for his ability to keep his "plane" level, while suffering from radiation sickness.

In February 1979, Dr. Donald Barnes, a researcher who had lost his position at the Base for questioning the necessity of a projected monkey experiment, contacted the International Primate Protection League. His statement to IPPL revealed the full horror of the life of the "military monkeys." Extracts follow:

I can no longer perform experiments with animals doomed, by virtue of their participation in such experiments, to a very early death, if not to pain and suffering, during the final weeks and months of their existence. From 1966 to mid-1978, I performed innumerable experiments with Rhesus monkeys, and 2 or 3 such experiments with baboons. In each experiment, 6 to 12 subjects were trained by the use of electric shock to perform a task of human design . . . the shock generators deliver at least 50 ma at 1200 volts. I couldn't guess the number of times I've seen these units used at full power to punish a slow learner; well into the thousands . . . Frustration leads to self-destructive behaviors, e.g., biting hunks of meat from an arm or hand.

Barnes described the gruesome restraint devices used to hold the animals still for their "training sessions."

The restraint devices are barbaric in themselves: e.g., metal couches with metal neck, belly, and ankle restraints. As the animal struggles to free itself, it often loses its teeth to the neck-bar, gains abrasions on the abdomen (often wearing entirely through the abdominal wall) or so severely chafes its ankles that they bleed and become infected.

The worst part of his duties was, for Barnes, the death-watch on the dying irradiated monkeys:

In years past, I was ordered to keep a death watch on these irradiated monkeys, which meant, simply, to see what happened until they died of radiation injury. Do you have any idea how miserable it is to die from radiation injury? I do, I've seen so many monkeys go through it.

Barnes saw the experiments as basically useless and a waste of money:

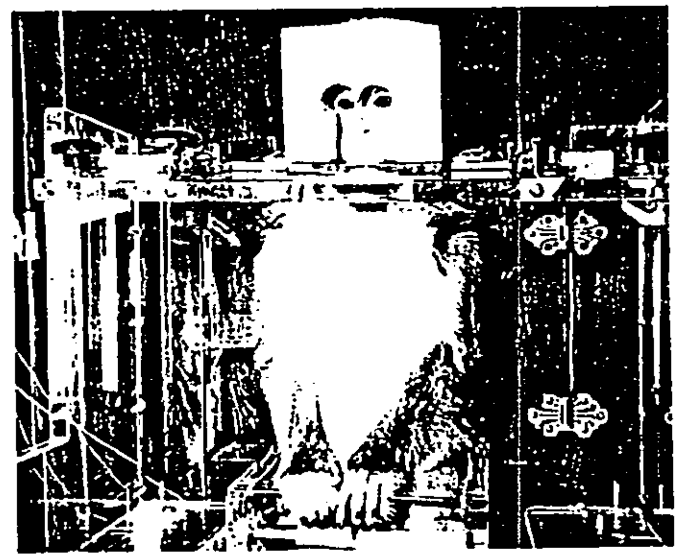
As I became familiar with the use of the data gained from these experiments, I discovered that the data was not used to help Man in the struggle against his environment. The data was, and is, used to generate more worthless experiments, thereby killing and crippling more animals.

Other experiments at the School of Aerospace Medicine have included administration of laser beam damage to monkeys' eyes, and use of monkeys to study the effects of possible antidotes to chemical warfare agents.

The School claims that it does not actually expose monkeys to chemical agents. However, exposure is known to occur at the Chemical Systems Laboratory in Aberdeen, Maryland. The laboratory is part of the U.S. Army Armament Research and Development Command. The International Primate Protection League has used the Freedom of Information Act to learn more about these experiments, but only gained limited information. Basically, two types of agents are tested on monkeys: incapacitants or "knockdown agents;" and lethal agents such as the nerve gas SOMAN, an organophosphate or "human insecticide." The papers obtained by IPPL included references to an agent called HS-6 and a study called "Project Cyanide." The pain suffered by the monkeys used at the Chemical Systems Laboratory must be unbearable. Recently, the CBS program "Sixty Minutes" included an episode about chemical warfare, and a scientist from the Chemical Systems Laboratory was interviewed. Mike Wallace did not even mention the monkey experiments on "Sixty Minutes," and IPPL's statement on the subject for the "Viewers' Opinion" segment the following week was not used. It might be that film of monkeys dying agonizing deaths might not have been in keeping with the segment's apparent bias toward development of chemical warfare agents.

The Armed Forces Radiobiology Research Institute (AFRRI) in Bethesda, Maryland, specializes in high-dosage radiation studies and has killed over 2000 monkeys in its experiments since 1965. AFRRI monkeys have received massive doses. No therapy is ever attempted on them, as it would be useless. The point of the experiments is the death-watch. In a typical experiment, monkeys would be taught to run in a treadwheel. A monkey could avoid shock only by continuing to run. Once a monkey had learned to run for several hours (alternating 10 minutes

Page 20: Dejected Rhesus monkey sits in restraint chair. Top: multiple wounds are evident. Rhesus monkey flying "Primate Equilibrium Platform." Postirradiation vomit runs over platform at right. Bottom: monkey in eye-burn experiment: head is held rigid to assure correct burn.



MAINSTREAM/Winter 1981

of running with 5 minutes of rest), he would be irradiated, and put back in the treadwheel, to run his way into eternity. A watching psychologist would count the number and duration of each monkey's "incapacitations" (periods during which the hapless monkey would crumple into a vomiting mass of misery on the floor of the treadwheel, accepting repeated shocks rather than trying to continue running for his Human Masters).

I visited AFRRI in December 1978. The dignity of the pathetic monkeys contrasted with the mentality of the people involved in inflicting such abuse on their bodies. One "veterinarian" had a photo of his children on his desk — but had no qualms about the agony he inflicted on his monkey "children."

Ironically, the suffering of the military monkeys has saved other monkeys' lives. India and Bangladesh both banned export of monkeys for ANY experimentation as a result of public and government outrage at the suffering inflicted on the monkeys they had exported to the United States. Malaysia has also restricted exports. In addition, a U.S.-sponsored resolution before the World Health Assembly calling on monkey habitat countries to export animals to Western research facilities, was withdrawn when African nations threatened to denounce military experimentation on monkeys on the World Health Assembly floor.

If you're one of those people who had trouble reading this article or looking at the pictures, remember that your pain is nothing compared to what these innocent primates snatched from their homelands have suff...d — so that the human race can "perfect" methods of warfare which may put an end to all of us... and the monkeys ... and all other life on earth.

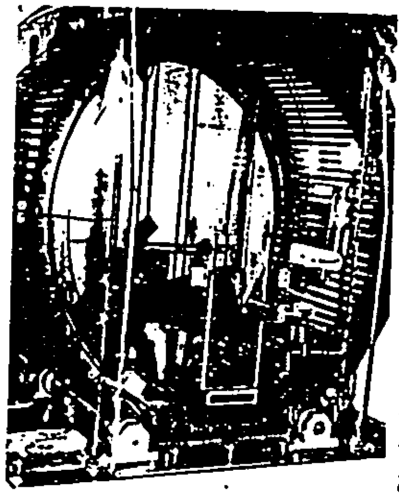
What You Can Do

1) Write to the Secretary of Defense, Washington, D.C. 20301, asking that the use of primates in military experiments be stopped.

2) Write a letter to Mrs. Gandhi, Prime Minister's Office, New Delhi, India, expressing your appreciation for the Indian ban on export of primates and asking that it be maintained.

3)Write a similar letter to Major-General Ziaur Rahman, President of Bangladesh, Ramna, Bangladesh, asking that Bangladesh continue its primate export ban.

4) The International Primate Protection League is leading the opposition to the use of monkeys in military experimentation. Interested people can contact us at PO Drawer X, Summerville, SC 29483.



Front cover: Monkey in restraint chair.
Left: Monkey in treadwheel for neutron bomb tests.
Photos courtesy of Armed Forces Radiobiology Research Institute.

Above: Rhesus monkey whose eyes where burned in radiation experiments.
Courtesy of International Primate Protection League.

ANIMAL PROTECTION INSTITUTE OF AMERICA
P.O. Box 22505
Sacramento, CA 95822
(916) 422-1921
TWX 910 367 2375 API SAC

Reprint:

MONKEYS GO TO WAR

MAINSTREAM/Winter 1981

HICA HAWAII ISLAND CONTRACTORS' ASSOCIATION
494 C KALANIKOA STREET • HILO, HAWAII 96720 • TELEPHONE (808) 935-1316

STATEMENT OF HAWAII ISLAND CONTRACTORS' ASSOCIATION
Environmental Impact Statement Hearing
Naniloa Hotel, Hilo, Hawaii
May 4, 1988

I am Walt Southward, executive director of the Hawaii Island Contractors' Association, an organization of more than 200 members. Our president, Norman Egusa, extends his regrets. He had a previous commitment and could not be with you tonight.

Our organization has endorsed and supports irradiation for Hawaii's farmers.

We strongly suggest, as you look at the overall environmental impact, that you remember that the economy is very much part of the environment.

The papaya farmers of this island contribute a great deal to our way of life and to the attempts to create a more viable agricultural sector of the economy.

By denying them the technology that would allow them to grow and expand within the marketplace, it is possible that once-vibrant industry could be weakened and perhaps even die.

We also urge that you not consider Hawaii as an isolated example. Although we who live here consider the Island of Hawaii a very special place, we strongly urge that in your studies you look very carefully at the 40 or more irradiation facilities in other parts of the United States, and that you look at nearly 100 located elsewhere throughout the world. Look at their safety records, and their industrial accident records, and let that be a factor in your studies.

We appreciate the opportunity to be with you and wish you well in your efforts.

C.3 COMMENTS, RESPONSES, AND LETTERS

APR 27 1988

25 Apr. '88 2.60L/ti

Dear Mr. Kaya,

The enclosed flyer illustrates the misinformed and fallacious rumors going around about the irradiation facility. I am very much in favor of having this facility built in Hilo.

Could you discuss the eight points brought up in this flyer, and supply evidence to dispute them, at the EIS hearing in Hilo on May 4?

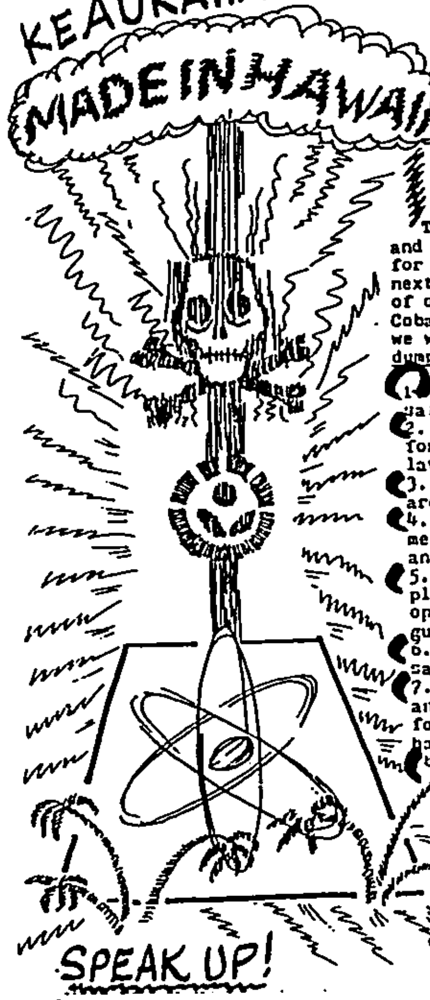
Thank you,

Betty Healy
Hilo, Hawaii

(Also a member of the Leleiwi Comm. Ass'n.)

C-47

HELP SAVE KEAUKAHA - PANAEWA - LELEIWI AND ALL OF HAWAII FROM IRRADATION



The government wants to build and operate a nuclear irradiation facility for papayas in our very own neighborhood right next to Hilo Airport within one to two miles of our homes! Huge amounts of radioactive Cobalt 60 or Cesium 137 will be used. Do we want Hilo to be used as a nuclear waste dump? You should know:

1. No amount of radiation is completely safe. It can cause cancer and birth defects.
2. Our island is geologically unsuited for such a plant with earthquakes, tsunamis, lava flows and high rainfall occurring.
3. Property values may go down in areas around the plant.
4. Other non-toxic, healthy and acceptable methods recently developed to treat fruits and other products should be used.
5. This is one of the first irradiation plants of this type to be built and/or operated in the U. S. Do we want to be guinea pigs?
6. Irradiated foods have not been proven safe to eat.
7. Is there a market for the papaya? Japan and some states will not take irradiated foods. Even the papaya industry itself has not committed to the irradiation process.
8. No insurance company will cover any individual, property or business for radiation accidents.

THE FOLLOWING GROUPS ARE OPPOSED TO CONSTRUCTION OF THE IRRADIATION PLANT: Leleiwi Community Association, Hui Kahakai Community Ass'n., KOA'E Community Ass'n., Aboriginal Native Hawaiian Ass'n., Hawaiian Acres Community Ass'n., Panaewa Young Farmers Keaukaha and Panaewa Community Ass'n.

ATTEND: EIS PUBLIC HEARING, WED. MAY 4, 6:30 P.M. NANILOA HOTEL, KILOHANA RM, HILO · CALL OR WRITE:

MAURICE KAYA, DBED, 335 MERCHANT ST., HONOLULU 96813
GOV. JOHN WAIHEE 961-7293, SENATORS ROBT. HERKES 0-548-7513, RICHARD MATSUURA 0-548-6291 (COLLECT), COUNTY COUNCIL MEMBERS 961-8225, MAYOR DANTE CARPENTER 961-8211

FOR MORE INFORMATION CALL: 935-9126, 935-3475

UA·MAU·KE·O·KA·AINA

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

0302k

April 29, 1988

Ms. Betty Healy
437 Nene Street
Hilo, Hawaii 96720

Dear Ms. Healy:

Thank you for your letter of April 25, 1988, which expressed your support for the Hawaii Commodities Irradiation Facility and enclosed an irradiation flyer.

I wish to insure you that the State is trying hard to provide rational, unbiased information about food irradiation technology and its potential application in Hawaii.

Our public meetings on May 3 in Honolulu and May 4 in Hilo are designed to permit our EIS consultants to receive concerns that the public would want addressed in the EIS. We will describe the project and the process, but time will not permit us to discuss in great detail, the points brought up in the flyer. Rather, the EIS is designed to address those and other concerns more fully in a written public document. Therefore, much of the evening will be devoted to receiving testimony on concerns from interested members of the public.

I encourage you to make your views known to other key County and State elected officials and administrators. Again, thank you for your statement.

Sincerely,

MAURICE H. KAYA
Energy Program Administrator

MHK/hk

MAY 03 1988

lcl
1. AAHK
2. GvL/RO

Mrs. Erla D. Weinert
P. O. Box 388
Kurtistown, Hawaii
96760

Aloha Mr. Kaya,

May 1, 1988

As a six year resident of the Big Island and one who hopes to live here forever, I am very concerned about the proposed irradiation facility.

I understand there is an environmental impact study underway, and I have several questions.

An accident, releasing radioactive material into our environment, either due to human error (a transportation or within plant disaster) or nature (an earthquake or tsunami) is a possibility.

1) What is the probability of such an accident, either on the land (Hilo or the mainland) or enroute (the Pacific)?

2) What are the projected consequences of such an accident?

In terms of the fruit that is irradiated, what are the effects?

1) Is the chemical composition changed, i.e. nutritional value or vitamin content? In what way?

I read that benzene (which is carcinogenic) is a byproduct of irradiated papaya.

2) Can you tell me what byproducts are produced, in what amounts, and what their implications are?

I also understand that irradiated fruit can appear perfectly ripe when actually the ripening process has continued within the fruit, and it actually contains formaldehyde (another carcinogen). Is this true?

Hawaii is a beautiful paradise. The environment can be spoiled only once, and it is spoiled forever. Please consider ALL implications and consequences in your environmental impact statement. Are (we the majority) willing to sacrifice our paradise for the benefit of the minority papaya industry, of which there are about 600 members?

What about the double dip, vapor heat and dry heat methods which are harmless to our environment?

Please, please, respect the aina and listen to your heart in considering this matter!! I look forward to hearing from you.

Sincerely,
Jennifer Weinert

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 12, 1988

Mrs. Eric D. Weinert
P. O. Box 388
Kurtistown, Hawaii 96760

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mrs. Weinert:

The following is provided in response to your letter of May 1, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, information relative to the potential impacts of natural hazards, including earthquakes, tsunamis and lava flows; transportation, storage and disposal of the radiation source (Cobalt 60); and the effects of irradiation on food products and consumer acceptance of irradiated food products, will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

MAY -5 1988

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

DOC. NO.: 3304E
FILE NO.: 88-447

MAY 4 1988

MEMORANDUM

TO: Mr. Maurice Kaya
Energy Division
Department of Business and Economic Development

FROM: William W. Paty, Chairperson
Board of Land and Natural Resources

SUBJECT: EIS Preparation Notice for Food Commodities Irradiation Facility

We have reviewed the document cited above; however, we have no comments to offer at this time. We may be able to comment on the project after review of its Draft EIS.

Thank you for the opportunity to review the assessment.

WILLIAM W. PATY

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 12, 1988

Mr. William W. Paty, Chairperson
Board of Land and Natural Resources
State of Hawaii
Department of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Paty:

The following is provided in response to your Memorandum of May 4, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, a copy of the Draft EIS will be forwarded to your department for review and comment. At present, we anticipate that the Draft EIS will be published and distributed for public review and comment in mid-August 1988.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 2 1 1988

PLEASE ENTER THE FOLLOWING QUESTIONS IN THE FINAL DRAFT OF THE EIS WITH THE ANSWERS. MHK

1. M...
2. GOL / [illegible]

[redacted]

[redacted]

1. Under what safety conditions will the radioactive material be shipped to Hilo?
2. Are there trained personnel in Hawaii that will be able to safely run an irradiation facility?
3. Where will the spent radioactive material be disposed of?

RB Sheetz

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

R. B. Sheetz
P. O. Box 283
Hilo, Hawaii 96721

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Sheetz:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the transportation and storage of the radiation source; operation and maintenance procedures to be followed and disposal of the radiation source will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

(1) Why did Maine & New Jersey outlaw the sale of irradiated foods?

(2) What other States have passed legislation regulating or restricting the sale of iradiated foods?

(3) What evidence is there at present that says its safe to (a) Irradiate food & (b) to consume that food?

(4) What will the long term effects be on the adult human body & childrens developing bodies from consuming irradiated foods?

(5) Is there a cumulative effect in the body?

(6) Why is the FDA willing to waive its customary approval standards for testing of the safety of iradiated foods?

(7) Specifically, what vitamins are destroyed and/or altered by the irradiation process?

(8) Specifically, which foods will produce more Aflatoxins after being irradiated?

(9) Since irradiation of food can make food appear fresh when it is in fact contaminated please describe the process by which consumers can be notified or otherwise alerted to the contaminated food Prior to CONSUMPTION.

(10) What basis has the consumer demand for irradiated food been evaluated? Does anyone really want to eat it? How do you know??

(11) What will be done with the radioactive waste products from such a plant?

(12) Where will the radioactive substance(s) enter the Island?

(13) How will they be transported on the island?

(14) Why/How could anyone possibly choose an Island with an active Volcano & many earthquakes for any type of Irradiation facility.

(15) What about the contamination of ground water from such a facility - ie - Specifically what studies have been performed to determine the extent of water pollution?

(16) What are the health hazards to the employees of such a facility?

(17) What are the potential health hazards to the Community - people & environment?

(18) Please list any & all Businesses individuals private & public who stand to recieve financial gain from such a facility.

Thank you,

[signature]

667 Waianuenue Ave
Hilo HI 96720

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Resident
667 Wainaku Avenue
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Resident:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the actions taken by other political jurisdictions regarding irradiation; potential effects of irradiation on food stuffs; potential impacts on humans as a result of consuming irradiated foods; regulatory and enforcement actions by governmental agencies; food labeling requirements; marketability and consumer acceptance of irradiated food products; transportation, storage and disposal of the radiation source; potential impacts of natural hazards including earthquakes, tsunamis and lava flows on the proposed facility; potential groundwater contamination; health and safety aspects of the proposed facility; and economic aspects of the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

MAY 02 1988
1. AAH Kaul
2. GL/BJ

MAURICE KAYA
DBED
Energy Division
335 Merchants St. Room 110
Honolulu, HI 96813

RE: ENVIRONMENTAL IMPACT STATEMENT
PROPOSED FOOD IRRADIATION FACILITY IN HILO

Mr. Kaya:

I have some questions that I wish to have addressed in the EIS.

1. Will the facility be inspected and monitored regularly by the Nuclear Regulatory Commission or another federal agency to determine if proper procedures are being followed, no contamination has occurred, all safety systems are working, and dose meters and all instruments which measure radioactity are functioning correctly.

2. How often will the above measured instruments be calibrated?

3. How will local authorities: Civil Defense, firemen, police, etc. be trained to handle a nucelar accident.

4. How will transportation of the Cobalt 60 be handled? To Big Island? After it arrives on Big Island? Will the route always be the same? Will any security be provided?

5. The proposed facility is near the Hilo Airport. What's the worst case scenario if an airplane crashed into the facility?

6. What special provisions are being made for earthquakes?

7. How many pounds of papayas must be processed on a monthly basis to make an irradiator economically feasible?

8. "What is the current production of papayas on the Big Island? Give a monthly breakdown for 12 months prior.

9. What percentage of the payapas are being treated by vapor heat?

10. Give a breakdown of percentages treated by each of the seven major packing houses, in terms of volume, for twelve months prior.

11. What is the projected price per pound of irradiating papayas? How was this information arrived at?

12. What is the cost per pound of vapor heat treating payayas?

13. How much papaya acerage is available on Big Island for increased payaya production? How long must papaya fields rest before they can be used again?

Thank you for including my questions.

Sincerely,

Colleen Mandala
COLLEEN MANDALA
Box 1546
Pahoa, HI 96778

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 10, 1988

Ms. Colleen Mandala
P. O. Box 1546
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Mandala:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the inspection and regulatory monitoring requirements; instrumentation checking and calibration requirements; emergency planning and procedures for plant and public service personnel; transportation, storage and disposal of the radiation source; risks of plant location relative to air port operations and potential accidents; provisions that would be taken to mitigate potential impacts due to natural hazards including earthquakes, tsunamis and lava flows; expected throughput of commodities; past and present papaya production levels; alternative treatment methods and approximate poundage treated by existing alternative treatment methods; economics associated with the proposed facility; and factors associated with the growing and processing of papaya as relevant to the proposed irradiation facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

COUNTY OF HAWAII

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720
(808) 961-8288

DANTE K. CARPENTER
Mayor

ALBERT LONO LYMAN
Director

TIM LUI-KWAN
Deputy Director

APR 25 1988
1. MHK
2. GTL/HO

April 21, 1988

State of Hawaii
Department of Business and
Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, HI 96813

ATTENTION: Mr. M. Kaya

Gentlemen:

Thank you for the opportunity to review the Environmental Impact Statement Preparation Notice for the Food Commodities Irradiation Facility. We provide the following comments:

C-57

1. The draft EIS should have a detailed discussion of the irradiation method, abatement systems, and the concept behind irradiation as a means of sterilization.

2. The draft EIS should discuss the source of Cobalt 60 supplies, the quantities needed, the transport and handling requirements of Cobalt 60 from the source to Hilo. Further, the EIS should also include how often the Cobalt 60 needs to be replenished and its useful life prior to replacement.

3. The waste products, disposal sites, as well as the transport and handling of the wastes to the disposal site(s) need to be described in the draft EIS.

4. Discuss the possibilities of irradiation leakage or other forms of radioactive leakage. A thorough analysis of emergency scenarios, including an emergency management plan for the facility, the site and the community should be described in the draft EIS. Impacts to the county's emergency services, i.e. Civil Defense, Police, Fire and Department of Public Works should be included.

5. Sites A and B are at the 27 feet elevation and Site C is at the 50 feet elevation. The EISPN diagram shows a 24-foot deep sump extending beneath the irradiator room. The draft EIS should describe any possible elevation of the water table at the proposed sites caused by large storms, hurricanes, or heavy rainy periods. The close proximity of the sump and the groundwater should be addressed.

6. Address the impacts on the hydrology at the sites as well as the surrounding areas in the context of potential contamination.

7. Discuss procedures for removal, storing, and alternate site for the radiation source should there be any potential lava flow or tsunami hazards.

8. Address the impacts on air quality and secondary effects on surrounding facilities, i.e. Hilo Airport and HELCO facility.

9. The discussion on alternative methods of disinfestation should also include alternative irradiation methods which do not need the use of radioactive material, i.e. electromagnetic means.

10. Alternative treatment technology continues to be researched and developed. Should the proposed facility become obsolete in the future, the decommissioning of the facility should be discussed. How or where will the radioactive remnants be discarded when the facility is no longer needed? Will there be any restrictions on utilization of the facility for other uses?

11. The draft EIS should address how the proposed facility will meet appropriate goals, policies and standards of the General Plan, and the objectives and policies of the Hawaii State Plan.

12. Discussion on transportation and circulation due to increased traffic, transporting and handling of commodities from other islands for treatment, and alternative sites. The draft EIS should also discuss the site relationship to the General Lyman Field Master Plan as well as Department of Hawaiian Home Lands (Site C) plan.

13. Describe the necessary permit approvals required for the project.

14. Since the project is experimental, the draft EIS should discuss the criteria/methodology for determining success/failure. What decides whether the project should be continued on a permanent basis.

Should you have any questions on the foregoing comments, please feel free to contact our office.

Sincerely,

ALBERT LONO LYMAN
Planning Director

AK:aeb

cc: Mayor
R & D

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. Albert Lono Lyman, Director
Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 97620

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Lyman:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the procedures and methods of operation of the proposed facility;, abatement systems to be employed and description of the irradiation treatment method; the transportation, storage, replenishment and disposal of the radiation source (Cobalt 60); potential impacts due to radiation leakage; emergency and safety measures that will be taken during the design, construction and operation of the facility; potential requirements on county services; potential impacts on the facility due to natural hazards including tsunamis, earthquakes and lava flows; potential effects on groundwater supplies; potential impacts of the facility on the air and noise quality of the surrounding area; alternative treatment methods; actions that would be taken should the facility be decommissioned; relationship of the proposed facility to land use policies and controls, including the Hawaii State Plan, State Functional Plans and County General Plan, for the affected area; potential traffic impacts resulting from the operation of the facility; necessary permits and approvals required; and the governmental agency inspections and controls that will be applicable to the facility will be discussed in the EIS. In addition, to the extent possible, research questions that the proposed demonstration facility will be designed to answer, such as economic and technical questions regarding irradiation treatment, will be discussed in the EIS. Many of the research questions and decisions regarding success/failure will be answered during the period the demonstration facility is operational.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 13 1988

1. MHKwk
2. GL/Bz

Leleiwi Community Association, Hilo, Hawaii 96720

April 9, 1988

laurice Kaya
BED - Energy Division
35 Merchant St. Rm 110
onolulu, HI 96813

Dear Maurice:

Jan Moon and I enjoyed our meeting with you recently in Honolulu. When I returned to Kalanianaole School, I mentioned your name to the intermediate counselor, Mrs. Satsuki Unoki, who does remember you. Please do take my invitation seriously and stop by and see us next time you are on the island!

We understand that there is an April 22, 1988 deadline to submit concerns about this plant. Our community association has many and here are a few:

1. Volcanic flows
2. Earthquakes
3. Tsunami
4. Rainfall and flooding
5. Hurricane
6. Contamination of water tables
7. Airline disaster(located near our airport!)
8. Property values declining around plant
9. No insurance coverage for citizens around plant in case of accident.
10. Airborne release of toxic substances

C-60

11. Danger to workers. Most workers coming from other places.

12. Few or no markets available for products. Affects on tourism.

13. Not economically vaiable for our island.

14. Danger of destruction of the entire papaya industry once a "negative reputation" is established in markets overseas due to concern of radiated food's safty.

15. Fear of Cesium 137 being used in the plant even though Cobalt 60 is "promised" in the press and by Mayor Dante Carpenter.

16. Movements of states and foreign countries to stop sale of irradiated foods.

17. Affect of the health food craze in the US and how vaiable irradiated foods would be for sale.

18. Concern by citizens that nuclear wastes from weapons systems will be used(nuclear waste dump).

19. Attempts of government to override the will of the people as shown in polls done by Hawaii County that indeed the majority of our people in East Hawaii do NOT WANT THE PLANT. Why is the Federal, State and local officials, at least some of them, continuing to push this on the people.

20. Impact on the Hawaiian people as some sights are on Hawaiian Home Lands. Hawaiians and others already have a sewage plant and airport to contend with.

21. Danger of plant to our ocean environments since it is located near a tsunami inundation area.

22. Explore the dangers of shipping these wastes on sea and land.

23. Explore the safty record of other plants(Ft. Armstrong, etc) to determine if it is wise to go ahead with this project.

24. Is it right for taxpayers to build a building or plant for private industry?

25. Re-evaluate the State of Hawaii's spending priorities as I am sure the taxpayers money could be used more wisely.

Again Maurice I strongly urge that this plant not be built. I hope that some of the points above will be explored in depth and fairness.

Sincerely,

Samuel J. Burris

Samuel J. Burris, PRESIDENT
1875 Kalanianaole Ave. # 705
Hilo, HI 96720
Tel: 935-9126

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Samuel J. Burris, President
Leleiwi Community Association
1875 Kalanianaole Avenue, #705
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Burris:

The following is provided in response to your letter of April 9, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential natural hazard factors that might affect the proposed irradiator facility; potential effects on potable water supplies; emergency and safety measures to be employed during the operation and decommissioning of the facility; insurance and financial liability factors; economic impacts; air quality issues; market acceptance of irradiated products; effects of irradiation on food products; disposal of waste products; need and purpose of the proposed facility; potential environmental impacts of the facility on the natural, social and economic environment of the Big Island and State; safety and emergency measures to be taken during the transportation and use of the radiation source (Cobalt 60); and costs and sources of funding for the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 14 1988

1. MHKela
2. GOL/Bg

1158 Heauka Place
Hilo, HI 96720
April 10, 1988

Maurice Kaya
DBED---Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya:

I would like to see a detailed economic justification for the proposed irradiation facility. What <u>existing</u> commodity will be run through the plant besides papaya? What existing industry will use the plant besides the papaya industry? Do you have any guarantee that the papaya growers will in fact use the facility?

It is anticipated that in a few months APHIS will approve the "dry heat" disinfestation system for use on papayas. This system will be installed at the expense of the industry, <u>not</u> the taxpayer. What is the legal justification under state law for the subsid, that is being offered to the papaya industry?

Exactly what will be the user fee structure? Will the papaya industry, if they are the only existing users, pay back the costs of the taxpayers' investment to the state in user fees in addition to the cost of operation? That is, will the user fee cover the cost of operation? Will the user fee, in addition, pay back the taxpayers' investment?

Has Japan said they will permit entry of irradiated papayas into Japan? Has any grocery chain said that they will accept and market irradiated papayas?

What are the plans for decommissioning the facility? Who will pay the costs of decommissioning? Is a trust fund being set up to handle decommissioning costs? If not, why not?

Who will operate the plant? If it is a private contractor, does he stand to bear any of the loss if the plant is an economic failure? What control will the state have over the user fee structure and the profit margin of a private contractor? If it is a private operator, will he be required to pay back the public monies that were used in the development and building of the irradiator? Has any arrangement or commitment been made by the state to any contractor for the operation of the plant? And, if so, on what basis was the selection made?

Please provide the annual cost of running the irradiator facility if:

1) <u>No</u> product is put through
2) Maximum tonnage is put through
3) Cost to taxpayers if no product is put through
4) Cost to taxpayers if maximum tonnage is put through

Please provide the following comparison:

1) Cost to taxpayers for studies, EIS, capital investment if papaya industry switches to dry-heat facilities?
2) Cost to taxpayers for studies, EIS, capital investment if the irradiator is built?

Using current production data and the unlikely condition that all of this papaya production is put through the irradiator, how much unused capacity (expressed as a per cent of total time available for a 24 hour/day, 365 day/year operation) is left? Do you have any contractual commitments from any source to use this unused capacity?

Sincerely,

Roy T. Cunningham

Dr. Roy T. Cunningham

The Gamma-Ray Gourmet

Scientists cook up tests for irradiated food

C-63

By RICK WEISS

What do you get when you irradiate an apple with 100,000 rads of gamma rays? Unfortunately, nobody knows for sure. And it is precisely this uncertainty that is stimulating a nationwide debate about the safety and usefulness of food irradiation.

Proponents see irradiation as a safe replacement for many pesticides, a way to reduce spoilage and a blessing for the world's hungry. Opponents point to potentially carcinogenic by-products in irradiated food, possible losses in nutritional value, and the problems inherent to nuclear facilities and the disposal of radioactive wastes. The debate involves farmers, food technologists and nuclear weapons activists.

If there is one thing that all factions can agree upon, however, it is that research into the chemical effects of high-energy food sterilization is still incomplete. So behind the din of antinuclear activists arguing with food industry representatives, such research, mostly funded by the Department of Agriculture (USDA), is quietly being done.

The technology in question involves the irradiation of fresh foods with gamma rays as a means of extending shelf life. Doses ranging from 20,000 to 3 million rads (the equivalent of up to 150 million chest X-rays) for each item of food are useful for killing spoilage-promoting bacteria or to delay ripening. Although spices are the only irradiated edibles currently being marketed in the United States, the Food and Drug Administration (FDA) has already approved irradiation for use on produce and some meats. FDA regulates irradiation not as a process but as an additive.

But what exactly is "added" to irradiated food? Irradiated food looks and smells better for an extended time, but little is known about the chemical changes induced by the process. This mystery is of concern to scientists and consumers for two reasons: First, without a reliable chemical "marker" to test whether food has already been irradiated, the technology is difficult to regulate. There is the possibility of nonirradiated food being sold fraudulently as irradiated food. Or food could be illegally re-irradiated — either inadvertently or as a substitute for maintaining hygienic practices between harvest and packaging. Over-irradiated food can be invisibly damaged.

A second concern is that even small doses of irradiation may destroy nutritionally important compounds or create potentially dangerous chemicals in food. Food chemists seeking to identify and characterize such "radiolytic" changes, however, are hindered by the chemical complexity that is typical of most foods.

"Food is not a defined substance," says Richard Piccioni, a senior staff scientist with Accord Research and Educational Associates, a public health research group in New York City. "You don't know what's in food to begin with, and when you expose food to radiation you have no idea what the changes are," he said at a recent food irradiation debate in Washington, D.C.

But while scientists agree that it is difficult to identify and measure such changes, several say the task is by no means impossible.

Michael Simic, of the Radiation Chemistry and Chemical Dosimetry Group at the National Bureau of Standards in Gaithersburg, Md., is working to identify altered amino acids that could be used as markers in irradiated foods (SN: 7/12/86, p.27). His group has already identified an altered form of tyrosine that is produced when meat is exposed to ionizing radiation.

Simic is also using electron spin resonance (ESR) to detect food-borne free radicals — highly reactive chemical compounds that appear in bone or cuticle (such as shrimp shell) after exposure to irradiation. Simic says the latest generation of ESR machines can detect food that has been irradiated with as little as 1,000 rads.

Meanwhile, researchers in Germany are having some success with the detection of thermoluminescence, or the emission of very small amounts of light that are "trapped" inside the matrix of irradiated food. In those experiments, the food is heated in a laboratory and emissions are measured with a spectroscope.

Other researchers are measuring the amount of hydrogen gas that is generated inside irradiated food. And still others are measuring the reaction products resulting from the bonding of DNA-thymin (a chemical component of DNA in food) with the hydroxyl radicals formed by the irradiation of water in food.

Some of the more promising research into irradiation markers is being performed by Wassef Nawar, a professor in the Department of Food Science and Nutrition at the University of Massachusetts at Amherst. Lipids produce the greatest number of detectable by-products in irradiated foods, Nawar says. In particular, he has found, radiation-induced cleavage of lipids tends to occur in a certain region of the fat molecule called the ester-carbonyl region. This results in the accumulation of compounds with a characteristic shortage of carbon atoms relative to the major fatty acid in the food — compounds he says can be measured simply and rapidly using gas chromatography.

In related research, Dan Schwartz, at the USDA's Agricultural Research Service in Philadelphia, is looking for naturally occurring markers in irradiated chicken. Working with chicken livers, he and his colleagues found a compound that is a degradation product of cholesterol and that may prove to be diagnostic of irradiation. The compound increases in concentration by about 100 micrograms for every 300,000 rads of exposure, making it a possible quantitative indicator as well.

Further tests are needed, however, to ensure that the marker is in itself nontoxic. Even if the compound is safe, Schwartz adds, scientists will have to see if its concentration changes significantly over time. They'll also have to confirm that the compound doesn't occur in traditional forms of processing that do not involve irradiation.

Indeed, one of the major disappointments in the search for irradiation markers is that many of the "unique" by-products of irradiation have subsequently been found in nonirradiated food as well.

"The trouble is not that it is difficult to detect these changes, but that it's hard to prove definitively what caused them," says George Pauli, a safety review coordinator for the FDA's division of food and color additives. Free radicals, for example, which have been detected in large quantities in irradiated dry foods, can also be formed by simple heating or even grinding.

In addition, identification of markers often requires sophisticated equipment not generally available to food inspection services. To detect Schwartz's cholesterol by-product, for example, requires a gas chromatography column and a mass spectroscope. The procedure is too complicated for everyday use.

For compounds that do prove to be good markers, there is always the hope that simpler tests might be designed. Some researchers say it may be possible to develop ELISA immunoassays — sensitive, enzyme-based biological tests — to detect the presence of suspected irradiation markers.

Equally difficult is the problem of quantitative analysis. An ideal marker would be produced in amounts proportionate to the amount of irradiation, and would remain relatively stable over the shelf life of the product. Many of the markers tested so far, however, have been found to disappear over time, making measurement inaccurate unless it is done immediately after processing.

"The quantitative [aspect] will be a real beast," Pauli says. "For example, I can look at a piece of meat and tell whether or not it's been cooked. But I can't tell you what temperature it was taken to or how long it was roasted." Indeed, he says, radiolytic products will vary in concentration depending on wavelength of radiation used, dose, temperature, time elapsed since irradiation and the conditions of storage. In addition, free radical concentration will depend in part on the amount of oxygen surrounding the product when it is irradiated. All of these variables make it difficult to devise a test that would tell to what degree, if any, certain foods have been irradiated.

Even more troubling, many scientists say, is that aspects of the irradiation process itself make it difficult to determine the health risks of irradiated food.

Under normal conditions, very small quantities of irradiation-caused by-products accumulate in food. Traditionally, scientists have tested the safety of low-concentration, nonirradiated food additives by giving unusually high doses to test animals and looking for such things as tumor formation, chromosomal abnormalities or birth defects. But how does one obtain large doses of these rare breakdown products? Counterintuitively, more radiation doesn't necessarily produce more radiation by-products.

"You simply can't get high doses of the stuff," says Piccioni, "because if you increase the radiation level 1,000 times, then you don't have food anymore — you have carbon dioxide and water." And for obvious reasons, he adds, you cannot simply irradiate food at normal doses and then force a test animal to eat 30 times its normal diet.

The impossibility of testing large doses of radiolytic products on animals puts government regulators in a difficult position. Additives are subject to the FDA's "Delaney clause," which requires that any additive shown to be carcinogenic *in any dose* must be kept off the market. It is difficult to see how the standard can be fully applied to irradiated food when no method exists to implement high-dose tests. In fact, some opponents argue, since gamma rays themselves are known to be carcinogenic, the wording of the Delaney clause could be interpreted to forbid their use altogether as food additives.

That argument ignores the fact that irradiation is not actually added to food in any traditional sense of the word. But it is representative of the somewhat strained logic that, in the absence of definitive scientific tests, has come to dominate both sides of the food irradiation debate.

Indeed, says one irradiation supporter with unintended irony, "Food irradiation is so good for food *because* it is so dangerous for everything that lives." □

A primer in food radiochemistry

Most food irradiation is accomplished with gamma rays, a form of electromagnetic energy similar in wavelength to X-rays. The process usually involves exposure to radioactive cobalt-60 in a heavily shielded processing facility. Radioactive cesium-137, retrievable through the reprocessing of nuclear waste, has also been used as a source of gamma rays.

Electron beam machines capable of accelerating electrons to high-energy states have also been used, but have limited usefulness as irradiators. Such beams fail to penetrate more than a few centimeters, and unlike radioactive gamma sources they produce unwanted heat in the food being irradiated. A new generation of electron beam X-ray irradiators looks promising, however, according to researchers at the Lawrence Livermore (Calif.) Laboratories.

A single gamma ray-energized electron may produce 30,000 to 40,000 individual ionization reactions in food, and may excite as many as 80,000 other electrons in the first 10^{-14} seconds of the radiation process. These secondary electrons, called delta rays, can in turn produce further chemical changes in food.

In dry foods, chemical changes may occur as a direct result of irradiation energy acting on organic molecules. In most foods, however, radiation is absorbed by water molecules. Electrons are knocked off of some water molecules, and these electrons may in turn disrupt surrounding chemical bonds with the subsequent formation of charged, highly reactive "free radicals."

Irradiation of fats, for example, results in a free-radical "chain reaction" that creates an immense variety of hydrocarbons, aldehydes, ketones and esters. In many cases, these are impossible to differentiate from the large variety of compounds that result from cooking.

Looking at proteins, researchers have found that sulfur-containing amino acids seem to be especially sensitive to irradiation, making them potential irradiation markers. Unfortunately, their destruction by gamma ray-propagated hydroxy radicals can give meat a rancid flavor. Other potential markers are equally undesirable, and ideally their production would be minimized. Of the many radiolytic products from carbohydrates, for example, there is some concern about the apparent production of small quantities of malondialdehyde, a chemical that has been shown to be deadly to cells.

Meanwhile, researchers are also looking into the effects of irradiation on various types of food packaging. In addition to concerns about gamma damage to plastics, scientists want to know if packaging residues can be transferred to prepackaged food that is subsequently irradiated. — R. Weiss

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Dr. Roy T. Cunningham
1158 Heauka Place
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Cunningham:

The following is provided in response to your letter of April 10, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the EIS will include discussions regarding the economic feasibility of the proposed irradiation facility; the products that will be tested and treated in the facility; the potential users of the facility; alternative treatment methods; the market acceptability of irradiated products; facility decommissioning factors; and operations characteristics of the facility.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

East Hawaii Coalition To Stop Food Irradiation

A Non-Profit Citizen Action Group

APR 21 1988

April 19, 1988

Maurice Kaya
DBED - Energy Division
335 Merchant St. Room 110
Honolulu, HI 96813

Dear Mr. Kaya,

Enclosed are a lists of concerns of our Coalition which reflect the concerns of many in our community.

Please send me the name of the project manager from Westec, his address in Honolulu; the address of the project manager at Belt-Collins and their address.

I would appreciate that information as soon as possible.

Looking forward to an honest EIS,

Sincerely,

Kathy Dorn
Director

P.O. BOX 1559 ■ PAHOA, HAWAII 96778 ■ (808) 965-7140

CATEGORIES OF CONCERN CONCERNING NUCLEAR FOOD PROCESSING ARE:

1. Environmental safety
2. Hazards to communities
3. Food safety
4. Consumer nutrition needs
5. Economic need and alternatives
6. Economic feasibility and impacts
7. Occupational risks
8. Consequences of consumer backlash

1a. What are the consequences to the local environment from the ordinary stray radiation emissions, and from major and minor radiation leaks and accidents which may occur during the course of the life of the plant?

1b. What methods would be used to detect contamination?

1c. How are "normal" baseline values being established?

1d. How uniform are these baseline values in Hawaii?

1e. How many local laboratories, if any, are equipped to do requisite analyses? Do they meet EPA Quality Assurance standards?

1f. Will the DOE commit in contract to remove all nuclear isotope should a referendum of the people demand it?

1g. Will the DOE commit in contract to remove the isotope promptly at the end of precisely three years, should no responsible agency come forth to take charge of the facility?

2a. What are the potential hazards to the residents near an irradiator from stray radiation, and from the gradually increased levels of background radiation?

2b. What methods would be used to determine whether there would be any stray radiation?

2c. Will specific transportation routes be publicly designated?

2d. Will security provisions be made for shipmentt?

2e. What is the potential for a terrorist diversion?

2f. What insurance would be required so taxpayers do not bear the cost of an emergency?

2g. Describe the methods of transporting the radioactive isotope, both for the original supply and for replenishment.

2h. How frequently would replenishment occur for Cobalt 60?

2i. How frequently would replenishment occur for Cesium 137?

2j. What are the hazards to all involved in the transportation process?

3a. On the basis of primary professional sources, other than International Atomic Agency sources, what is the basis, if any, for proof of safety of longterm consumption of irradiated foods?

3b. Describe in detail the observations of the Indian Human Feeding Study (1975), and subsequent studies using monkeys, mice and rats. What were the conclusions?

3c. Describe the studies of Levina & Ivanov (Russian studies). What were the conclusions of these studies?

3d. Provide an analysis of the adverse effects Dr. Josef Barna (1979) lists in his review of the literature on nuclear food processing. What are his conclusions?

3f. How will increased levels of radiation from increased distribution of radioactivity impact the immune system of people in the vicinity of a nuclear food processing facility?

3g. Why did the FDA recind its approval for the irradiation of canned bacon in 1968? What adverse health effects were reported from eating irradiated bacon?

3h. Did the FAO/IAEA/WHO joint committee on food irradiation provide detailed references to the scientific literature to support their conclusions? If they did, please provide those references.

3i. What were the findings of Dr. Donald Louria, Chairman of the DEPT. of Preventive Medicine and Community Health of the New Jersey Medical School, after an intensive review of the 5 studies upon which the FDA based their approval of irradiation in the processing of food?

3j. Of the studies that the FDA reviewed many were found to show adverse health effects in test animals from eating irradiated food. Did the FDA or any other agency shown that the safety concerns raised by many of the studies can be discounted be reference to other studies which did not find these results under similar conditions?

3k. The FDA also based its approval of food irradiation on the assumption that the amount of radiolytic products produced in irradiated foods up to the 100,000 rad dose would be so low as to be acceptable. On October 23, 1987, the United States Court of Appeals for the District of Columbia upheld the strict interpretation of the Delaney clause and ruled that the FDA may not permit the use of any food additive regardless of the level. (Public Citizen vs. FDA No. 86-1548. No. 86-5150) Food irradiation is a food additive. If the legality of the FDA's approval of food irradiation were challenged in the courts, how would the Delaney Clause be interpreted? is it possible that the FDA's approval of food irradiation was not legal?

3l. What were the conclusions of George Tritsch, Cancer Research Scientist at Roswell Memorial Park Institute, concerning the carcinogenicity and the mutagenicity of radiolytic products produced by irradiation of foods, as presented in testimony in Congress before Congressman Henry Waxman's Subcommittee of Health and the Environment, June 19, 1987?

3m. What were the conclusions of Richard Piccione Ph.D., in testimony at the same Congressional hearing?

3n. What did Dr. S.G. Srikantia, former director of the National Institute of Nutrition, have to say in defense of the famous Indian Feeding Study, at the same Congressional hearing?

3o. Is it possible that irradiation leads to mutations in viruses, insects, and bacteria in food, leading to more resistant strains? Could insects become genetically altered by irradiation?

3p. There are several sources in the scientific literature which show that irradiation stimulates the production of the potent liver carcinogen, alfatoxin. Review these studies and report there findings. (Bullerman et al. Use of Gamma Irradiation to Prevent Alfatoxin production in Bread. Vol. 38, Jounal of Food Science 1238, 1973.; E. Pryadorshini and P.B. Tuple. Effects of Graded Doses of Gamma Irradiation on Alfatoxin Production by Aspergillus Parasiticus in Wheat. Cosmet Toxicology No. 505, 1979. Alfatoxin Production on Irradiated Foods. Cosmet Toxicology No. 293, 1976.; also Jemmali & Guilot, 1969; Schindler & Noble 1970; Schindler et al. 1980.

3q. At the doses necessary to kill salmonella, would irradiation kill the much more dangerous bacteria clostridium botulinum?

3r. Is it possible to control, regulate and monitor a food irradiation industry to enforce labelling laws and prevent foods from receiving multiple irradiation treatments?

4a. Is irradiation of food justified nutritionally in the long run after 10 years, 20 years, 40 years?

4b. Will feeding children irradiated food affect their lives, their ability to learn, their health and well-being?

4c. How will nuclear food processing affect the nutritional value of food?

4d. What are the specific consequences of gamma irradiation at all doses ranging from 10,000 to 3,000,000 rads on essential nutrient compounds?

4e. What are the possible health/disease effects which may result from the consumption of irradiated food consumed on a regular basis?

5a. Identify which economic entities will suffer, and which people people will suffer financially after irradiation is introduced with financial subsidy which is not offered to private industry?

5b. What alternative techniques exist (describe fully) which effectively accomplish the results to be achieved by using nuclear food processing (irradiation)?

5c. What is the cost of facility maintenance for nuclear food processing?

5d. What entity is responsible for safety and maintenance should crops fail and the facility remain idle?

5e. What is the capital investment and cost of processing for alternative technologies to nuclear food processing?

5f. What is the capital investment and cost of processing (including fixed costs of plant maintenance) for nuclear food processing?

6a. Would accomodations in the type, timing and capacity of transportation of products be required for nuclear food processing in order to allow for an even throughput?

6b. What will be the consequences to farmers, packers and community businesses should irradiated products be rejected at marketplaces in California, the West Coast, the East Coast and Japan?

6c. What agencies will be financially responsible for the adverse impacts on farmers, packers and distributors should the technology of nuclear food processing prove to be economically infeasible, or should there be an accident which would incapacitate the facility?

6d. What impact will the presence of a nuclear food processing facility have on tourism and the tourist industry in Hilo and on the Big Island?

6e. What will be the actual additional costs to the growers of irradiating papayas in the first year, second year, third year, and all the way through to the tenty year, assuming an average crop?

6f. What will be the effect on the profits of the industry if a consumer boycott occurs?

6g. Based on the experiences of other food industries and companies (Campbell's, Nestle, Coors, California grape growers) what is the estimated time and costs of recovery to the Hawaiian papaya industry?

6h. Who will pay for this recovery?

6i. What would be an alternative use of the energy and money being spent to promote and examine irradiation technology which would benefit papaya growers?

LETTERS

Food is affected

Editor:

Acting as a community-based, consumer educational group for two years in Kona, we would like to take this opportunity to briefly update some of the scientific research being conducted worldwide to determine the human health hazards of irradiated food.

First, a brief description of the irradiation process: Food irradiation is mainly accomplished with gamma rays, a form of electromagnetic energy similar in wavelength to x-rays. One process involves exposure to radioactive cobalt-60 in a heavily shielded processing plant. Radioactive cesium-137, obtained through the reprocessing of nuclear waste, has also been used as a source of gamma rays. A single gamma ray energized electron may produce 30,000 to 40,000 individual ionization reactions in food, and may excite as many as 80,000 other electrons in the first 10 seconds of the radiation process. These secondary electrons, called delta rays, can in turn, produce further chemical changes in food. Chemical changes can occur in dry foods as a direct result of irradiation energy acting on organic molecules. But in most foods, radiation is absorbed by water molecules. Electrons spin off of some water molecules, and may in turn disrupt surrounding chemical bonds with the subsequent formation of charged, highly reactive "free radicals." Irradiated fats result in a free-radical chain reaction, creating immense varieties of hydrocarbons, aldehydes, ketones and esters.

The Radiation Chemistry and Chemical Dosimetry Group at the National Bureau of Standards is working to identify altered amino acids that could be used as markers in irradiated foods, and identified an altered form of tyrosine that is produced when meat is exposed to ionizing radiation.

German research is having some success with the detection of thermoluminescence, or the emission of very small amounts of light that are "trapped" inside the matrix of irradiated food. Emissions are measured with a spectroscope. Other research includes measuring the amount of hydrogen gas generated inside irradiated food, and the reaction products resulting from the bonding of DNA-thymin with the hydroxyl radicals formed by the irradiation of water in food. Researchers have found that in proteins, sulphur-containing amino acids are especially sensitive to irradiation, making them potential irradiation markers. But their destruction by gamma ray-propagated hydroxy radicals can give meat a rancid flavor. Of the many radiolytic products from carbohydrates, there is some concern about the apparent production of small quantities of malondialdehyde, a chemical that has been shown to be deadly to cells.

The inability, at present, of testing large doses of radiolytic products on animals puts government regulators in a difficult position: additives are subject to the FDA's "Delaney Clause," which requires that any additive shown to be carcinogenic in any dose must be kept off the market. One difficulty is how the standard can be fully applied to irradiated food when no method exists to implement high dose tests. Some opponents argue that in fact, since gamma rays themselves are known to be carcinogenic, the wording of the "Delaney Clause" could be interpreted to forbid their use altogether as food additives.

So what do you get when you irradiate an apple or a papya with 100,000 rads of gamma rays? Unfortunately for all of us, nobody knows for sure. It is precisely this uncertainty that is stimulating a worldwide debate about the safety and usefulness of food irradiation. The debate involves farmers, food technologists, environmentalists, consumer avocates and nuclear weapons activists. Rep. Virginia Isbell has repeatedly advised that a food irradiation plant will never happen here in Hawaii. During this election year, we are networking with the Hawaii Democratic Party to issue a resolution to ban the sale of all irradiated foods in Hawaii County. Ask all candidates where they stand on the issue of safety of irradiated foods.

Kara Billingsley-Riordan
Director
Hawaii Democratic Party
Dist. 3, Prec. 4, President

No irradiation

Editor:

Enclosed you will find a one-page executive summary of the main reasons why the members and officers of the following community groups believe it is unwise to construct a food irradiation facility in the city of Hilo on the Big Island of Hawaii:

The Leleiwi Community Association, The Hui Kahakai Community Association, The Koa'e Community Association, The Panaewa Young Farmers, The Aboriginal Native Hawaiial Association, The Hawaiian Acres Community Association, The Church-in-Society Committee of the First United Protestant Church.

We, the officers and members of the above-mentioned community associations and other organizations, are publicly expressing our opposition to the construction of a nuclear irradiation facility on our island of Hawaii for the irradiating of papaya and other agricultural products.

Our main objections to such a facility are related to the health and safety of the people of our island and our local communities:

1. We are seriously concerned about the shipment of radioactive materials to our island and their transportation in our coastal and bay waters and on our streets and highways.

2. Another major concern has to do with the legally allowable emission of 500 millirems of radiation from the plant per year (which greatly exceeds the release amount allowable from nuclear power plants).

3. There is the ongoing potential for human error in the daily operation of the facility, with conceivably dangerous consequences.

4. Our island is in an earthquake zone, and this alone poses an ultra-hazardous risk to a facility housing large amounts of radioactive materials. We have seen no documents proving that the proposed plant would be safe from an earthquake of major size.

5. Added to these concerns, the proposed location of the plant beside Hilo airport borders a tsunami inundation area.

6. The possibility of an airliner accident cannot be ruled out, not when the plant is built next to an airport runway.

7. There is of course an ongoing risk of volcanic flow.

8. In the event of a natural disaster, there are no adequate emergency resources or effective means of evacuation (e.g., from the Keaukaha district, which is adjacent to the proposed facility).

These risks deeply concern us.

Beyond this, we question the spending of taxpayers' dollars to build an irradiation plant for private industry, much less a plant that would compete with the new vapor-heat papaya treatment facility opened in Hilo just last summer by private enterprise (Hawaiian Host).

Our citizens' organizations join together in urging our government officials to pursue needed projects that do not threaten the health, safety, and peace of mind of our island residents. We ask that respect for our people be shown, and that, in all good conscience, the land be preserved in righteousness.

Sam Barris
Hilo

West Hawaii Today, Monday, April 11, 1988—8A

East Hawaii Coalition To Stop Food Irradiation

A Non-Profit Citizen Action Group

Dear Joe & Sylvia,

Thanks!!!

Our regular meetings at are 5 pm on Sundays. Across from Pioneer Savings and next to the two-story yellow building is an alley. Go down alley. - 2nd house on left. Red. House w/ bamboo gate.

You are welcome and we look forward to meeting you.

Kathy Dorn

P.O. BOX 1559 ■ PAHOA, HAWAII 96778 ■ (808) 965-7140

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Kathy Dorn
P. O. Box 1559
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Dorn:

The following is provided in response to your letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, environmental safety, including the facility design and operation safety measures that will be taken; potential radiation hazards, including those that might be caused by potential natural hazards due to tsunamis, earthquakes and lava flows; potential effects of irradiation on food stuffs; consumer acceptance and marketability of irradiated food products; alternative treatment methods; economic impacts associated with the proposed irradiation facility; and the health and safety risks associated with the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 2 1 1988
1. [illegible]
2. [illegible]

P.O. Box 69C
Na'alehu, Hi. 96772
April 19, 1988

Maurice Kaya
DBED--Energy Dept.
335 Merchant St. Rm.110
Honolulu, HI. 96812

Re: Environmental Impact Statement on a Commodities Irradiation Facility

Please note my concerns within the statement:

What countries have outlawed the import of irradiated foods and why?

What states are considering legislation banning irradiated foods?

What states have banned irradiated foods and why?

What legislation is being considered by the U.S. Congress/Senate with regard to irradiated foods?

What are the particles found in food as a result of irradiation? Where do these particles go in the human body when ingested?

What radioactive materials would be used in the food irradiator?

What amount (rads) of exposure to those radioactive materials would cause death in the human beings within 24 hours? Within one week, within one month, within one year?

Aside from death, what are other results of human exposure to those radioactive substances? Please identify all known cancers and diseases resulting from exposure to those radioactive substances. Determine time of degeneration of the various organs, the symptoms of the diseases, and life expectancy of victims once diagnosed.

What other alternatives are viable for elimination of the fruit fly?

What are methods of elimination currently used on this island?

Has DBED attempted to determine the market for exporting dried papayas? Has DBED attempted to market dried papayas to the cereal companies?

Is there a current market for irradiated papayas, or other irradiated tropical fruits? Where?

What is the possibility that fruit fly/larvae would survive exposure to the radiation, reproduce a mutant species indestructable by radiation exposure? What research has been conducted with regard to insect mutations? What scientists have conducted the research and where are they located? What did they find?

How much radioactive materials will be used at the irradiator facility? How much radioactive materials will be brought into this island for use at the irradiator? Will the radioactive materials be stored at any other sites other than the irradiator? If so, where?

In the event of an earthquake resulting in a leak or radiation, what evacuation procedures are planned? Who would be evacuated, how and to where?

What clean-up routine would be required in the event of such an accident? Who would do the work, who covers the cost for this liability? What if the state could find no local contractors to clean up the radioactive leak, how long would it take to find companies to do the job? from outside the state?

What is the impact on the air quality should such an accident occur? What are all the wind patterns for dispersing the radiation around the island?

What is the results of cattle exposure to radiation in the pastures? Will the milk become contaminated by the radiation? Would the animals develop any disease or cancer resulting from exposure to the radiation? Are any birthdefects attributed to exposure of radiation?

Please list all known incidences of cattle exposed to radiation in the last [illegible] years. What affect did the radiation have on the milk, cheese, yogurt. What affect did the consumption of the products have on the humans.

What was the most immediate result of radiation in human life in the bombing of Hiroshima? How many people died within the first week? What were all the symptoms experienced by those who survived exposure to radiation? What were the resulting birth defects?

What mutations occur in human genes as a result of radiation exposure?

Is it possible for a nuclear chain reaction to occur at the facility should a nuclear explosion occur near our islands?

Have any studies been done to investigate nuclear chain reactions? If so, who are the scientists who have conducted these studies and where are they located? What did they find?

What countries have conducted upper atmosphere nuclear testing in the Pacific region? When was the last recorded test [illegible] by whom was it done?

Thank you,

[signature]
RUTH MARIE BASS

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Ruth Marie Bass
P. O. Box 690
Na'alehu, Hawaii 96772

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Bass:

The following is provided in response to your Letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the present domestic and foreign uses of irradiation treatment; actions that have or may be taken by various political jurisdictions and bodies; effects of irradiation on food products; radiation source, quantity and dosages to be used in the proposed Hawaii Commodities Irradiation Facility; potential impacts on humans from radiation from the irradiator facility; alternative methods of treatment; present insect disinfestation treatment processes being used in Hawaii; marketability and consumer acceptance of irradiated foods; efficiency of irradiation as a method of disinfestation of insects; storage and disposal of the radiation source; potential effects of natural hazards, such as earthquakes, tsunamis and lava flows on the irradiator facility; safety and emergency procedures that will be followed at the irradiator facility; potential impacts on air and noise quality in the vicinity of the irradiator facility; potential effects of irradiation on the flora and fauna of the irradiator site; and the relationship of irradiation to nuclear fission and fusion will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

University of Hawaii at Hilo
COLLEGE OF ARTS AND SCIENCES
SOCIAL SCIENCES DIVISION

APR 21 1988
1. [illegible]
2. [illegible]

April 18, 1988

Mr. Maurice Kaya
DBED - Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Sir:

The effects of gamma irradiation produce the isomeric effect as well as producing radioactive isotopes via the photonuclear effect as described in the accompanying letter to Dr. John Lewin concerning irradiated food products.

The general claim of the food irradiation industry has been that the effect of gamma irradiation is not detectable in any way subsequently to the irradiation of the food product. In the journal, "Nature," the world's leading news journal of Science, a recent article on "Thermoluminescence in irradiated foodstuffs," (Moriarty, T. F., Oduko, J. M. & spyrou, N.M. Nature 3 March 1988, p. 22) states, "When natural crystals form, they absorb ionizing radiation ... which then serves to generate electrons that become trapped in the irregularites of the crystal. If ... material containing such crystals is heated, the electrons are freed, photons are produced, and the result is thermoluminescence. The amount of light given off is proportional to the radiation dose." (Probing the Authenticity of Antiquities with High Tech Attacks on a Microscale, Science, 18 March 1988, p. 1374-1375)

The absorbtion of energy by the crystal, is therefore evidence for the isomeric effect since other forms of electron storage would produce a static potental discharge not detectable via thermoluminesence observations. The electron energy for the food object would therefore typically be emitted in the form of gamma rays producing neoplasia (CANCER) in those ingesting the irradiated food stuffs. This kind of emission is the isomeric efect.

As is the case with those objects studied as antiquities, there is steady increase in the amount of thermoluminesence after the initial formation of the obect in a kiln or forge. In the case of irradiated spices such as cumin, as shown in the enclosed article, there is decrease in the amount of emmitted thermoluminesence for well over a two month period above that of the unirradiated control spices subsequently to gamma irradiation. As it is shown in this article that there is a significant difference betweeen

tumeric which shows twice the thermoluminescence of cumin, the chemical compostion of the spice effects the isomeric effect, as expected.

Should these effects be due to the accumulation of electron charge as postulated in the measurement of thermoluminescence in antiquities there should be a steady increase in thermoluminesence over time after irradiaion with gamma rays. This is, however, not observed as we note a rapid diminution of thermoluminesence dependent for its specific energetics on the kind of spice irradiated.

We must thank the physicists for having developed an exact science which predicts in a precise gallilean sense to observations in the physical world. We must therefore assume that any failure to detect radioactive byproducts of ionizing radiation is an artefact of improper experimental design and not the lack of radioactive components in the irradiated foodstuffs. Any other assumption is clearly of a suicidal nature.

1. Can we then in all good conscience produce foodstuffs which harbor radioactive byproduects for consumption by the general public.

2. Is it safe for the peoples of the state of Hawaii to have a facility containing radioactive substances on the most seismically and volcanically active island on earth?

We all thank you for your significant and important efforts on behalf of citizens of Hawaii.

Respectfully,

Paul W. Dixon

Paul W. Dixon, Ph.D.
Professor of Psychology

Enclosures:

University of Hawaii at Hilo
COLLEGE OF ARTS AND SCIENCES
SOCIAL SCIENCES DIVISION

June 25, 1987

John C. Lewin, M.D.
Director of Health
State of Hawaii
Department of Health
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Sir:

May I thank you for your kind letter of June 8, 1987 regarding food irradiation. Your concern for the possibility that irradiating food products may be generative of radioactive isotopes is commendable.

May I comment upon your resume of my statement regarding the photonuclear effect. You are in agreement that the photonuclear effect is seen between 5 to 15 MeV, yet disallow the following statement that the photonuclear effect will be observed in the normal range of all gamma radiation. This is based on the range of observed radiation from Cesium 137 which decays to stable Barium via beta particles of 0.51 MeV (93%), 1.18 MeV (7%), and also emits gamma radiation at 0.66 MeV. (Please note: Sax, N. E. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS) You therefore conclude that, "Not only does gamma radiation fail to form Carbon 14, they also do not have sufficient energy to induce the photonuclear effect for any element."

Alas, such a view of nuclear interactions would be true in a universe controlled by the tenets of Newtonian physics. Quantum mechanical considerations are germane, however, where we must consider the dual nature of matter. As de Broglie has indicated in his description of the wavelike nature of subatomic particles, particulary we see in the case of the electron, which is the active principle of the gamma ray, (Plese note: Duality and the Uncertainty Principle, Condon, E. U. And Odishaw, H., HANDBOOK OF PHYSICS 2nd Edition p. 26-27) produces uncertainty in the action of the electron when it interacts with other particles or more generally atoms composed of elementary particles. Thus from the point of view of classical physics, a particle must have the energy to penetrate the potential barrier surrounding an atom and dislodge a neutron or proton; "the wave mechanical interpretation shows that there is a definite possibility that a particle with less energy may do so."

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(Please note: Potential Barrier, THE INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS 2nd Edition)

Where this occurs there is a coefficient of negative adsorption following the Einstein coefficent of negative emmission where the neutron or proton is subtracted from the atomic nucleus as you have indicated. There is also, however, a coefficient of upward transistions per cubic centimeter per second. These effects are found to be independent of conditions of excitation, temperature, etc. and are thus very stable. (Please note: Aller, L. Atomic radiation processes in Condon, E. U. and Odishaw, H., HANDBOOK OF PHYSICS p. 7:54-55) It must, therefore, be concluded that the cascade of neutrons and protons resultant from the bombardment of the food product by gamma rays will also add subatomic particles such as neutrons giving rise to radioactive isotopes, including Carbon 14, which will be subsequently ingested by the child or adult. It is important to note that these effects are maintained by collisions, recombinations and cascades thus forming a distribution of interactions between the electrons of the gamma wave and the atoms in the irradiated food item. (In this way the Einstein coefficients of emission and absorbtion are implemented)

The ingestion of radioactive isotopes will cumulatively lead to neoplasia such as Leukaemia, Adenocarcinoma, Colorectal tumors, and other malignant and cancerous growths. The current wisdom in nuclear medicine being that any additional increase in radiation exposure is contraindicatied due to increased incidence of neoplastic formation.

It is also important to note that isomeric transitions for gamma ray emmision can be of the order from 1 second up to several years. Since the ingestion of the food item will lead to active gamma ray emitters being adsorbed into the body, this alone must make all irradiated food items extraordinarily dangerous. (Please note: McGRAW HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY 6th Edition, Vol. 15, p.117) There is simply no way that we can assume that the ingestion of radioactive isotopes in any amount will not induce neoplasia (CANCER) in a statistically large sample.

Though my formal training is in experimental psychology, this last year, I was nominated for the Nobel Prize in Physics. Correspondence from Dr. Carlo Rubbia, Nobel Prize in Physics (1984) for his work in high energy physics, Prof. Virginia Trimble, world's leading authority on Supernovae and related phenomena, as well as a very kind letter from Dr. Siegfried Hecker, the director of our nation's leading defense laboratory at Los Alamos, New Mexico, is submitted for your information.

May I also indicate that my residence upon the Island of Hawaii for the these last twenty-two years of full time service to the University of Hawaii though long from our human point of view, is insignificant from a geological point of view. Yet in this time, I have myself experienced major seismic events (Richter scale, 7.2) which have destroyed major structures on the Island of Hawaii, and have resulted in the death of citizens of our State. I have seen the millions of tons of lava poised over the city of Hilo ready to engulf the entire metropolis. Currently an entire township in the Kalapana region is being destroyed by incursion of lava. Tidal waves have reached inwards of half a mile in the Punaluu region and historically have come within two hundred feet of the Lyman House Museum. The journal, Science, has indicated that as recently as about 1450 A. D. the wave action reached some 1800 feet elevation due to a tsunami on the Island of Mauai. Can we in good conscience, advise the use of this highly volatile, and reactive substance, Cesium 137, as described in DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS for a location such as the Island of Hawaii which has conditons against which no manmade structure, no matter how designed, can long withstand?

May I conclude, therefore, in the light of the best knowledge known to modern science, both in medicine and in physics, that the irradiation of food products is generative of radioactive isotopes whose ingestion is contraindicated from the standpoint of nuclear medicine. May I also conclude, that the presence of an Irradiation Facility on the Island of Hawaii would provide a major health hazard to the residents of our island owing to the extraordinary geological nature of the island.

There are many pitfalls and difficulties in the world of quantum physics. It is best, therefore, not to rely too heavily on the wisdom found in the literature of the food irradiation industry.

Thank you for your kind attention and consideration in this most significant matter of health and safety for the citizens of the State of Hawaii.

Respectfully,

Paul W. Dixon

Paul W. Dixon, Ph.D.
Professor of Psychology

Enclosures:

Copy to: Governor of the State of Hawaii, John Waihee

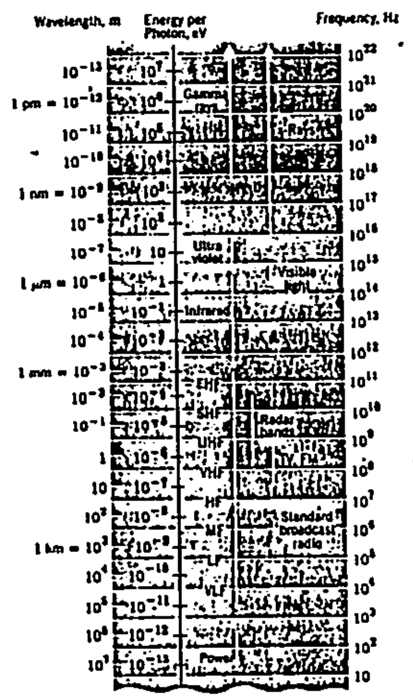


Figure 5-4. The electromagnetic spectrum, showing wavelength, frequency, and energy per photon on a logarithmic scale.

the so-called *conduction electrons*, which are bound to the metal by energies of only a few electron volts.

Photons in the x-ray or gamma-ray region of the spectrum can eject electrons from deep within the structure of the atoms on which they fall. The innermost electrons of uranium, for example, are bound with an energy of 116 keV, so the incident photons must have at least this much energy to eject them. Photons with still higher energies can even knock neutrons and protons out of the atomic nucleus in what are called *photonuclear* reactions. One of these particles may be bound into the nucleus by an energy in the range 5 to 15 MeV.

Notice that the photons are absorbed in the photoelectric process. This requires the electrons to be bound to atoms, or solids, for a truly free electron cannot absorb a photon and conserve both energy and momentum in the process (see Problem 12). We must have a bound electron, therefore, in which case the binding forces serve to transmit momentum to the atom or solid. Because of the large mass of atom, or solid, compared to the electron, the system can absorb a large amount of momentum without, however, acquiring a significant amount of energy. Our photoelectric energy equation remains valid, the effect being possible only because there is a heavy recoiling particle in addition to an ejected electron. The photoelectric effect is one important way in which photons, of energy up to

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
File:

June 8, 1987

Paul W. Dixon, Ph.D.
Professor of Psychology
University of Hawaii at Hilo
College of Arts and Sciences
Social Sciences Division
Hilo, HI 96820-4091

Dear Dr. Dixon:

Thank-you for your April 13, 1987, letter regarding food irradiation. Your letter (attached) mentions several points regarding gamma rays and the photonuclear effect that I feel needs clarification.

Depending on their energy level, gamma rays may interact with atoms in several ways. Rays with energies between 10 eV to 500 eV usually participate in the photoelectric effect, between 100 KeV to 10 MeV in Compton scattering, and greater than 1.02 MeV in pair production (Figure 1). While these effects involve interactions with orbital electrons or nuclear electromagnetic forces, higher energy gamma radiation may react with atomic nuclei in a process called the photonuclear effect.

I agree with your statement, "This [photonuclear] effect is seen between 5 to 15 MeV." but disagree when you conclude that "...the photonuclear effect will occur in the normal range of all gamma radiation." Energy levels of gamma radiation fall between 10^2 to 10^7 eV, or 100 eV to 10 MeV (Figure 2). In order to initiate these reactions, the incoming gamma radiation must be equal to or greater than the nuclear binding energy, the force required to eject a nucleon (proton or neutron) from the nucleus (Figure 3).

The principal reactions between gamma rays and atomic nuclei are those in which either a neutron or a proton is ejected. These are referred to as (γ,n) or (γ,p) reactions; (γ,n) reactions lead to a lower isotope of the same element and (γ,p) reactions to a different element of one lower atomic number. Of those nuclides likely to occur in foods, only ^{2}H at 2.23 MeV, ^{17}O at 4.14 MeV, and ^{13}C at 4.95 MeV have threshold energy values for nuclear reactions with gamma rays of energy levels that may be used for food irradiation. The reactions that they undergo are:

Dr. Paul Dixon
June 8, 1997
page 2

^{2}H + gamma ray ---> ^{1}H + n

^{17}O + gamma ray ---> ^{16}O + n

^{13}C + gamma ray ---> ^{12}C + n

Since the γ,n reaction ejects a neutron, the reaction products are isotopes of lower atomic weight. In your letter you mention that the photoelectric effect will produce ^{14}C. This reaction will not occur with carbon because carbon has a mass of 12, to get ^{14}C there would have to be a gain in atomic mass. The photonuclear effect produces a loss in atomic mass. To form this element, a gamma ray must have an MeV greater than 7.26 to eject a proton from ^{14}N. When disintegration schemes of ^{60}Co and ^{137}Cs are examined (Figure 4), the gamma rays emitted fall below the nuclear binding energy level of nitrogen; 0.66 MeV from ^{60}Co and 1.17 MeV and 1.33 Me from ^{137}Cs. Not only does gamma radiation from these elements fail to form ^{14}C, they also do not have sufficient energy to induce the photonuclear effect for any element.

Incoming gamma radiation may react with atomic nuclei in other ways besides ejecting a nucleon. Stable nuclei of some elements can be raised from ground state to a higher and metastable state by direct absorption of gamma rays of energy less than required for particle emission from the nucleus. The spontaneous return to the ground state is accompanied by gamma ray or electron emission. Such nuclear excitations are called isomeric. In all nuclides only 32 isomeric states have half-lives longer than 10 min. Of these only 11 occur in foods, and only in trace amounts. In view of this, isomeric excitation is not a significant mechanism for inducing radioactivity in irradiated foods. Estimates show that not even one excitation of any nuclide in 1 kg of meat sterilized with electron radiation is likely to occur.

The above described considerations, combined with confirmatory information secured as a result of using radiations within these limits can be visualized by relating it to radioactivity present in foods due to naturally occurring radionuclides such as ^{40}K, ^{50}V, ^{87}Rb, ^{115}In, ^{204}Pb, ^{14}C and ^{3}H. In meat this natural activity amounts to about 100 Bq (100 disintegrations/sec). The possible added radioactivity in meat irradiated with what is the largest dose likely to be used in all food irradiation applications, that is, the dose for sterilization (radappertization), is equal to about 10^{-6} Bq, or one disintegration per week. It constitutes about 10^{-7} the natural radioactivity present before irradiation. This small increment of activity is deemed to be radiologically insignificant.

Dr. Paul Dixon
June 8, 1987
page 3

Worth noting is the fact that most irradiated foods are likely to be consumed only after the passage of time after irradiation. This is so not only because most of the uses of food irradiation are for the purpose of preservation, but also in uses such as insect disinfestation for shipment of the irradiated food.

I am convinced, based on thorough scientific research that the proposed irradiation facility will not induce radioactivity in the food or produce harmful radiolytic products in treated foods. The Department of Health will continue to monitor the literature and review the safety of the procedure. However, food irradiation appears at this point to be a viable and safe process if properly applied. Thank-you for bringing this interesting phenomenon to my attention.

Sincerely,

For John C. Lewin, M.D.
Director of Health

attachments

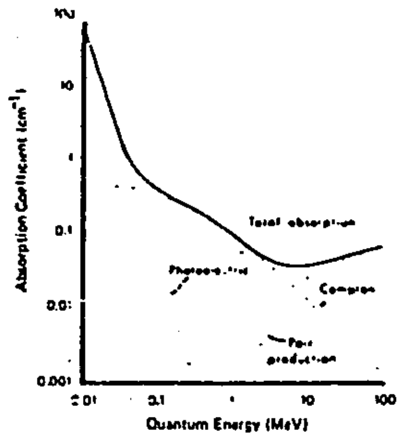
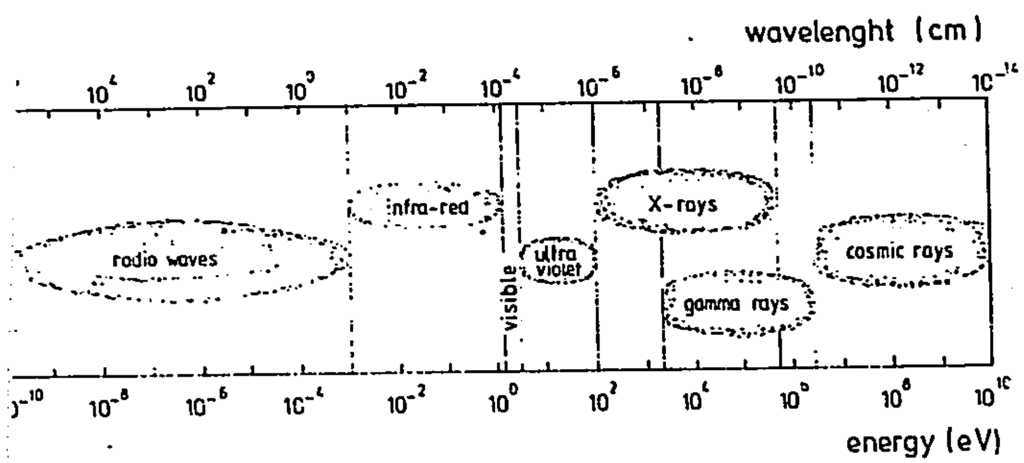


Figure 1.6 Absorption coefficients in aluminum for various energies of γ radiation. The relative contributions of the photoelectric effect, Compton effect, and pair production are indicated. From A. P. Casarett, "Radiation Biology," Prentice-Hall, Englewood Cliffs, New Jersey, 1968. Copyright by U.S. Atomic Energy Commission.

FIG. 1



[illegible] 1. Electro-magnetic spectrum.
[illegible]m: Food Irradiation Now, Martinus Nijhoff/Dr W. Junk Publishers. 1982

FIG. 2

[illegible] 1.4 A graph showing binding energy per nuclear particle (left ordinate) and mass loss per nuclear particle (right ordinate), each plotted against the mass number of the nuclide.

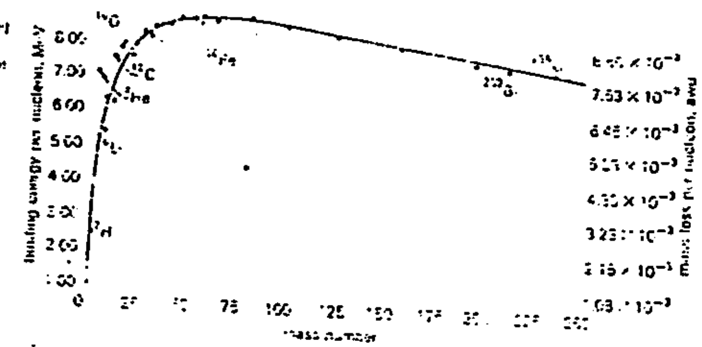


FIG. 3

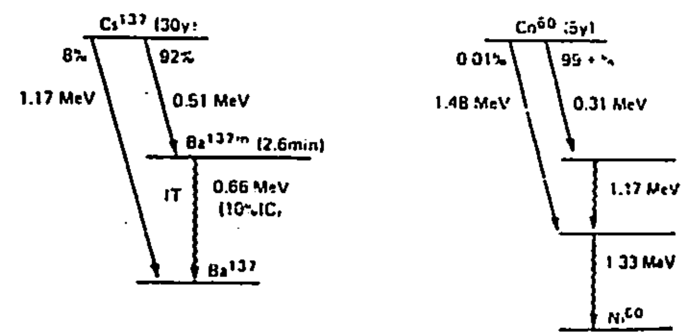


Figure 15.13 Disintegration schemes for [illegible] From "Training Manual on Food Irradiation Technology and Techniques" [illegible] Energy Agency, Vienna 1970.

FIG. 4

and 69. Note that whatever the mechanisms involved in this reshuffling, its causes remain to be determined.

C. BIÉMONT
A. AIJUAR
C. ARNAULT

Laboratoire de Biologie des Populations, Université Claude-Bernard, Lyon I 69622 Villeurbanne, France

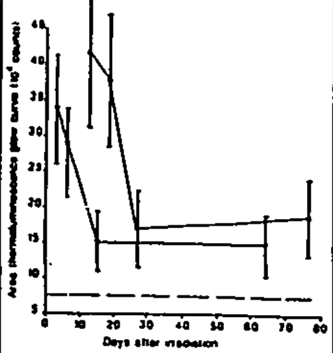
1. Biémont, C., Aouar, A. & Arnault, C. *Nature* 329, 742–744 (1987).
2. Biémont, C. & Aouar, A. *Heredity* 58, 39–47 (1987).
3. Biémont, C. & Gautier, C. *Heredity* (in the press).

Thermoluminescence in irradiated foodstuffs

SIR—The UK government has recently confirmed that a ban on the irradiation of foodstuffs will remain in force until suitable regulatory controls, including a simple method to detect whether food has been irradiated, can be devised. In 1983, the United Nations Codex Alimentarius Commission[1] of the Food and Agriculture Organisation/World Health Organisation stated that "despite the many investigations designed to detect physical, chemical and biological changes in foods subject to ionising energy, no satisfactory method for identifying food as having been irradiated has so far been developed". Methods previously used in such investigations were found to be unsatisfactory for a variety of reasons[2], but thermoluminescence[3] appeared to us to be worthy of investigation. We have measured the thermoluminescent response of seven different spices and found that most irradiated specimens could be clearly distinguished from unirradiated ones up to two to three months after irradiation.

The seven spices chosen for investigation were nutmeg, paprika, black pepper, cinnamon, cumin, turmeric and cayenne pepper. These are likely candidates for commercial irradiation and would receive doses of up to 10 kGy. Two samples of each spice received radiation doses of 5 kGy and 10 kGy, respectively, in a gamma-irradiation facility (cobalt-60 source) while a third sample served as an unirradiated control. The light output of samples from each group was subsequently measured with a photomultiplier tube while they were being heated from ambient temperature to 180 °C at a linear heating rate of 2.5 °C s⁻¹. A steady flow of nitrogen was used during heating to reduce smouldering.

We obtained simple, reproducible glow-curves; for example, the curve for turmeric is a single broad peak with a maximum at about 130 °C, decreasing in height (fading) as the interval between irradiation and readout increases. Initial fading is rapid for all the spices (except nutmeg), but the thermoluminescent response persists well above that of



Integrated light output at different times after irradiation from cumin that had received radiation doses of 5 kGy (— ▼ —) or 10 kGy (— ▲ —), and from unirradiated cumin (— — —). Error bars are 1 s.d. (25 %) of values obtained by repetitive measurements.

unirradiated spices for over two months after irradiation. The results for cumin are shown in the figure. We obtained similar results for paprika, cayenne pepper, cinnamon, black pepper and turmeric, the highest response being from turmeric (twice that of cumin).

Nutmeg has the lowest response of all the spices investigated, with light output approximately 30 times less than that of cumin. Its response fades to that of unirradiated nutmeg after two and four weeks for the 5 kGy and 10 kGy-irradiated samples, respectively. Spices irradiated with 10 kGy initially show twice the thermoluminescent response of those irradiated with 5 kGy doses; however, further work is necessary to confirm whether the response is linear for a range of absorbed doses.

The errors obtained in this preliminary study are quite large but could be reduced by improving the heating and light measurement systems. It seems possible that this technique could be applied to a broad range of other foodstuffs and it therefore appears to be a promising candidate in the search for a simple test of whether food has been irradiated, as demanded by government, the food industry and public opinion.

T. F. MORIARTY
JENNIFER M. ODUKO
N. M. SPYROU

Department of Physics, University of Surrey, Guildford, Surrey GU2 5XH, UK

1. Codex Alimentarius Commission, Vol XV *General standard for irradiated foods* (FAO/WHO, Rome, 1983).
2. Deschreider, A. R. *Results of a European Research Programme. Proc 2nd Int. Conf. on the identification of irradiated foodstuffs* 303–325 (EEC, Luxembourg 1974).
3. Heide, L. & Bögl, W. *Fresenius Z. Analyt. Chem.* 338, 682–683 (1985).

Techniques of py. building in Egypt

SIR—A principle illustrated in 5J old Egyptian art work has yielde: method of creating mechanicail tage. It has long been known tha peoples had the ability to lift and t. huge masses of stone. The Incan walls, for example, contain blocl weigh over 300 tons[1] and the mo on the Giza plateau, which incl Great Pyramid, involved the tr: ation of over 11 million cubic stone. In both cultures this was iously accomplished without the the pulley or domesticated be burden[2].

Considerable debate has been dered by this mystery[3-6], and many edgeable authorities have conclu ancient peoples may have had a m: lifting and transporting heavy wei; is unknown today.

In ancient Egyptian art, lo: commonly depicted being carr poles[7] and actual poles exist in n collections. The evidence app indicate that ancient peoples r lifted and carried heavy weights by them . . . bending poles arranged symmetrically and often in parallel under a load. (Intere this method of carrying things is st in parts of the world today.)

I have built models consister these observations. A load represe a cement brick 3½ inches wide, 7 and 2½ inches thick was placed o stainless steel rods 0.045 inches in eter. The rods were evenly spaced the brick and arranged perpendic the brick's long axis. These rods we perted on a wood fram. consisting parallel wooden supports spac inches apart. The rods were long to extend several inches to either the bearing supports (see figure construction establishes an equil state between the bending rods a load. Each rod supports only the sl the brick's weight which is acting c above it. Lifting one rod end up and ing it at a new height (¼ inch abc initial height, for example) caus entire load to move up; one has energy to the system, the rods th: not been moved straighten slightly rod elevated is bent more. Equil must be maintained over the enti tem. It can be observed that the ce mass, with one rod end elevate moved up much less than ¼ of an ir

If all the rod ends are lifted th distance, one at a time, and bloc shimmed up in an elevated position the initial bearing point, the gradually rises. When the last rod elevated, the brick will have been the same distance the individual ro

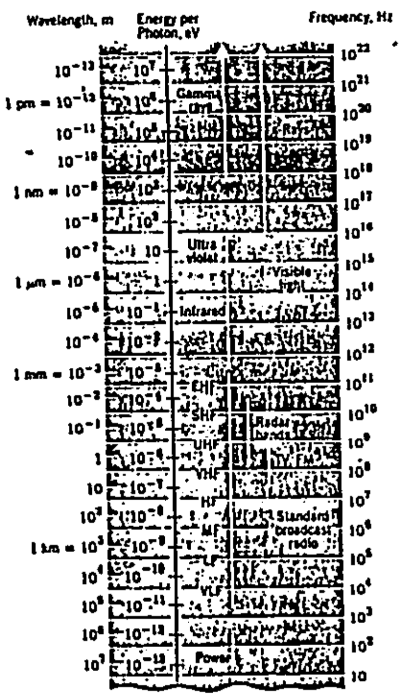


Figure 5-4. The electromagnetic spectrum, showing wavelength, frequency, and energy per photon on a logarithmic scale.

the so-called *conduction electrons*, which are bound to the metal by energies of only a few electron volts.

Photons in the x-ray or gamma-ray region of the spectrum can eject electrons from deep within the structure of the atoms on which they fall. The innermost electrons of uranium, for example, are bound with an energy of 116 keV, so the incident photons must have at least this much energy to eject them. Photons with still higher energies can even knock neutrons and protons out of the atomic nucleus in what are called *photonuclear* reactions. One of these particles may be bound into the nucleus by an energy in the range 5 to 15 MeV.

Notice that the photons are absorbed in the photoelectric process. This requires the electrons to be bound to atoms, or solids, for a truly free electron cannot absorb a photon and conserve both energy and momentum in the process [see Problem 12]. We must have a bound electron, therefore, in which case the binding forces serve to transmit momentum to the atom or solid. Because of the large mass of atom, or solid, compared to the electron, the system can absorb a large amount of momentum without, however, acquiring a significant amount of energy. Our photoelectric energy equation remains valid, the effect being possible only because there is a heavy recoiling particle in addition to an ejected electron. The photoelectric effect is one important way in which photons, of energy up to

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
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European Laboratory for Particle Physics

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Prof. Paul W. Dixon, Ph.D.
Professor of Psychology
University of Hawaii at Hilo
College of Arts and Sciences
Hilo
Hawaii 96720-4091

Votre référence / Your reference
Notre référence / Our reference EP/UA1/CR/8691/ep/1277

Geneva, 21 January 1987

Dear Professor Dixon,

Thank you very much for your very kind letter and for the time taken in letting me know some details on physics which although known to me look quite interesting from you point of view.

Thank you again for your kind attention and consideration.

With best regards.

Sincerely yours,

Carlo Rubbia

UNIVERSITY OF CALIFORNIA, IRVINE

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DEPARTMENT OF PHYSICS IRVINE, CALIFORNIA 92717

19 February 1987

Dr. Paul Dixon
Social Sciences Division
Univ. of Hawaii
Hilo HI 96720

Dear Dr. Dixon:

Your preprints and letter of 4 January only just found their way here. About the only way to distribute ideas widely through the scientific community is by publishing them in some standard journal. The most widely read in astronomy, at least in the US, is the Astrophysical Journal. Manuscripts should be submitted to its editor (Dr. Helmut Abt, Kitt Peak National Observatory, Box 26732, Tucson AZ 85726), but need to be in a rather rigidly defined format, explained from time to time in the journal itself (which your university library probably gets).

As far as reaching the Soviet community, there as here, there are many groups actively engaged in investigating supernovae, quasars, and the rest. None that I am aware of are attached directly to particle accelerator facilities. The closest I can think of is one of their senior neutrino people, Dr G.T. Zatsepin, of the Inst. for Nuclear Research, USSR Academy of Sciences, 117312 Moscow B-312, USSR.

Yours sincerely,

Virginia Trimble

Foreign and Commonwealth Office
London SW1A 2AH

Telephone 01- 233 5938

Professor P W Dixon PhD
Professor of Psychology
University of Hawaii at Hilo
1400 Kapiolani Street
HILO
HAWAII 96720

Your reference

Our reference

Date 22 April 1986

Dear Professor Dixon,

The Prime Minister has asked me to thank you for your letter of 30 March. Your suggestions and the documents you enclose are of scientific interest and have been passed to officials concerned with these areas.

Yours sincerely,

Paul Hare

P W Hare
Energy, Science and Space Department

C-80

Max-Planck-Institut für Radioastronomie

Auf dem Hügel 69 · D-5300 Bonn 1

Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-5300 Bonn 1

Prof. W.Dixon
University of Hawaii at Hilo
College of Arts and Sciences
Hilo HI 96720
USA

6.11.1987

Dear Professor Dixon,

Thank you very much for the interest you have shown in the recent article on the peculiar variations in the quasar 3C454.3, published in Nature. Thank you, too, for your preprint and the attached letters. In all fairness, I must point out that the so-called "superluminal motions" in various extragalactic objects have been known for some time (see,e.g. "Superluminal Radio Sources", publ. Cambridge University Press, eds. J.A.Zensus,T.J.Pearson). Our article merely pointed out variations in one object that do not appear to fit easily into current theoretical schemes.

I am not, myself, a theoretician, and so cannot comment on your ideas. I can only reiterate Dr.Trimble's advice, to submit the article to a journal. It is good to see that work on astrophysical theory is not confined to the "accepted" specialists!

Purely out of curiosity, I would be interested to learn how you came to be interested in this field. Perhaps as a "spin off", I could imagine that the responses of astrophysicists, confronted with a paper by an "outsider", might in themselves be an interesting topic in the social sciences! (Though significant statistics would be hard to achieve.)

Once more, many thanks for your interest.

Yours sincerely

I. Pauliny-Toth

(Dr. I. Pauliny-Toth)

Los Alamos Los Alamos National Laboratory of the University of California
Los Alamos, New Mexico 87545

March 2, 1987

Professor Paul W. Dixon
Professor of Psychology
College of Arts and Sciences
University of Hawaii at Hilo
Hilo, Hawaii 96720-4091

Dear Professor Dixon:

My reaction to your paper is well expressed by the comments of Carlo Rubbia which you so graciously included with your letter. You have indeed drawn some novel inferences from the literature.

Sincerely,

Siegfried S. Hecker
Director

10 DOWNING STREET
LONDON SW1A 2AA

6 April 1983

Dear Professor Dixon

The Prime Minister has asked me to thank you for your recent letter and the enclosure.

Yours sincerely

Professor P W Dixon
University of Hawaii
College of Arts and Sciences
Social Sciences Division
Hilo
HAWAII 96720-4091

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Dr. Paul W. Dixon
University of Hawaii at Hilo
College of Arts and Sciences
Social Sciences Division
Hilo, Hawaii 96720-4091

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Dixon:

The following is provided in response to your Letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential impacts of irradiation on papaya and other products likely to be tested at the proposed facility and potential impacts of natural hazards, such as tsunamis, earthquakes and lava flows on the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 12 1988

1. AHHK
2. GZL/KY

Dr. Robert L. Lawyer
493 Ocean View Dr.
Hilo, Hi 96720
(808) 969-1569

April 10, 1988

Maurice Kaya
DBED- Energy Division
335 Merchant St. Rm 110
Honolulu, Hi 96813

Dear Mr. Kaya:

More than three decades of government promotion, research and financial support for the nuclear electric power industry has been wasted. Three decades of experience has convinced the private sector that the costs of nuclear power outweigh its benefits. Not a single new commercial electricity generation facility of the nuclear type has been planned or ordered during the 1980's. The major factors contributing to the demise of the nuclear electric industry included:

1) unforeseen safety problems,

2) unforeseen opportunities for human operator error,

3) unforeseen design flaws, and construction flaws due to human sloth or error even where design was appropriate,

4) unforeseen problems in disposing of spent fission source materials, as well as with other parts of the plant which become radioactive via operations (e.g. shielding, materials to hold the fission source materials in place, cement flooring and the structure itself),

5) unforeseen dramatic escalation of costs in futile attempts to resolve the first four items above.

Papaya irradiation is assuredly a distinct technology from power generation, a horse of a different color, if you will, but a nuclear horse nevertheless. The five factors listed above are

all relevant to the proposed papaya irradiation facility, and should be addressed.

I, personally, favor nuclear weapons, and would not fear eating an occasional irradiated papaya, but I am appalled that my state and county representatives would:

1) Play with such a very hot fire;

2) Experiment physically with the firms, land, wildlife, and also, psychologically, with the people of the Hilo area;

3) Imagine that they and the meager financial resources (a few $ million) tendered from federal sources for this experiment could satisfactorily resolve the five unforeseen factors which the massive nuclear electric industry ($ Billions per installation) together with the ACE, the NRC, the TVA and the Departments of Energy and Defense could not.

A partial list of some of my more serious concerns which the EIS on the papaya irradiation facility should specifically address follows. These concerns are grouped into five categories:

I. Routine Operational Safety Concerns

II. Extraordinary Event Safety Concerns

III. Concern for Economic Impacts on Papaya and Other Hawaiian Industries.

IV. Decommissioning Concerns

V. Concerns about the Unforeseen

I. Routine Operational Safety Concerns

1) Need for automatic, continuous, real time radiation monitoring system on site. This system should detect both gamma particles, hence faulty shielding; as well as alpha and beta radiations, hence faulty radiation source material containment structures.

2) Need daily, manual, back-up monitoring of facility by expertly trained and superbly motivated, independent (not employed by the firm operating the facility) personnel, with particular attention to those portions of the plant where we all hope no radiation will ever be detected (e.g. loading docks, parking lots, offices, break and restrooms, lockers, surface and ground water downstream from plant, sewage system, etc.)

3) Need investigate and estimate the size of any pay premium facility workers might demand as compensation for risk or perceived risk.

4) Need expertly trained, and more problematic, superbly motivated operators.

5) Much more problematic, is the need for a management system or structure which will encourage, rather than suppress, the reporting of, and positive response to, major or minor irregularities of procedure, operations, or facility status.

6) Need systems to minimize and monitor the transport of low level radioactive materials off-site by a) insects, b) rodents, and c) birds, which would all naturally be attracted by the presence of fruit.

7) Need estimate the dollar value of stress on people working or residing in neighboring areas (say within 1-2 miles) of facility.

II. Extraordinary Event Safety Concerns.

1) Need to a) identify all foreseeable "nonroutine events" (things which might go "wrong" in the radiological sense); b) estimate probabilities for each of these foreseeable events; c) estimate all economic consequences for all business, residence, and other properties, of each of these nonroutine events; d) estimate all human physical and mental health consequences of each of these events; e) estimate general environmental consequences of these events; and f) estimate all costs or expected costs associated with any of these consequences, their prevention and/or mitigation. g) Particular attention should be given to applying the above six steps (a through f) to the spectrum of worst case scenarios. My own concerns are not limited to: gamma ray source material (cesium, cobalt, etc.) transport mishaps; aircraft impact with irradiation facility; flood, earthquake, tsunami or volcanic destruction

of facility; minor human error (no release off-site, but facility and operators contaminated); major human error (material escapes facility, public and/or environment contaminated); sabotage by individuals or groups, foreign or domestic, rational or otherwise; and combinations of these.

2) Need map the surface and underground water flows makai from the plant to the sea for the water soluble gamma ray source material (cesium), so that impacts of release can be estimated.

3) Need contingency plans for evacuations, medical treatments and cleanups for those scenarios which are foreseeable, with more attention given to the worst case outcomes.

III. <u>Concerns for Economic Impacts on Papaya and other Hawaiian Industries</u>

1) Need estimate the impact this experiment would have on the demand for papayas under three different scenarios of market acceptance by the hysterically radiophobic publics in California and Japan (markets downwind or downdrainage from Three Mile Island or Chernobyl may safely be neglected).

(i) Irradiated papayas are credibly labelled.

(i) Papayas are labelled, but nonirradiated papayas are rumored or otherwise believed to be irradiated also.

(iii) Papayas are not labelled, so that all papayas are suspect to a public paranoid of radiation.

2) Need estimate the impact of this papaya experiment on the demand for all other Hawaiian produce under scenarios (ii) and (iii) above (sugar, nuts, coffee, beef, fish, fruit, juice, vegetables, etc.)

3) This EIS should contain legal findings assigning liabilities in the event that the papaya or any other Hawaiian industry is reputationally or otherwise commercially harmed by this experiment or its proposal.

4) Need evaluate all less desperate alternative fruit fly larva control options, including that of the status quo, and compare these in benefit net of cost with the proposal for an irradiator.

5) Economic impact on tourist industry of the image of Hilo, and the Island, as home of a nuclear facility (the irradiator).

6) Since the irradiator is a first step towards broader development of the Island as a good location for other nuclear industries (production and processing of medical, electronic and other goods and devices incorporating radioactive components), the cumulative, long term impacts of such broad scale nuclear development should be considered now, at the start, before this long term development begins, <u>even though no specific projects other than the irradiator are considered or proposed at this time.</u>

IV. <u>Decommissioning Concerns</u>

1) Need clear assignment of responsibility and liability for decommissioning and all its cost.

2) Need contracts, before project proceeds, which guarantee where all radioactive materials (gamma ray source materials, materials supporting these, flooring, building structure, etc.) will be accepted when facility is decommissioned.

3) Need estimate of all costs of decommissioning including disposal of:

   a) gamma ray source material (cesium, cobalt, etc.?)

   b) source material containers and support structures

   c) fruit containers which enter gamma ray portion of irradiator

   d) conveyor system

   e) shielding materials

V. <u>Concerns about the Unforeseen</u>

1) Need real, creatively imaginative, expert effort to identify some of the presently unforeseeable, i.e. to find scenarios which are possible but have not yet occurred to anyone. In my judgement, this is where funds for studying this proposed experiment will earn their highest return. A non-trivial

sum should be invested here. Truly imaginative experts are scarce and will not be cheap.

The opportunity to state my concerns regarding this proposed facility, and to have them addressed in the EIS, is greatly appreciated.

Sincerely,

Robert L. Lawyer

Robert L. Lawyer, Ph.D.,
Resource and Environmental Economics

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Dr. Robert L. Lawyer
493 Ocean View Drive
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Lawyer:

The following is provided in response to your letter of April 10, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable state regulations, the potential environmental impacts of the proposed Hawaii Commodities Irradiation Facility will be described and discussed and proposed mitigation measures designed to minimize potential adverse impacts included in the EIS. Also to be included in the EIS will be discussions of the design and operational safety measures to be taken to prevent radiation accidents, the procedures that would be followed during the transportation and decommissioning of the facility and the economic factors associated with the proposed treatment method. The concerns raised in your letter will be dealt with in detail.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

By Leslie Patrick
General Delivery
Pahoa Hi. 96778

APR 25 1988
MHK

To whom it May Concern:

2)

A Voice against Mass Suicide
A Voice against the Dark.

Is IT the dark ages we are about to so vilely thrust upon ourselves again?

WE - As a PEOPLE - Better Ask this most vital Question

OR ELSE ———
our FOOD, WATER - AIR - EarTH all around us
Has & might Become totally Poisoned to reek not only sickness & it's slow lurching death - NON-EXISTENCE of ALL LIVING THINGS!!!

Let's take this to the Supreme Court!
or do we yet realize the seriousness & violation toward All Life forms they are about to perpetrate upon us!!
WE MUST RAISE Questions, for questioning our very right to life IS AT STAKE -
& Some Have Eyes to SEE THIS!
For The Life of ALL man- & Living kind IS At Question!

or don't we yet want to realize this?

I have to tell my little 4 year old daughter, Well, They're going to irradiate and poison a lot of the food we live on, & we're going to have to either stop eating, try to stop Them, leave, or try to find & grow only food That hasn't been irradiated. For no matter what they believe, we know it is bad & will be poisonous & uneatable to us, & we do not want to starve, So what can we do?

Have They thought what we're all gonna do when our food, water, air, ground sources are too poisoned to use
There IS Enough scientific evidence to at least warrant serious & sufficient question to stop this. If I can't stop This along with others what other resource do I have but to leave this country & become directly involved in government so it doesn't happen where I go to, tell where I'm going exactly why I left. Don't you realize how this is contributing to the death principle so rampant & prevalent today trying to kill us all off. Or can't you see this 'trend' afoot and abroad, not everywhere one looks, even within, for there one encounters much sickness to flea
Don't be fools. Don't cause massive food shortages, & if there is even the remotest chance That you might be seriously damaging anything, why for God's sake, risk it. Please do not continue to support the death principle. Leslie Patrick

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Leslie Pollock
General Delivery
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Pollock:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential health and safety factors associated with the proposed irradiation facility; potential impacts of the proposed facility on the natural, social and economic environment and potential effects of irradiation on foodstuffs will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 25 1988
1. MHK
2. G-UL/[illegible]

P.O. Box 367
Volcano, Hawaii 96785
April 21, 1988

Maurice Kaya
DBED - Energy Division
335 Merchant Str. Rm. 110
Honolulu, HI 96813

Subject: EIS for Irradiation Facility, Hilo, Hawai'i

ACCIDENTS:

1) What would be a worst case scenario for an accident in a food irradiation facility? For an accident in transporting the radioactive substances over 2,000 + miles of ocean and on land and seas arcund our state?

2) What are the risks to the surrounding community, my friends in Keaukaha? to beachgoers, fishermen, canoe-paddlers and others who use the ocean near the proposed facility site?

3) How long would contamination of ground water last?

4) What are the costs of clean-up for radioactive spills and who will be paying the costs of clean-up?

5) What are the emission standards and other health and safety standards for a food irradiation facility? Do the standards take into account the unique risk factors of the Big Island: tsunami inundation, earthquakes, lava flows and plane crashes?

6) How long have food irradiators been operating? Are any of them built in areas at risk from tsunamis, earthquakes, lava flows, next to airports?

7) Has the health of irradiation or nuclear power plant workers been assessed for long-term health risks? (for 5, 10, and 20 years or more of exposure)

8) Has the health of residents living near irradiators or nuclear power plants been monitored to determine the presence or absence of any long-term health effects?

9) . Will the State of Hawai'i be conducting long-term comprehensive health assessment of plant workers and the community surrounding an irradiation facility? Who will pay these additional costs?

ECONOMIC FEASIBILITY

10) How does the cost of irradiation compare with alternatives including dry and wet heat processing?

11) Where is the study proving there's a market for irradiated

1

fruit? (Lichees -- all they can send --- are already shipped overseas to Canada from Hilo by one wholesaler I know personally. He doesn't need an irradiator to increase sales; he needs more lichee.)

OTHER PUBLIC COSTS:

12) Who will be paying for the upkeep and maintainance of the facility?

13) What are the risks and costs of accidental dumping of the radioactive materials on their 2,000 + mile jour ney here?

14) Who will train the physicians and public safety workers in handling radioactive contamination? Who will pay for the initial training and continuing in-service training to keep public safety workers prepared? (Our County has had a very difficult time dealing with sewage and garbage; I'm very skeptical about their being competent to handle spills of the most dangerous substances known to humans.)

ALTERNATIVES TO PAPAYA IRRADIATION

15) What are the alternatives to an irradiation facility that have been considered?

16) Has the State of Hawai'i ever supported a comprehensive program of fruit fly eradication? If other places have been able to eradicate the fruit fly, why not Hawai'i?

17) Have any market studies been done of dried, canned and bottled papaya products?

While I sympathize with the plight of the papaya growers and wholeheartedly support diversified agriculture, I cannot agree that the success of the papaya industry hinges on an irradiation facility and I resent the audacity of government demanding that we rush into using what is still a very controversial technology.

How can this EIS possibly adequately address the many, many issues of public health and safety when not just citizens here, but many others across the country and Congressional delegates are also questioning the adequacy of FDA's approval of food irradiation? Wouldn't it be prudent and in our own best interests for the State of Hawai'i to push for Congress to fund the proper, careful studies of this new technology by a non-biased research group, such as the National Institute of Health, instead of blundering ahead with this technology while a lot of questions about its use remain unanswered?

Sincerely yours,

Mary Mino Finley

Mary Mino Finley

2

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mary Miho Finley
P. O. Box 367
Volcano, Hawaii 96785

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Finley:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, transportation and storage of the radiation source (Cobalt 60) relative to the proposed irradiation facility; potential impacts on groundwater supplies and risks to surrounding areas; emergency and safety measures that will be taken during design, construction and operation of the irradiation facility; health and safety standards applicable to the proposed facility; health, safety and inspection actions to be taken during the operation of the facility; economic aspects of the proposed facility; marketability and consumer acceptance of irradiated foods; proposed operation and maintenance plans, including assignment of costs for the facility; disposal of the radiation source; training programs; and alternative methods of treatment will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 25 1988
1. MHK
2. [illegible]

Helga Keicher Costello
Star-Route 5077
Keaau, Hawai'i
96749

2. Environmental Impact Statement on Commodities Irradiation Facility.

April 19, 1988

Maurice Kaya
DBED - Energy Division
335 Merchant Street, Rm. 110
Honolulu, Hawai'i, 96813

Dear Mr. Kaya;

Because of the disastrous accident at the Hawai'i Development Irradiator and its far reaching radioactive contamination of the ground and the public sewer system I request the following concerns to be covered by the Environmental Impact Statement on the Commodities Irradiation Facility:

1.) What would be the result of radioactive contamination of groundwater? How long would it last? How would it be cleaned up? Where would clean-up-wastes be deposited?

2.) What are the radiation hazards to residents in the surrounding communities of the facility? What are the radiation hazards to workers. What are the allowable emission standards?

3.) Where and how would injured residents/workers be treated in the event of an accident (worst case) at the plant or while shipping radioactive materials through our communities?

4.) How is irradiation economically feasable? Where are the markets for irradiated papapayas? What about consumer boycott?

5.) Why did the State of Maine outlaw the sale of irradiated food?

Sincerely,

Helga Keicher-Costello

Copy to: East Hawaii Coalition to Stop Food Irradiation.

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Helga Keidie Costello
Star Route 5677
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Costello:

The following is provided in response to your Letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential impact of groundwater contamination; potential radiation hazards to nearby residential and industrial area; plant design and operational safety measures; insurance and liability issues; radiation source transportation factors; economic factors associated with the proposed facility; marketability and consumer acceptance of irradiated products; and actions taken by other political jurisdictions will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

April 17, 1988 APR 25 1988

1 MHK
2 6 - / BJ

Maurice Kaya
DBED Energy Division
335 Merchant St.
Rm 110
Honolulu, Hi 96813

Dear Mr. Maurice Kaya,

I am writing this letter to express my concerns regarding the proposed food irradiation facility on the Big Island of Hawaii.

I would like further investigations into previous accidents at the following irradiation facilities: The Hawaii Development Irradiator, International Nutronics Inc., Isomedix, Radiation Technology Inc. and Radiation Sterilizers Inc.

In 1966, the Atomic Energy Commission (now the Dept. of Energy) released a report called "The Genetic Effects of Radiation." Please include these findings in the Environmental Impact Statement

Is irradiation economically feasible? Why is there so much national and international objection to food irradiation? Why has the State of Maine outlawed the sale of irradiated food?

(2)

Was the FDA wrong to approve irradiation in the processing of food? Evidence is accumulating from respected scientists that challenges this approval.

What are the radiation hazards to workers and the residents in the surrounding community? What are the allowable emission standards?

What would be the result of radioactive contamination of ground water? How long would it last?

From the overwhelming scientific data proving that low doses, moderate doses and large doses of ionizing radiation cause cancer, leukemia, and birth defects, I ask the EIS why would we consider such an experiment?

Please investigate and respond to these concerns for the Environmental Impact Statement.

Thank you

Sincerely yours,

Randal Lee

Randal Lee
P.O. Box 943
Pahoa, Hi. 96778

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Randal Lee
P. O. Box 943
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Lee:

The following is provided in response to your Letter of April 17, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, safety issues relative to the design and operation of the proposed irradiation facility; information relative to the potential effects of irradiation on food stuffs and consumers; economics; marketability and consumer acceptance of irradiated products; actions taken by appropriate regulatory and enforcement agencies regarding irradiated food products; issues relative to worker safety; potential impacts of radiation on groundwater supplies; and the need and purpose of the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 22 1988

Geoffrey R. Last
Homeowner Voter
Leilani Estates
Pahoa Hi 96778

Mr. Maurice Kaya
DBED
Energy Division
335 Merchant St Rm 110
Honolulu Hi 96813

Dear Mr Kaya,

I am writing in regards to the irradiation facility proposed for Hilo Hawaii. As a resident, homeowner and concerned voter I have a few questions I feel need to be answered.

① In case of an accident what would happen to our ground water here in East Hawaii? Air?

② How economically feasible is this facility? Cost effective answers. All costs

③ Is there a market? Will people buy a controversial product? Is there any health risks or nutritional value in irradiated fruit?

④ What is wrong with other methods of treatment of Fruit? Vapor method?

I guess the answer to these questions is not so much what is good for the people of Hawaii but politics. D.O.E. wants to find a use for their waste material and will go to any means to achieve their ends. You as a legislator should ask yourself, if you can without worrying about your job, what is really good for Hawaii? Do we want to bring this proven poison into our beautiful enviroment? Are you going to listen to a bunch of bureaucrats tell you or pressure you into doing something as ridiculous as bring radioactive waste into your state? Common Sense! Think about it. What in Gods name is wrong with Vapor Heat? Tell me I want to know!

Sincerely my vote will count!

Geoffrey R Last

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. Geoffrey R. Last
Leilani Estates
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Last:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential impacts of the proposed irradiation facility on groundwater supplies and air quality; economic aspects of the proposed facility; marketability and consumer acceptance of irradiated food products; alternative treatment methods; and radiation source transportation, storage and disposal will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 22 1988
1. MHK
2. cc/BY

P. O. Box 1975
Pahoa, HI 96778
April 20, 1988

Maurice Kaya
D.B.E.D.--Energy Division
335 Merchant St., Room 110
Honolulu, HI 96813

Re: Commodities Irradiation Facility in Hilo, Hawaii

Dear Mr. Kaya:

It is my understanding that the Environmental Impact Statement for a commodities irradiation facility in Hilo is now being prepared. As a resident of the Big Island, I am interested in this development and wish to ensure that the following concerns are properly addressed in the E.I.S.

1) DESIGN INTEGRITY

What levels of radioactive release to the external environment are considered acceptable? What design features are envisaged to ensure that these levels are not exceeded under normal operating conditions and under severely upset conditions which include:

a) Hurricane conditions (with wind speeds exceeding 200 km/h.)
b) Earthquake conditions (exceeding 7.5 on the Richter Scale.)
c) Fire
d) Sabotage.

2) DECOMMISSIONING PROCEDURES

What methods are proposed for the final disposal of the radioactive source and any ancillary equipment rendered radioactive by prolonged exposure to the source?

If disposal within Hawaii is envisaged, the location and method of disposal must be carefully elucidated. If it is proposed to dispose of this radioactive waste in a mainland site, then serious consideration must be given to the feasibility of obtaining a firm contractual agreement that will remain binding in future years.

3) INSURANCE COVERAGE

What type of insurance coverage is proposed to compensate residents affected by inadvertant radioactive release, however small the risks are expected to be for this type of occurrence?

Yours truly,

Raymond G. Carr, Ph.D.
Metallurgical Engineering

cc: Rep. A. Levin
R. Kokubun

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Dr. Raymond G. Carr
P. O. Box 1975
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Carr:

The following is provided in response to your letter of April 20, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the design and operational safety measures that will be taken with the proposed irradiation facility; potential impacts due to natural hazards including earthquakes, tsunamis, lava flows and severe storms; decommissioning actions, including storage and disposal of the radiation source (Cobalt 60); and the issues of insurance and liability will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 20 1988

Maurice Kaya
DBED - Energy Division
335 Merchant Street
Honolulu, Hawaii

Re: EIS Commodities Irradiation Facility, Hilo

We, the residents of the Keaukaha area, represented by the Leleiwi Community Association and the Keaukaha-Panaewa Community Association, live within three miles of the proposed irradiation facility planned to be built near the Hilo Airport. There are 150 homes and 600 condominium units with over 2000 people residing in the Leleiwi-Keokea Loop Road area. There are 425 homes in the Keaukaha area and 100 homes in the Panaewa area with over 1600 people residing there, all on Hawaiian Home Lands.

This is also the most popular area of the Hilo District. Hundreds of people visit this shoreline daily for recreation and sustenance. We believe, therefore, that it is imperative to protect and preserve this area from contamination of any kind, not just for ourselves, but also for future generations.

We believe there are many concerns which the government has not fully answered or has answered vaguely. In addition is the large question: Is it fair to risk the lives, health, and welfare of long time residents for the questionable economics of another small, select group?

We would like the following questions answered comprehensively in the Environmental Impact Statement for the Commodities Irradiation Facility of Hilo:

1. The island of Hawaii is geologically unstable with verified earthquakes. What was the largest earthquake on record and when was it? How big an earthquake will the facility withstand? What proof is there?

2. Hilo has had highly damaging tsunamis in recent history. Can it be predicted what area they will effect, the size, and what kind of damage will be caused? What about off-shore earthquake generated tsunamis?

3. It is a fact that accidents have happened in irradiation facilities and they will happen in the future. What training and equipment should emergency services have? Who will pay for this? What methods of evacuation will be used. What techniques will be used for cleaning the area contaminated and restoring the health of the residents. How long would the residents be forced to leave their homes?

4. What would be the result of radioactive contamination of ground water? Would it go into our drinking water? Our shoreline waters? Would it effect the fish? Who would it effect? How long would it last? How would it be cleaned up? What would be the cost of clean-up? Discuss both Cobalt 60 and Cesium 137.

5. The Island is an active volcano with high natural emissions of toxins. Is it a good health practice to increase the emission to an even higher level? What is a safe level of emissions? How is that determined? How will that be controlled or monitored? Who will pay for this? What is the basis you use in determining a safe level?

6. How much radiation emission will be allowed outside the facility? How does this compare to a nuclear power plant?

7. How many people will be exposed to radiation going to and from the airport? What mental attitude will people have knowing the facility is there?

8. Should an irradiation facility be built near an airport or populated area? Why? Besides safety, what about interference with airport-aircraft signals?

9. What USA states, cities, workers unions, supermarket associations, consumers unions, scientists, and international countries oppose and/or ban irradiated foods or facilities? Why? What did our Hawaii Island Mayor's Poll show?

10. Is there any insurance company that will cover any radiation accident to individuals, property or business? If not, is not that a clear indication of the extremely high risk involved in a nuclear industry? Has not the government put a limit on the amount of liability? How then will damages be compensated and by whom?

11. Will Cobalt-60 or Cesium-137 be used? What is the difference? Give justification for the use of each? How much radiation dosage will be used?

12. What is the cancer rate for workers in present radiation plants?

13. What will be the effect on property values around the irradiation facility? What is the basis of your evidence?

14. Is irradiation of foods really needed. What are the other methods used? What is the cost comparison, including insurance, compensation, risk, health, clean-up, transportation, storage of materials and foods, research, facility installation and cost of "educating" the public to accept irradiation.

Leleiwi Community Assoc.
Janette M. Moon, Director

Keaukaha-Panaewa Community Assoc.
Stephen Kalauli, President

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Janette M. Moon, Director
Leleiwi Community Association
and
President Keaukaha-Panaewa
Community Association
121 Lokoaka Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Moon and Madame President:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the health and safety aspects of the proposed irradiation facility; potential impacts of natural hazards including earthquakes, tsunamis and lava flows on the proposed facility; emergency and safety measures that would be employed during the design, construction and operation of the proposed facility; potential impacts on groundwater supplies; radiation source (Cobalt 60); air quality aspects; potential radiation leakage; marketability and consumer acceptance of irradiated food products; insurance and liability issues; purpose and need for the facility; economic factors associated with the proposed facility; and the transportation, storage and disposal of the radiation source will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 19 1988

1. [illegible]
2. [illegible] 1/13

MOKU · LOA · GROUP

SIERRA CLUB • HAWAI'I CHAPTER

Mr. M. Kaya
Dept. of Business and Economic
Development
Energy Division
335 Merchant St., Rm. 110
Honolulu, Hi 96813
April 17, 1988

The Moku Loa Group of the Sierra Club requests to be a consulted party in the matter of the Hawaii Food Commodities Irradiation Facility planned for the General Lyman Field, Hilo, Hawaii.

We wish to submit the following questions for the EIS scoping process and further want them to be included in the Draft EIS.

SAFETY

What is the worst case scenario for a fire in the facility? Does the local Fire Dept. have the knowledge and the equipment to deal with that event? What would be the risk to Keaukaha and the exposure of the airport?

What is the risk of siting the facility near the Hilo airport runway? Does the airport have air controllers that direct night flight activities?

What traffic growth/load is expected at the Hilo Airport during the life of the facility?

Is the facility in the glide path of helicopters? What is the risk of helicopter accidents affecting the facility?

What is the worst case scenario for terrorism for the facility? What counter measures are there and what will be implemented for the security of the facility?

How far is the facility from the seashore and what will be the effect of salt corrosion on the facilities?

What contaminated materials could be produced from the facility under "normal" use and "worst case scenario"? Where would the contaminated materials go in either case? Would any contaminated clothing be generated? Where would it be disposed of?

P.O. BOX 1137 · HILO · HAWAII · 96721

Identify what NRC and State regulations would govern this facility?

How often will this facility be inspected by State and Federal regulators? Who has expertise on the State level?

ECONOMIC ISSUES

Has any irradiator been subject to insurance claims litigation? Are there any Federal or State laws limiting liability regarding claims against irradiators?

What is the potential impact of this irradiator to the existing non- radioactive papaya treatment facilities?

How many jobs would be lost be within the papaya industry be if the irradiator is the dominant method of fruit fly infestation control?

What would become of the facility should a widespread boycott occur and the papaya growers decide not to use the facility?

What is the long term impact on the Hawaii papaya industry if there is a negative association regarding irradiation?

Could the industry recover after a successful boycott of irradiated foods?

What is the cost of dismantling the facility at the end of its life? What is the procedure? Who will pay for it?

Thank you for the opportunity to provide these questions.

Deborah Ward
Deborah Ward
for the Conservation Committee

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Deborah Ward
Moku Loa Group
Sierra Club, Hawaii Chapter
P. O. Box 1137
Hilo, Hawaii 96721

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Ward:

The following is provided in response to your Letter of April 17, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, safety issues relative to fire, potential aircraft accidents, traffic, security, construction materials, potential contamination outside the facility, regulatory and enforcement agencies and inspections; and economic issues related to liability and insurance, potential impacts on other types of treatment methods; types and numbers of jobs that would be created and potentially lost, market acceptance of irradiated products and decommissioning of the facility will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

04/18/88 APR 19 1988
9R5664
Keaau 49, Hawaii

Maurice Kaya
DBED-Energy Division
333 Merchant St., Rm. 110
Honolulu, Hi. 96813

Dear Folks,

I have perhaps a silly question concerning a papaya irradiation plant in Hilo or Kona. But so far none of my silly friends have had an answer for me, so I want to ask someone in the know.

Maybe 2 months back, Hilo Tribune Herald sunday feature focus on Agriculture, an article about Vapor heat Treatment of Papaya + other fruit. Article said they have been low key while testing this method, but now tests have been completed and method has been proven entirely satisfactory.

I understand the vapor heat method is considerably cheaper than irradiation. It is, as far as I know, non controversial, and will trigger no consumer resistance. All this keeps money in Hawaii's pocket.

If these facts are correct, why in the world would any one in Hawaii still want papaya irradiation?

I have heard the federal government needs a dumping place for their radioactive wastes and if this is correct then it may explain why Washington is pushing the idea. OK they got a legitimate interest. But what's the interest of the County Government and the Papaya Grower's Association who still are supporting irradiation and financial death?

Yours Truly,
[signature] Fulks

C-104

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 17, 1988

Mr. Ollie Fulks
SR 5664
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Fulks:

The following is provided in response to your letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, alternative treatment methods; radiation source disposal; and governmental and private agency interests in the proposed irradiation project will be described and discussed in the EIS.

The purpose of the public informational meetings that were held in Honolulu and Hilo on May 3 and 4, 1988 respectively, were to allow the public another opportunity to indicate the concerns and issues that should be addressed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

Theodore W. Brazeau
SR 6430, Ka'au, Hawai'i 96749

APR 19 1988
1. MHK
2. G-ɩc/ɩɩ

April 14, 1988

Maurice Kaye
DBED - Energy Division
335 Merchant Street, Room 10
Honolulu, Hawai'i 96813

Dear Mr. Kaye:

I am writing in connection with the Environmental Impact Statement on the proposed irradiation facility in the Big Island.

1. Such a facility competes with and prevents the development of other, safer, technology. Why not promote the safest methods?

2. The nuclear industry has a decades long history of disregarding the safety of the public, and of being less than truthful. There is no reason to assume they will change now. How can we trust them or believe what they tell us?

3. The extreme dangers of earthquakes, tsunamis, lava flows and ocean storms are so clear and present that considering any single one of them should be enough to kill the project. How can these hazzards be effectively guarded against?

4. Any such facility, radioactive or not, should not be funded by the taxpayers. Why should taxpayers fund controversial and dangerous projects for private businessmen?

5. There is an ever present danger in any radioactive material: in its transport, its use or in its just sitting there. There is potential for horrible deaths, permanent contamination of large areas and for economic disaster. How can this risk be, not lessened, but eliminated?

6. The risks would not be worth it even with an assured and lucrative market. Such a market does not exist and it is doubtful that it ever will. Japan and most of Europe will not accept irradiated products; there may be Federal legislation banning or delaying their marketing in the United States; most large supermarket chains even now will not accept them; protests are already organized on the mainland to weaken what little market there is. Why should this facility, with all its accompanying physical dangers, be built on speculation?

7. By association, the backlash against irradiation may harm the marketability of other Hawaiian products. Why risk an economic and environmental disaster for so little gain?

Please do not allow this to be done to this beautiful island.

Yours sincerely,

Theodore W. Brazeau

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Theodore W. Brazeau
SR 6430
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Brazeau:

The following is provided in response to your Letter of April 14, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, alternative treatment methods; facility design and operational safety factors; natural hazards of earthquakes, tsunamis and lava flows; facility funding; radiation source transportation factors; product marketability and acceptance issues; and the economic factors associated with the proposed irradiation facility will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 20 1988

1. [illegible]
2. GCL/[illegible]

2

Betty J. Eade
P.O. Box 128
Pahoa, Hawaii 96778
Telephone 965-9458

Mr. Maurice Kaya
DBED
Energy Division
335 Merchant St. Room 110
Honolulu, Hawaii 96813

18 April 1988

Re: Hilo Irradiation Facility Proposal

Dear Mr Kaya,

While we have been silent up until now, regarding the proposed Hilo food irradiation facility, we now feel, with the recent pending approval, we must speak in proposed opposition to this project and take the time to ask some of the questions which require serious and thorough answers. We speak also for friends and neighbors who are not taking the time to write. Would you be so kind as to inform us.

What is the market for irradiated produce, when people all over the country are leary of its effect on food value?

What will be the hazards to plant workers and nearby residents?

What will be the result of radioactive contamination of our groundwater? What is the life of the radioactivity?

What precautions will be taken to protect the plant from earthquakes and earth movements from tsunamis or volcanic activity? How could they be effective?

In a State where pristine beauty and a healthy environment are our main entity both for our residents and in broader economic terms, is this really a desirable addition to our Big Island? And is it truly economically feasible?

Does your office realize and duly recognize the extent of resident opposition to this irradiation facility for ecological, economic, aesthetic and health related reasons? Do you realize the extent of consumer awareness of irradiation?

I will look forward to reviewing thoroughly the forthcoming Environmental Impact Statement, and wish to reiterate our strong opposition to the building of this or this facility anywhere in Hawaii. I am in favor of the Vapor Steam Method for our papayas.

Betty J. Eade

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Betty J. Eads
P. O. Box 128
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Eads:

The following is provided in response to your Letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, marketability and public acceptance of irradiated products; potential plant and worker safety issues; potential groundwater contamination; safety measures relative to design and operation of the proposed facility and protection against natural hazards, including tsunamis, earthquakes and lava flows; the need and purpose of the proposed facility; economics associated with the proposed facility; and public concerns regarding the proposed facility will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 21 1988

1. [illegible]
2. [illegible]

Hawaii Tropical Botanical Garden

A Non-Profit Foundation
Nature Preserve and Sanctuary located at Onomea Bay

Office - 248 Kahoa Road • Hilo, Hawaii 96720
Telephone: (808) 935-4703

April 18, 1988

Certified Return Receipt Mail

Mr. Maurice Kaya
DBED-Energy Division
335 Merchant Street, Room 110
Honolulu, HI. 96813

Dear Mr. Kaya:

Following are some of my concerns regarding the Food Irradiation Facility proposed to be established in Hilo, Hawaii. It is requested that the EIS consider these concerns and respond with answers:

1. I believe it is absolutely necessary that an in-depth study of the overall economics of this proposed irradiation facility be prepared, to include but not limited to, the financial benefits to the County of Hawaii, as well as to the papaya industry, including the cost of construction, costs of operations, production costs and production revenues, costs of construction overruns, if there are shortfalls in production versus revenues, who will pay for the deficits, and who will provide and pay for insurance costs. All of the above should be toward the final and conclusive answers of: Is it truly to the benefit of the County of Hawaii and its taxpayers? Is the facility truly to the benefit of the papaya industry? I have not been able to locate such an all-inclusive economic study that addresses these factors.

2. Who will operate the facility? The Federal Government, the State, the County, or private industry?

3. Will the facility be operated as a business; i.e., for profit? To break even? Or is a loss anticipated and if so, who will continue to fund the losses? The taxpayers? The papaya industry?

4. Who will assume the potential liabilities connected with the following, and are these liabilities insurable?

   A. the transportation of radioactive materials to and from the site;

   B. injury to the public and to workmen at the facility for any reason whatsoever, to include accidents, human failure, and/or Acts Of God.

5. Who would assume the legal liability and who would pay for the salvage and cleanup costs in the event of accidents? The taxpayers or the papaya industry?
   For examples:

   1. What if a transporting barge sinks and the radioactive substances are on the bottom of Hilo Bay or on the ocean bottom off the coast of the County of Hawaii?

   2. A transport truck has an accident and radioactive materials are spilled on County roads or State property?

(cont'd.)

C-110

   3. Workmen at the facility cause an accident or there is a mechanical failure and the facility and its surrounding ground area or water table are contaminated?

   4. Who will assume the legal liability for workmen over-exposed to irradiation?

<u>ANY ONE OF THESE POTENTIAL ACCIDENTS COULD COST FROM HUNDREDS OF THOUSANDS TO MILLIONS OF DOLLARS !</u>

6. Have the papaya processing companies all agreed to use the facility if it is constructed?

   A. Which companies have agreed (by name)?

   B. Which companies will not use it because they presently use or plan to use methods other than the double dip process?

   C. What percentage of the total estimated Hawaii County papaya production is estimated to be processed through the proposed irradiation facility?

   D. Will the above percentage of total production be sufficient to effectively and economically operate the facility?

7. Will the "Operator" (be it County, State or private industry) of the proposed facility have written agreements with the papaya processors to guarantee that they will use the facility if it is constructed and made operational?

8. Why should the taxpayers be required to fund and help pay for the establishment of an irradiation facility which will benefit a private industry, and which facility will be in competition with a portion of the industry (those using other methods)?

9. <u>Survival Of The Papaya Industry:</u>

   To the best of my knowledge, the papaya industry has been surviving financially all these past years, and their production is expanding; all in spite of their problems with fruit flies.

   There are alternate methods being used, being developed and financed by the papaya industry to combat the fruit fly problem. If an irradiation facility were constructed, it would be at least four to five years from now before it were operational. In the meantime, the alternate methods would be more perfected and by then, possibly fully operational.

   There is a strong possibility that the irradiation facility would be <u>obsolete</u> by the time it was constructed and it may become another "White Elephant" paid for by the taxpayers. In addition, the City of Hilo and the public will be exposed to the potential dangers of severe radioactive poisons which are proposed to be used in the irradiation facility.

   <u>AN INACCURATE MARKET STUDY COULD DESTROY THE PAPAYA INDUSTRY !</u>

   The market study made to test the public acceptability to irradiated papayas <u>WAS A FARCE</u>. A very in-depth comprehensive study should be made of the public's acceptance of irradiated papayas. To the public, the name, "Hawaii", means clean and pure. The consumer public may associate the papaya industry of Hawaii and other Hawaiian-grown products with "Irradiation", and this could kill or greatly harm Hawaii's fruit and produce marketability. I have personally asked several hundred people

(cont'd.)

the simple question, "Would you eat or feed your family irradiated papayas?" - and 100% of the answers were "NO!" or "Absolutely Not!".

To move forward on an irradiation facility would be absolutely wrong, and a waste of taxpayer dollars, until such a market study were accurately made.

EMPLOYEE AND PUBLIC SAFETY

1. Who will be responsible for the safe operation of the facility? The Federal Government, State, County, private industry?

2. Will there be trained personnel available, and who will provide and pay for special equipment, protective clothing, etc., all necessary to be used in the event of radioactive spillage?

3. Regardless of the amount of money spent for preventionary measures, every mechanical device created by man has resulted in accidents, injuries and death, due to human failure - to include motor vehicles, airplanes, space rockets, ships, trains, and also a number of facilities using dangerous radioactive substances. Radioactive poisons are, by far, the most terrible poisons created by man. Why are we so sure an accident could not happen in Hawaii? Why do we want to bring these terrible poisons to Hilo and the County of Hawaii? Why does our Government want to spend in excess of Five Million Dollars of taxpayer money for an experiment which may or may not help the papaya industry; which industry, I am sure, will survive regardless of whether or not an irradiation facility is constructed?

TOURISM

Whether we like it or not, many people are, or become paranoid when you mention the word, "Irradiation". You may be sure that some tourists will "vacate", or not come to Hilo when they learn there is an irradiation facility in or near Hilo, and/or its airport. The disclosure or knowledge of such a close-by irradiation facility may have a bad influence on investors in tourism and other businesses.

To me, and to many other conscientious people who have taken the time to read and think about the true pros and cons of establishing an irradiation facility in the County of Hawaii, it would be absolutely wrong, and an injustice to the public, without first conclusively arriving at the answers to the questions and problems I have addressed in this letter. To the best of my knowledge, these questions have not been answered.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN

Dan J. Lutkenhouse
Founder & Director

DJL/pl

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Dan J. Lutkenhouse
Hawaii Tropical Botanical Garden
248 Kahoa Road
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Lutkenhouse:

The following is provided in response to your Letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the economic benefits and costs of the proposed irradiation facility; the ownership and operation of the facility; the business arrangement under which the facility will operate; legal and financial liability and insurance issues; radiation source transportation and disposal; plant design and operation safety measures and precautions; identification of users of the facility; alternative treatment methods; estimated product flow through the facility; funding, purpose and need for the facility; marketability and consumer acceptance of irradiated products; governmental regulatory and enforcement agencies that will be involved with the facility; employee training and safety requirements; and potential impacts of the facility on other industries will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

PO Box 432 APR 22 1988
Paauilo, HI 96776
April 20, 1988

Janice Kaya
DED - Energy Div
335 Merchant St, Rm 110
Honolulu, HI 96813

Dear Ms Kaya:

I've been following the irradiation saga from the onset, have read the CH2M Hill Feasibility Study carefully, and - after thinking about this project for the past 18 months - feel compelled to list my concerns in order for them to be included in the EIS. In order of incident these are:

1). Who will do the EIS? Is this firm experienced with food irradiation? Why were they chosen?

2) What will fuel the facility? Cobalt or cesium? What are the risks of both to human health and the environment? If cobalt alone is used (as has been called for by the legislature) how are we to know/be assured that cesium won't be substituted at some later date?

3) Who will actually operate the facility? A contractor? A state bureaucratic entity? A county entity? Who will actually manage the operation of the facility? At what cost (per annum)?

4) Who will inspect the facility to insure safe practices/adherence to safety procedures? Where are they located? How often will inspections occur? What are the qualifications of the inspectors? What will this cost?

(5) How will transportation and storage of fuels be accomplished? Who will supervise this? Who will inspect this? What are the criteria to be adhered to?

(6) Should an accident/incident occur, who will manage the crisis? How will this be accomplished? What are the qualifications of individuals/agencies concerned? Where are they stationed/located? How soon can they be on station? What is the risk to surrounding communities / the area / the island in general? What will be the alert notification procedures? How will compensation/indemnification be handled? Who will insure/assure the general population vis-à-vis the facility? Who pays the insurance premium? For how long? At what price? Who pays for the cost of cleanup?

(7) What is the total cost of the facility to the taxpayers of Hawaii? Please be sure to include all costs of construction, operation, maintenance, and liability?

8) What are the costs of constructing and operating an alternative facility(ies) such as - specifically - dry heat treatment? What are the pros and cons of dry heat vs irradiation in terms of costs? Why is the administration opting for irradiation instead of alternative treatment processes?

(9) What is the state's contractual agreement with the US Dept of Energy regarding the operation of this

irradiation facility? How do we get rid of it if we choose to do so? at what costs?

(10) In accepting the DOE-offered irradiation facility do we open the door to accepting nuclear wastes? How do we insure ourselves against this?

(11) What private capital — if any — will be included in this venture? How much? What terms? What is the total cost to the state of monitoring activities surrounding irradiation (ex: CH2MHill study, DBED's "Envision Hawaii", etc.)?

(12) What is the envisioned social, economic, and environmental impact if an accident/incident involving an (A) cobalt-fueled irradiator and (B) a cesium-fueled irradiator?

I realize that the answers to these and similar type questions will be developed carefully by the contractor performing the EIS (or the agency concerned) but I request an acknowledgement by your office that these questions have been received and will be addressed, and further request that such an acknowledgement be forthcoming not later than 21 days from now.

Thank you for your anticipated assistance.

Sincerely,

R.N. Williams

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. R. N. Williams
P. O. Box 432
Paauilo, Hawaii 96776

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Williams:

The following is provided in response to your letter of April 20, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the preparers of the EIS and their qualifications and experience; the radiation source (Cobalt 60); potential impacts of radiation leakage on the surrounding environment; the proposed plan of management and operations of the irradiation facility; the safety and inspection measures that will be employed during design, construction and operation of the facility; the transportation and storage of the radiation source; emergency procedures that would be followed should an accident occur; potential risks to the community as a result of damage to the facility due to natural hazards, including earthquakes, tsunamis and lava flows; insurance and liability issues; construction and operation costs; alternative methods of treatment; purpose, need and funding of the proposed irradiation facility; radiation source disposal; as well as all other applicable potential natural environmental, social and economic impacts that might result from the design, construction and operation of the proposed irradiation facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 12 1988

Mr. Maurice Kaya
DBED -Energy Division

THE BIOLOGICAL EFFECTS OF IONIZING RADIATION

No one seriously doubts the mountain of scientific evidence verifying the fact that ionizing radiation causes a wide variety of injuries to the health of human beings. Many of these injuries are either fatal or guarantee a life of misery. They include cancers, leukemias and chromosome damage. Although for years the nuclear industry has assured us that low doses are harmless; scientific analysis has shown time and again, that even minute amounts of ionizing radiation are carcinogenic and mutagenic(to illustrate, a MICROCURIE, one millionth of a curie, of any radionuclide emits 37,000 disintegrations per second, only one of which is sufficient to initiate a cancer or mutation). In fact, a major cause of the cancer epidemic worldwide is low level ionizing radiation.

Ionization is the ejecting of electrons from atoms. When this is done chemically, in a natural, orderly fashion, the amount of energy needed is between .5 to 5 electron volts(ev)per transfer. With ionizing RADIATION, electrons are removed from their atoms and endowed with energies huge compared to those in ordinary chemical reactions(from 155 ev to millions of ev per electron!!). These high powered electrons start a chain reaction in the atoms of living tissues, knocking other electrons out of orbit, endowing them with huge energies and they in turn, knock other electrons around until all the energy is spent. This chemical and biological mayhem rearranges molecules, creates unique molecules, and destroys the exquisite natural bonds of organic matter. It also destroys or alters the genes in chromosomes, which is the triggering mechanism that causes the UNREGULATED, UNCONTROLLED PROLIFERATION OF THE DECENDANTS OF A SINGLE CHANGED CELL---in other words, CANCER.

IN the nucleus of all human cells that are normal or healthy, 46 chromosomes are the data discs which contain many thousands of genes that program every activity and function of that cell. Not only that, these 46 chromosomes contain information that differentiates between types of cells and their separate functions and how and when they divide to replace just the right amount of dying cells. These incredible phenomena preserve the "integrity of structure" of the complex organism known as a human being. Collectively, these phenomena are referred to as cellular regulation or cellular control. Think of the human cell as a super-sophisticated computer that can and will divide itself according to it's genetic blueprint. The chromosomes have the ability to replicate themselves during cell division(mitosis), so that each new daughter cell contains identical genes and chromosomes as the mother cell.

If a gene is damaged in any of the chromosomes, when that chromosome replicates, the information in that gene is lost and/or altered in the daughter cells. That is how many cancers orginate. Certain chemicals can cause genetic injuries. These chemicals are termed carcinogenic or "cancer causing" substances.(dioxin, asbestos, etc.) But the most effective carcinogen and mutagen known today is ionizing radiation. There are many valid epidemiological studies that prove beyond any doubt, that ionizing radiation causes cancers of almost every type. I shall list some of the more important studies at the

end of this report.

Since 1890, patholagists observed that one predominating feature of cancer is the occurance of chromosomal and mitotic irregularities in the cancer cells themselves. Some cancer cells have more than 46 chromosomes, some have less, and those cells that have the normal human count of 46, are damaged or imbalanced. All of these chromosomal injuries and abnormalities have been reproduced in laboratories with low doses of ionizing radiation. To quote a world-renowned cancer researcher..."there is simply no doubt at all that the vast majority of human cancer cells studied do indeed show an abnormal number of chromosomes, often deviating very widely from the normal number. Moreover, it is very common to find structurally altered chromosomes in the cancer cells"[1]

The Department of Business and Economic Development(DBED), in promoting a food irradiation facility for Hilo, has ignored the very severe biological effects of super-lethal ionizing radiation. In doing so, DBED is violating my constitutional rights and the rights of all the population of the island of Hawaii by imposing grave risks to the domestic tranquility and general welfare that we the people are entitled to under the United States of America's Bill of Rights.

Mr. Kaya, please answer these questions in the EIS with scientific analysis and candor:

1) What will be the true cost per pound of commodities irradiated when all hidden costs are computed(liability, county nuclear civil defense dept., hot water pre-treatment, transportation of large amounts of radionuclides,cost of cobalt 60)?

2) What will be the health consequences of a commodities irradiator that emits 20 times the amount of ionizing radiation that a nuclear power plant is allowed to emit yearly? (NRC current rules.)

3) Will the State Dept. of Health conduct an epidemiological study of Big Islanders to determine how many more cancers will result from the siting of an ionizing radiation plant in Hilo?

4) Who will the citizens of Big Island be able to sue when the inevitable accidents occur?

Sincerely, Anthony Almada

Anthony Almada

Footnote 1: Radiation and Human Health, Gofman pg. 72
Radiation Carcinogenesis: Studies involving external exposure: 1)Hiroshima-Nagasaki Studies of A-bomb survivors-82,000 subjects(Beebe, Kato, Land 1978 Japan)2) Ankylosing Spondylitis Study-14,000 subjects Court, Brown, Doll-1965 England. 3) Hempelmann Studies-5055 subjects-1975 New York 4) The Tinea Capitis Study-10,900 subjects-Modan et al-1975 Israel. 5) Hanford Nucl ear Reservation Workers Study-3,308 subjects Mancuso,Stewart, Kneale. 1975 Washington state. 6) Diagnostic Pelvimetry Studies- Stewart, Kneale-1975 England.

Anthony Almada
Bx. 1546
Pahoa, Hi. 96778

4-1-88

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Anthony Almada
P. O. Box 1546
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Almada:

The following is provided in response to your letter of April 1, 1988 to Mr. Maurice Kaya, DBED Energy Division regarding the subject EIS Preparation Notice and the biological effects of ionizing radiation.

In accordance with applicable state regulations, the potential environmental impacts of the proposed Hawaii Commodities Irradiation Facility will be described and discussed in the EIS and mitigation measures designed to minimize potential adverse impacts proposed.

The descriptions and discussions in the EIS will include the topic of ionizing radiation. In addition, a complete description of the plant operational characteristics; costs of irradiation, including hidden costs to the extent possible; possible actions by the State Departmnent of Health; and liability issues will also be included in the EIS. To assure that we address the issues raised in your letter satisfactorily, we would appreciate receiving more detailed descriptions of the references listed in your footnote, such as the author (s), title of article or book and the journal, magazine or book in which the reference was published.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

April 19, 1988

APR 21 1988

Mr. Maurice Kaya
DBED--Energy Division
335 Merchant Street Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya,

I am writing in regard to the Irradiation Plant which has recently been funded by the Legislature.

My questions are:

a. Will cesium be one of the materials imported for use in this plant?

b. On a geologicaly unstable island such as the Big Island, what certainty do we have that a spill could not take place and seep into our water table as the result of earthquakes?

c. If the experiment with irradiated products proves unsuccessful, e.g. the public does not accept the idea of irradiated papaias, etc., would this nucleur waste material (cobalt, cesium) be returned to the source from whence it came, or will we be storing this material on our island indefinitely?

Sincerely,

Pauline W. Chillingworth
5 Kahoa Street
Hilo, HI 96720

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Ms. Pauline W. Chillingworth
5 Kahoa Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Chillingworth:

The following is provided in response to your letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the radiation source (Cobalt 60); the potential effects of natural hazards such as earthquakes, tsunamis and lava flows; the marketability and public acceptance; and storage and disposal of the radiation source will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 12 1988

1. AAH [illegible]
2. [illegible]

P. O. Box 1493
Hilo, HI 96721-1493
April 11, 1988

Maurice Kaya
DBED - Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya:

The East Hawaii Coalition to Stop Food Irradiation has just sent out a notice stating that a public comment period is underway regarding the EIS on a commodities irradiation facility. We have read materials about the advantages and disadvantages of having an irradiation facility, but each side seems blinded by its own views. We have a few concerns of our own and would hope that you would try your best to address them:

1. How can we expect this irradiation facility to be maintained to insure no "spills" when our own county's Department of Public Works cannot even control its own "accidental" sewage spills?

2. Why is it that only the papaya growers association (and not even all of its members) wants this facility and no one else? Why should only the 400 or so growers be appeased with this so-called "more efficient, more technologically advanced treatment facility?"

3. Why look only at "cost-effectiveness" of an irradiation facility and not at a whole environment that money alone cannot replace? Why take that "one-in-a-million" chance?

4. If Hawaiian Host already has a vapor treatment method of handling the fruit-fly problem with its papayas, has the association approached Hawaiian Host to set up a pilot program for the industry as a whole? If not, why not? If yes, what was the outcome?

Thank you for your time.

Sincerely,
Casey & Linda Ibaraki
Casey and Linda Ibaraki

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Casey and Linda Ibaraki
P. O. Box 1493
Hilo, Hawaii 96721-1493

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Casey and Linda Ibaraki:

The following is provided in response to your letter of April 11, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable state regulations, the potential environmental impacts of the proposed Hawaii Commodities Irradiation Facility will be described and discussed and mitigation measures designed to minimize potential adverse impacts proposed included in the EIS. Also to be included in the EIS will be discussions regarding the safety measures to be followed during construction, operation and decommissioning to prevent accidental "spills"; the need for the project, including industry participation; the tangible and intangible cost effectiveness of irradiation vis-a vis the tangible and intangible environmental costs, to the extent that those costs can be estimated; and the alternative treatment methods available.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

4

APR 12 1988

724 B. Wainaku St. HMHK
Hilo, Hi 96720
April 10, 1988

Dear Mr Kaya:

I am concerned about a possible irradiation facility on the island of Hawaii.

Specifically, I fear that the public will reject irradiated foods of any kind, thereby destroying our papaya industry. Once Hawaiian papayas get a bad name, we will be many years in reestablishing a healthful image for consumers. The trend among consumers of today is for healthful, nutritional foods and away from any tampering with natural products.

Sincerely

Susan J. Roberts

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Ms. Susan J. Roberts
724 B Wainaku Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Roberts:

The following is provided in response to your letter of April 10, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Your concerns regarding consumer acceptance and the papaya industry and the nutritional aspects of irradiated fruit will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

5

April 8, 1988

APR 11 1988

Maurice Kaya
DBED Energy Division
335 Merchant St.
Honolulu, Hawaii 96813

Aloha:

I find it impossible to believe that persons responsible for the well-being of the people of Hawaii can propose the imposition of an irradiation facility on the island of Hawaii or anywhere else in this State. There are at least two reliable alternatives to food treatment and the future assuredly will find us with others if double dip and /or vapor -vac should prove unreliable which is highly unlikely if the procedures are properly carried out.

Anything dealing with nuclear energy is dangerous and should be relegated to the very final last resource, srely we are far from that drastic situation. We are a turbulent geological entity, ruptures have occured and will again without warning. To assume that no radiation could escape a facility as proposed is irresponsible and borders on felonious criminality. The People of America will not eat the residue and byproducts of the mad arms race. The People of Hawaii deserve the best in safety and health protection; it is time to stand up to the pentagon, the Energy Department and Mr. Inouye and tell him and them that NO NO NO is our response to the proposal to any but the safetest and best means of handling our food export problems,!

This should be the guiding premise for any and all additions and subtractions to what occurs on these Islands.

Our health is not an issue for compromise, experimentation or speculation. This is part of a Peoples confirmation globally, and locally. Imposing a facility of any questionable nature is totally unacceptable and will become more so in the immediate future.

May the Spirit of Aloha Aina guide you and all of us in determining the future of Hawaii and the world.

Aloha and best wishes,

Tomas N. Belsky
po box 1530
Hilo, Hawaii 96720

C-119

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Tomas N. Belsky
P. O. Box 1530
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Belsky:

The following is provided in response to your letter of April 8, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the alternative methods of treating papayas and other fruits will be discussed in the EIS. To the extent that information is available, the technical, economic and public perception of the various treatment methods will be included. Additionally, the regulatory, safety, consumer acceptance and health aspects of irradiated products will also be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 1 1 1988

April 8, 1988

Maurice Kaya
DBED/Energy Division
335 Merchant, Room 110
Honolulu HI 96813

Dear Mr. Kaya:

I wish to express my opposition to the construction or establishment of a commodities irradiation facility in the Hilo area.

My concerns are (1) that the irradiated products, principally papayas, according to present plans, will meet with buyer resistance from the public and that the project will therefore be economically unfeasible; (2) some danger exists to the public because of radiation hazards and the unknown long-term effects of consumption of irradiated food, and (3) the project is environmentally undesirable.

Most residents of the Big Island love it because it is relatively unspoiled, and is free of the high-rise buildings, traffic congestion, noise and dirt, throngs of people and air and water pollution which are found in areas where the quality of life has been "improved". We want to keep it that way. We have successfully opposed construction of additional high-rise condominiums in our beautiful Keaukaha area, and cannot believe that the addition of an irradiation facility or a spaceport will benefit our people or our environment.

Your consideration of this position will be appreciated.

Aloha pumehana,

Mason Teter
1875 Kalanianaole #603
Hilo HI 96720

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Mason Teter
1875 Kalanianaloe #603
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Teter:

The following is provided in response to your letter of April 8, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the topics of consumer acceptance of irradiated products; radiation hazards; and natural, physical, social and economic environmental impacts of the proposed Hawaii Commodities Irradiation Facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR - 8 1938

1. [illegible]
2. [illegible]

Jeff Haun
SR 5655
Keaau, HI 96749

Maurice Kaya
DBED- Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Maurice Kaya,

I would like the EIS on a Commodities Irradiation Facility to answer the following questions. What are the radiation hazards to people in and around the facility and the environment? What will be the consumer reaction to irradiated foods? What are all the alternatives to the facility and their comparitive safety and economic security?

Mahalo.

[signature]

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Jeff Haun
SR 5655
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Haun:

The following is provided in response to your undated letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the topics of radiation hazards, consumer acceptance of irradiated products and alternative treatment methods will be included in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

[signature]
for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 11 1988

1. MH [illegible]
2. [illegible]

Pacific Computer Services Company

P.O. BOX 328 KEALAKEKUA, HAWAII 96750
(808) 328-9149

April 7, 1988

Energy Division, DBED
ATTN: M. Kaya
Room 110
335 Merchant Street
Honolulu, HI 96813

Dear Mr. Kaya:

I would like to serve as a consulting party for the review of the Draft Environmental Impact Statement (DEIS) for the proposed Irradiation Facility. Can you please send me a copy of the DEIS, the public notice requesting comments and any related documents.

Thank you and Aloha,

Steven Bernstein

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Steven Bernstein
Pacific Computer Services Company
P. O. Box 328
Kealakekua, Hawaii 96750

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Bernstein:

The following is provided in response to your letter of April 7, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, copies of the EIS will be available at most state libraries on the island of Hawaii as well as being available at the DBED offices in Hilo. If possible, a copy of the EIS will be sent to you directly when it is published. At present, the Draft EIS is scheduled to be published and available for public review and comment in mid-August of this year.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR - 8 1988

STATE OF HAWAII
OFFICE OF HAWAIIAN AFFAIRS
1600 KAPIOLANI BLVD., SUITE 1500
HONOLULU, HAWAII 96814
(808) 548-8960
(808) 946-2642

April 5, 1988

Honourable John Waihee, Governor
State Capitol Building
Honolulu, HI. 96813

Dear Governor Waihee:

SUBJECT: EIS Preparation Notice for Food Commodities Irradiation Facility, Hilo, Hawaii
TMK: 2-1-12: 106 (Site A)
2-1-12: por. 34, 86 (Site B)
2-1-25: 86 (Site C)

Thank you for giving our office the opportunity to comment on the proposed undertaking.

This project proposes to provide an inexpensive means for sending disease free produce to mainland markets, and should be beneficial to Hawaiian farmers. We encourage and support such activities which help to make rural, agricultural living a viable alternative for Hawaiians. It is important that the health hazards associated with this form of food treatment be thoroughly investigated and that appropriate actions be taken to eliminate potential adverse effects.

Sincerely,

Kamaki A. Kanahele III
Administrator

KAK:EN:pc

cc: State of Hawai'i Dept. of Business and Economic Development
WESTEC Services, Inc., Sr. Project Manager

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
April 25, 1988

Mr. Kamaki A. Kanahele, III,
Administrator,
Office of Hawaiian Affairs
1600 kapiolani Blvd., Suite 1500
Honolulu, Hawaii 96814

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Kanahele:

The following is provided in response to your letter of April 5, 1988 to Governor John Waihee regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the economics of the proposed irradiation facility will be described and discussed. Irradiation appears to be one possible method of economically and safely treating Hawaiian agricultural products. In addition to the economics of irradiation, the EIS will also discuss the issues of potential health hazards and offer possible measures to mitigate potential adverse effects if required.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meetings regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm and in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

RUSSELL S. KOKUBUN
Councilman

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
25 Aupuni Street
Hilo, Hawaii 96720

APR 07 1988

April 4, 1988

Mr. M. Kaya
State of Hawaii
Department of Business and
Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, HI 96813

Re: Hawaii Food Commodities Irradiation Facility
General Lyman Field
Hilo, Hawaii

Pursuant to the OEQC Bulletin of March 23, 1988, may I request that I be a consulted party to the environmental impact statement pertaining to the above-mentioned subject matter.

Russell Kokubun
Councilman
County of Hawaii

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Russell Kokubun, Councilman
County of Hawaii
Hawaii County Building
25 Aupuni Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Councilman Kokubun:

The following is provided in response to your letter of April 4, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

A copy of the Draft EIS will be forwarded to your office as soon as it is published. At present, the Draft EIS is scheduled to be published and available for public review and comment in mid August, 1988.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 05 1988
1. [illegible]
2. [illegible]

LIFE OF THE LAND

April 3, 1988

Department of Business and Economic Development
Energy Division, Attention Mr. M. Kaya
335 Merchant Street, room 110
Honolulu, HI 96813

Dear Mr. Kaya;

Life of the Land would like to assist in the preparation of the EIS for a food irradiation facility in the Hilo area. We hope to receive a copy of the EIS when it is available. Following are some concerns that we would like to see addressed in detail.

1) What will be the eventual disposition of the radioactive isotope (Cobalt 60) after completion of its use cycle? Can we be assured of no environmental danger after disposal?

2) In regards to the irradiated fruit,
a) What new compounds will be created within the fruit as a result of exposure to the high radiation intensity? In the trade jargon I believe these are called radiolytic compounds. What effects might occur to an individual as a result of consumption of these compunds? Please indicate the knowledge about these compounds individually, where knowledge is available.
b) What is the mutation potential on viruses which may be found in the fruit? Is there a potential for new strains of virus to be created which might be harmful to the human consumer, or to plant life? Please try to obtain specific information.

3) Would you determine the economic value of an irradiation facility as opposed to alternative methods for the treatment of the commodity? The alternative methods might be those now existant or those which could be utilized. Please indicate any loss of market that could result from irradiation.

4) The federal funds which will help to construct and/or operate the facility will have an economic impact, likely a positive one. Please research the basis for the federal funding. Indicate the source of authorization of the funds, the purpose behind the authorization, etc. Point out to an interested reader where he could find the primary documents relating to the federal authorization.

Sincerely,

Bill Graham
LOL Big Island rep.
Box 155
Hawi, HI 96719

copy: OEQC

19 Niolopa Place, Honolulu, Hawaii 96817. Tel. 595-3903

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. Bill Graham
Life of the Land
P. O. Box 155
Hawi, Hawaii 96719

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Graham:

The following is provided in response to your letter of April 3, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the disposition of the radioactive isotope, Cobalt 60, following completion of the planned three-year research and demonstration phase of the proposed irradiation facility will be discussed in detail. The radioactive isotope will be disposed of per applicable federal regulations in effect at that time. In addition to the disposition of the radioactive isotope, the EIS will include discussions regarding the effects of irradiation on the fruit to be treated and possible effects, if any, on consumers; potential side effects of irradiation; the economics of irradiation as a treatment method; alternative treatment methods; and the authority for the use of federal funds for the proposed irradiation facility.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

12

4/4 1. mhk
2. GOL/BN APR 04 1988

March 31, 1988

Department of Business & Economic Development
Energy Division
335 Merchant St. Rm. 110
Honolulu, HI 96813

To Whom it May Concern:

Please include me on the list of consulted parties for the Irradiation Facility being considered for the Big Island.

I would like to recieve a copy of the Prep notice, DEIS and any other related documents as they are developed.

My address:

William H. Dendle
Independent Planning and Research
2066 Lanihuli Drive
Honolulu, HI 96822

Thank you very much for your assistance.

William H. Dendle

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. William H. Dendle
Independent Planning and Research
2066 Lanihuli Drive
Honolulu, Hawaii 96822

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Dendle:

The following is provided in response to your letter of March 31, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

A copy of the EIS Preparation Notice should have been sent to you under separate cover by Mr. Kaya. In accordance with applicable EIS rules, copies of the EIS will be available for public review in selected state libraries and at the offices of the DBED Energy Division. At present, the Draft EIS is scheduled to be available for public review and comment in mid August, 1988. If possible, a copy will be sent directly to you.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 25 1988

1. MHK
2. CGL/BB

P. O. Box 275
Volcano, HI 96785
April 21, 1988

Mr. M. Kaya
Dept. of Business & Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, HI 96813

Re: EIS Preparation Notice for Hawaii Food Commodities Irradiation Facility, General Lyman Field, Hilo Airport, Hilo, Island of Hawaii

Dear Mr. Kaya:

I wish to be a consulted party in the preparation of an EIS for the proposed irradiation facility to be sited in or near Hilo.

I am particularly concerned that the EIS contain full disclosure as required by law of alternatives other than irradiation for treating local fruit susceptible to infestation by alien fruit flies.

One alternative that should be fully discussed is the vapor heat procedure that is already established as efficient and economically feasible for exported fruit. Another alternative that shows great promise is the dry heat procedure that kills alien fruit fly eggs and larvae but does not damage the fruit.

The release of vast numbers of sterilized male alien fruit flies that have been produced in laboratories in Hawaii apparently has had success in California. This method should be fully discussed in the EIS as a control technique for Hawaii.

Decisionmakers need to be fully informed on advantages and disadvantages of alternative procedures before they can make rational decisions on whether or not to permit an irradiation facility on the Big Island. Considering the magnitude of opposition to an irradiation plant, in-depth treatment of alternative procedures is essential.

I welcome your reply to the issues raised here.

Sincerely yours,

Mae E. Mull

Mae E. Mull

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Mae E. Mull
P. O. Box 275
Volcano, Hawaii 96785

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Mull:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, alternative insect disinfestation treatment methods will be fully discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 25 1988

1. MHK
2. GUL

April 21, 1988

Dear Mr. Kaya

I am writing concerning the possibility of building an Irradiation facility in the town of Hilo by the airport.

Since Amfac (a private company) is already using a safe vapor heat treatment plant to rid fruit of fruit flyes, public monies should not be used in competition with this safe process (which is acceptable in Japan and the Mainland.)

Another concern about the use of dangerous radioactive materials transported to a possible seismic & tsunami zone are can only have a negative, long term impact.

Your attention of these factors in DBED's Irradiation EIS would be appreciated,

Douglas K. Walsh

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. Douglas K. Walsh
P. O. Box 158
Na'alehu, Hawaii 96772

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Walsh:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, alternative treatment methods; transportation and storage of the radiation source; potential impacts due to natural hazards including earthquakes, tsunamis and lava flows; and the marketability and public acceptance of irradiated food products will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

april 21-88

APR 25 1988
1 MHK
2. GV-1/R

Maurice Kaya
DBED Energy Division
335 Merchant St. Rm 110
Honolulu, Hi. 96813

Sending a few questions on Irradiation for EIS.

How does it produce dangerous Substances.

Does the air become bad the closer you get to a Irradiation plant.

Is there a proposed evacuation procedure in the event of an Irradiation facility disaster. (In Hilo)

Has all research for Safety been done that needs to be done.

Thank you
Joyce Kneff

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Joyce Kneff
P. O. Box 554
Keaau, Hawaii 96749

SUBJECT: HAWAII' COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Kneff:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential effects of irradiation on food stuffs; potential impacts on air quality of the area surrounding the proposed irradiation facility; and the emergency and safety procedures that will be employed during the design, construction and operation of the facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

JOHN WAIHEE
GOVERNOR

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

SUZANNE D. PETERSON
CHAIRPERSON, BOARD OF AGRICULTURE

ROBERT Y. TSUYEMURA
ACTING DEPUTY
TO THE CHAIRPERSON

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822-0159

APR 22 1988
MHK
2-6-0C

April 19, 1988

Mr. H. Kaya
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 100
Honolulu, Hawaii 96813

Dear Mr. Kaya:

Subject: Environmental Impact Statement Preparation Notice for Hawaii Food Commodities Irradiation Facility, General Lyman Field, Hilo Airport, Hilo, Hawaii

The Department of Agriculture would like to be a consulted party to the subject proposal. Please send the pertinent information to:

Suzanne D. Peterson, Chairperson
Department of Agriculture
P. O. Box 22159
Honolulu, Hawaii 96822

Thank you very much for your prompt attention to this matter.

Sincerely,

PAUL J. SCHWIND
Planning Program Administrator

cc: Masao Hanaoka

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Paul J. Schwind
Planning Program Administrator
State of Hawaii
Department of Agriculture
1428 South King Street
Honolulu, Hawaii 96814-2512

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Schwind:

The following is provided in response to your letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Per your request a copy of the Draft EIS will be forwarded to Ms. Peterson, Chairperson, Department of Agriculture by the Office of Environmental Quality Control. At present we anticipate publication of the Draft EIS in mid August 1988.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 22 1988

April 19, 1988

Mr. Maurice Kaya
DBED—Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Dear Mr. Kaya:

This is to express my concerns and questions regarding the proposed commodities irradiation facility in Hilo and I would hope you would address these in the upcoming environmental impact statement.

I like fresh produce, but I will not buy any irradiated food. I think my concerns are shared by many that question whether irradiated food in fact has a market in this world. Britain retains a ban on food irradiation. West Germany prohibits food irradiation for Germans. The Japanese Parliament has withdrawn its support for all food irradiation.

I noticed on April 10, 1988 that seven community groups and organizations issued a public statement opposing the construction of the food irradiation plant in Hilo area.

My concerns are such that they could be formed as questions which I would appreciate your addressing:

1. What safeguards can be guaranteed the public for transportation and shipment of radioactive materials around this island and in the coastal bay waters of this island?
2. Why is the legally allowable emission of 500 millirems of radiation from the plant per year as high as it is and what safeguards will be taken to protect the public and employees from this high level of radiation?
3. What safeguards will the public have from accidents occurring due to the location of the facility on a highly seismic area also susceptible to tsunamis and volcanic lava flows?
4. Lastly, how can you justify spending taxpayers' money to build an irradiation plant for private industry when in fact there is already a new vapor heat papaya treatment facility already opened in Hilo just last summer by Hawaiian Host?

I hope you would join with concerned citizens, the Hilo medical community, and those of us concerned members of the Hawaii Island Chamber of Commerce in addressing these questions in the upcoming environmental impact statement.

Once again, thank you for addressing my concerns.

Sincerely,

Jeffrey Mermel

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Jeffrey Mermel
110 Keawe Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Mermel:

The following is provided in response to your Letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, marketability and consumer acceptance; radiation source transportation factors; potential effects of radiation escape from the facility; design and operational safety factors; potential impacts due to natural hazards such as tsunamis, earthquakes and lava flows; and the purpose, need and economic and funding factors associated with the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 22 1988
1. ~~[illegible]~~ ikle
2. boc/By

1. Hawaii is geologically unstable - earthquakes etc. Natural disasters such as earthquakes, tsunami, volcano. How could the radioactive material be contained safely under these conditions?

2. Is it economically feasible?

3. Is there a big enough market for irradiated papayas?

4. What would be the allowable emissions?

5. How would emissions affect the public?

6. How many people from Hawaii would be employed.

7. How could we deal with an accident here, on route to Hawaii with the radioactive material.

Kelly Stauffer
Box 392
Keaau, HI 96749

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Kelly Stauffer
P. O. Box 392
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Kelly Stauffer:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the economic aspects of the proposed irradiation facility; marketability and consumer acceptance of irradiated food products; potential emissions and their effect on the surrounding environment; numbers and types of people to be employed; and the emergency and safety measures that would be employed during the design, construction and operation of the proposed irradiation facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

P.O. BOX 1365
Hilo, Hi. 96720

APR 22 1988

Dear Mr. Maurice Kaya,

I am concerned about the possibility of an irradiation plant being built here on the island of Hawaii. In the event of contamination to ground water, (1.) What would we develop?...cancer or perhaps be continually sick from radiation poisoning like our neighbors in the Bikini Islands? (2.) What are the hazards to workers and islanders here? (3.) Are the allowable emission truly safe??...by whose standards? (4.) Can the farmers afford irradiation? (5.) What of boycotts of these irradiated papayas and other foods? (6.) Why did Maine, the state, outlaw irradiated food? (7.) In the event of an accident at the plant, would we have to leave our homes and be compensated monetarily by the government for allowing this plant here? (8.) What does it do to the foods value, nutritively speaking? (9.) How many of these plants are in operation today and what is their history of accidents? What resulted from these accidents? (10.) Could we return the radioactive material to the government in the event the plant closed down? If not, Why Not?? Sincerely, Jeanne C.

C-133

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Jeanne C. Clarke
P. O. Box 1365
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Clarke:

The following is provided in response to your letter of April 21, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential impacts of the proposed irradiation facility on groundwater supplies; safety and health risks to facility workers and residents of the area; air, noise and radiation emission levels; economic aspects; marketability and consumer acceptance of irradiated foods; legislative actions taken by other political jurisdictions; emergency and safety measures to be employed during the design, construction and operation of the proposed facility; insurance and liability factors associated with the facility; potential effects of irradiation on food stuffs; experiences of other irradiation facilities; and the transportation and storage of the radiation source will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 20 1988

1. MHKaya
2. Gil/BH

Margaret Foust
SR 5633
Keaau, Hawaii 96749

Maurice Kaya
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Dear Mr. Kaya,

I am a resident of Hawaii Island, and I am concerned about the proposal to build a food irradiation facility on this island.

There are many health, safety and environmental questions that I seek answers to, which I believe will be addressed in the Environmental Impact Statement on a food irradiator in Hilo. Please add the following questions to the list of those that will be answered in the Environmental Impact Statement:

1.) My son, who suffers asthma symptoms from atmospheric contaminants, attends school in Hilo. What will be the effect of the emissions from an irradiation facility (those legally allowed, and those which may be emitted by human error in excess of the allowable amount) on the many people who already suffer from asthma or inhalant allergies?

2.) The many fair-skinned people living in Hawaii already face a possibility of developing skin cancer from the abundant sunlight here. Would contaminants in the atmosphere from an irradiation facility increase the possibility of developing skin cancer?

3.) A great segment of the population of the Island of Hawaii will be affected by exposure to emissions from an irradiation facility and by the effects of an accident in the use, transportation or storage of the fuel used in an irradiation facility should an accident occur. What percentage of these people who will be receiving the negative impact of a food irradiator are those people who will be receiving the direct benefits of such a facility (people in the papaya industry, facility employees, etc.)?

4.) Can the purveyors of nuclear technology with all the intellectual brilliance which they possess, also possess the wisdom to develop technology that benefits everyone affected without big trade-offs in safety and side affects? Is food irradiation such a beneficial industry?

Thank you for the opportunity to present this input for the Environmental Impact Statement.

Sincerely,

Margaret Foust

Margaret Foust

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Margaret Foust
SR 5633
Keaau, Hawaii 96749

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Foust:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the health and safety issues associated with the proposed irradiation facility; radiation leakage factors; transportation and storage of the radiation source; emergency and safety measures to be employed during the design , construction and operation of the facility; and the need and purpose of the facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 20 1988

1. [illegible]
2. [illegible]

To whom it may concern:

I have some serious questions about the proposed irradiation facility:

What are the potential hazards to the workers in the facility?

What would happen, if there were a disaster such as an earthquake or volcano eruption, to people in the surrounding areas, ie. what risk of radiation poisoning.

☆☆☆ WHY ARE WE POISONING FOOD WITH RADIATION ??? The government may have "acceptable" levels of radiation in food, but it doesn't make sense to me to add poisonous substances to the food we eat.

☆ Will we be able to sell papaya's or any other food that has been poisoned with radiation?

☆ Why did the state of Maine, ban the sale of irradiated food?

Please address these questions in your committee
Thank you. Ted Erhard, Box 1915 Pahala, HI 96778

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Mr. Ted Erhard
P. O. Box 1915
Pahala, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Erhard:

The following is provided in response to your letter to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the health and safety aspects of the proposed irradiation facility; emergency and safety measures that will be taken during the design, construction and operation of the facility; potential impacts of natural hazards including earthquakes, tsunamis and lava flows; potential effects of irradiation on food stuffs; marketability and consumer acceptance of irradiated food products; and actions taken by other political jurisdictions will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 20 1988

Adan & Calley O'Neill Eads
P. O. Box 128
Pahoa, Hawaii 9 6 7 7 8

Telephone: 965 9458

Mr. Maurice Kaya DBED
Energy Division
335 Merchant Street Room 110
Honolulu, Hawaii
9 6 8 1 3

18 April 1988

Re: Hilo Irradiation Facility Proposal

Dear Mr. Kaya,

While we have been silent up until regarding the proposed Hilo food irradiation facility, we now feel, with the recent funding approval, we must speak in profound opposition to this project and take the time to ask you some of the questions which require serious and thorough answers. We speak also for friends and neighbors who are not taking the time to write. Would you be so kind as to inform us:

What is the market for irradiated produce, when people all over the country are leary of its effects on food value?

What will be the hazards to plant workers and nearby residents?

What will be the result of radioactive contamination of our groundwater? What is the life of the radioactivity?

What will be the allowable emission from the facility? based on what safety standards?

What precautions will be taken to protect the plant from earthquakes and earth movements from tsunamis or volcanic activity? How could they be effective?

In a state where pristine beauty and a healthy environment are our main assets, both for our residents and in broader economic terms, is this really a desirable addition to our Big Island? And, is it truly economically feasible?

Does your office realize and duly recognize the extent of resident opposition to this treatment facility for ecological, economic, aesthetic and health related reasons? Do you realize the extent of consumer wariness of irradiation?

We will look very much forward to reviewing thoroughly the forthcoming Environmental Impact Statement, and wish to reiterate our strong opposition to the building of this facility anywhere in Hawaii. We are in favor of the vapor steam method for our papayas.

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Adan and Calley O'Neil Eads
P. O. Box 128
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Adan and Calley Eads:

The following is provided in response to your Letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, marketability and public acceptance of irradiated products; potential plant and worker safety issues; potential groundwater contamination; safety measures relative to design and operation of the proposed facility and protection against natural hazards, including tsunamis, earthquakes and lava flows; the need and purpose of the proposed facility; economics associated with the proposed facility; and public concerns regarding the proposed facility will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 19 1988

University of Hawaii at Manoa

Department of Food Science and Human Nutrition
~~Henke Hall 224, 1800 East-West Road~~
Honolulu, Hawaii 96822

April 13, 1988

Memorandum

TO: Mr. Maurice Kaya
Chief, Energy Division
DBED

FROM: James H. Moy
Professor of Food Engineering

SUBJECT: Comments on the Notice of Preparation of an EIS for the Hawaii Agri. Commodity Demostration Irradiator

Referring to the above-indicated document copies of which were recently distributed to various interested parties for comments, I would like to offer the following observations on the documents on behalf of Dean N. P. Kefford of our college:

1. On the top portion of page 4, line 4, along with DOE and EPA, USDA-APHIS should be mentioned because it is the agency which will oversee the use of irradiation as a quarantine treatment for papayas in the future.

2. On the top part of page 7, I would assume that, ". . . transportation, . . ." means transportation of the radioactive materials. Somewhere in the document, it may be desirable to mention that the radioactive materials used for the irradiator will one day be returned to the DOE depot on the mainland when their activities fall below certain economic and efficiency level, but these materials will not be disposed of or stored in Hawaii.

Thank you for conveying these comments to the contractor involved in the environmental impact study.

cc: Dean N. P. Kefford

AN EQUAL OPPORTUNITY EMPLOYER

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Dr. James H. Moy
Professor of Food Engineering
University of Hawaii at Manoa
Department of Food Science and
Human Nutrition
1920 Edmonson Road
Honolulu, Hawaii 96822

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Moy:

The following is provided in response to your Memorandum of April 13, 1988 to Mr. Maurice Kaya, Chief, Energy Division, DBED regarding the subject EIS Preparation Notice.

The EIS will include information relative to the USDA-APHIS role in the quarantine and irradiation treatment process. Similarly, transportation issues, including transportation of the fruit and the radiation source and return of the radiation source to DOE will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your Memorandum and this response will be appended to the Draft EIS.

Sincerely,

For James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

Henry A Ross

Energy Division, DBED Hawaii,
Room 110, 335 Merchant Street
Honolulu, Hawaii, 96813

Attn Mr M. Kaya

19 April 1988

Re. EIS for Food Irradiation Facility

This is to inform you that I would like to be a consulted party in the procedure of drafting an environmental impact statement for a commodities irradiation facility as planned by the state and for which you are the proposing agency. Thank you for your kind consideration.

Henry A Ross

Henry A. Ross
P.O. Box 99
Kapaau, HI, 96755
Phone 889-5587

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Henry A. Ross
P. O. Box 99
Kapaau, Hawaii 96755

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Ross:

Thank you for your letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject project. Under separate cover DBED will be sending you a copy of the EIS Preparation Notice. Should you have any questions or comments, please forward them to Mr. Kaya.

As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 19 1988

April 22, 1988

Maurice Kaya
DBED Energy Division
335 Merchant St. Rm. 110
Honolulu, HI 96813

Dear M. Kaya,

In light of the Environmental Impact Statement currently gathering public opinion on concerns regarding a food irridiation treatment facility for Hilo, a few questions have arisen which I hope you may be able to help me find the answers to.

How long does run-off ground water contamination last in terms of radioactive life?

Why did the state of Maine outlaw sale of irridiated food?

Is this project economically feasible?

Is there a market for irridiated papayas?

Aren't many grocery stores nationwide beginning to post public notice to their shoppers stating which fruit has been preserved with irridiation as a warning ?

What are the long term safety concerns for workers and residents of Hilo?

Mahalo for your time and concern.

Maria Kay Kolstad
resident of Hilo

M.K.K.
87 Hoaloha Street
Hilo, HI 96720

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Maria Kay Kolstad
87 Hoaloha Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Kolstad:

The following is provided in response to your letter of April 22, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential impacts of the proposed irradiation facility on groundwater supplies; actions taken by other political jurisdictions; economic aspects of the proposed facility; marketability and consumer acceptance of irradiated foods; and the emergency and safety measures that will be taken during the design, construction and operation of the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

Waa Waa Community Association
Box 1333
Pahoa, HI 96778

APR 19 1988

1. AHHkk
2. CIL

April 18, 1988

Maurice Kaya
DBED - Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya,

Our Association is ~~considered~~ Concerned!! about the environmental impact of a Commodities Irradiation Facility on the Big Island.

Specifically, we hope you will satisfactorily answer the following questions:

1) Any contamination of ground water and how long such contamination might last.

2) Any radiation hazards to workers and residents in the surrounding areas. Are transportation and storage of radiactive materials safe?

3) Is there really a market for irradiated papayas in view of consumer concern and possible boycott?

4) Is such a plant, therefore, economically feasible?

Sincerely,

Richard Hilliard,
President

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Mr. Richard Hilliard, President
Waa Waa Community Association
P. O. Box 1333
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Hilliard:

The following is provided in response to your letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, potential contamination of groundwater supplies; potential radiation hazards to workers and residents in surrounding areas; transportation of the radiation source (Cobalt 60); the marketability and consumer acceptance; and the economic factors of the proposed irradiation facility will be described and discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

f. James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

April 19, 1988
Dana Moyer
P.O. Box 1135
Kealakekua
Hawaii 96750

APR 21 1988
1 MHK
2 GOL/BJ

Maurice Kaya
DBED Energy Dept.
335 Merchant St. #110
Honolulu, Hawaii

Dear Sir,

I would like to pose some questions that confront the building and use of a food irradiation facility on the Big Island of Hawaii.

1) What guarantee do we have for the safety of the residents near such a facility? The history of problems and accidents involved with the handling of radioactive materials is absolutely nothing to be taken lightly. When they occur, they can be serious and enduring. It should be of particular concern here because of our fragile island ecosystem, which is prone to earthquakes and volcanic activity. Such a facility would be a time bomb waiting to happen.

2) Is the process of irradiating food the answer to the fruit fly's eradication? With the danger and expense involved, as well as the potential unmarketability, it would seem more prudent to explore safer alternatives: Expand and/or improve the vapor/heat method, which is already in operation and seems to work. Dried fruit could be very profitable if marketed properly. Who knows what else researchers could discover with the kind of money required to build an irradiation facility?

3) Do we know for certain irradiated food is safe and marketable? There is little that is known of the effects years from time radiation alters or rearranges the food molecules. Any one thing by itself may seem safe, as in the many processes we use to produce, process and preserve our foods, but in combination (like taking several different kinds of drugs into your body at one time), all the herbicides, pesticides and preservatives in our food, along with industrial wastes, aerosols, exhaust fumes and shrinking forests, etc. all contribute to the rapid depletion of the life sustaining qualities of our planet.

4) How does greed fit into this situation? I have great misgivings that irradiation of food, as the "answer to our problems" is more likely an excuse to unload radioactive waste by the nuclear energy industry. That they are producing massive amounts of dangerous wastes and are desperate to create any possible means of disposal of such wastes, leaves me very suspect that this may be a major reason behind the push by the government for food irradiation facilities.

We must begin now to realize the overall impact of everything we do. To compromise the health and safety of the residents of this community, and perhaps the consumer as well, out of blind desperation to profit is greed, pure and simple. Just because it is happening nation-wide and world-wide does not give it credence.

I believe this would be a serious mistake to build what could likely become a white elephant to haunt us for generations.

Sincerely,

Dana Moyer

P.S. Enclosed are two of numerous letters that appear almost daily in our local newspaper, which echo the feelings of many here on this island.

C-141

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 27, 1988

Dana Moyer
P. O. Box 1135
Kealakekua, Hawaii 96750

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dana:

The following is provided in response to your Letter of April 19, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the facility design and operation safety measures to be taken; the need and purpose of the proposed irradiator facility; alternative treatment methods; marketability and consumer acceptance of irradiated food products; and the storage and disposal of the radiation source (Cobalt 60) will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

P.O. Box 423
Kurtistown, HI 96760
April 20, 1988

APR 21 1988
1. [illegible]
2. [illegible]

Maurice Kaya
DBED - Energy Division
335 Merchant St. Rm 110
Honolulu, HI 96813

Dear Mr. Kaya,

Here are my questions for the Environmental Impact Statement concerning food irradiation:

1. What system of containment has been devised to assure that there will be no leakage of cooling or shielding water under all possible earthquake and volcanic eruption conditions?

2. If there is any waste water where will it be disposed?

3. Given that the facility is to be located right next to the airport, what would happen if an airplane crashed into it?

4. What will be done with the irradiated fruit if California and Japan refuse to purchase irradiated fruit as they have stated they will?

5. If irradiated food is safe why is it banned in many countries throughout the world.

6. Given the undeniable fact that the only way that we can know the long term effects of the ingestion of irradiated foods is to wait a long time (20-25 years after ingestion). What are these long term effects?

Sincerely, Arlene Pennington

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 28, 1988

Ms. Arlene Pennington
P. O. Box 423
Kurtistown, Hawaii 96760

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Pennington:

The following is provided in response to your letter of April 20, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the design and operational safety measures that will be taken for the proposed irradiator facility; potential impacts due to natural hazards including earthquakes, tsunamis and lava flows; waste water generation and disposal; risks associated with the location of the facility; marketability and consumer acceptance of irradiated fruit; and the potential impacts of irradiation on food stuffs and consumption of those foods will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
DIVISION OF PUBLIC WORKS
P. O. BOX 119, HONOLULU, HAWAII 96810

RUSSEL S. NAGATA
COMPTROLLER

KEN KIYABU
DEPUTY COMPTROLLER

LETTER NO. (P)1257.8

MAR 30 1988

Energy Division
Department of Business
and Economic Development
State of Hawaii
Honolulu, Hawaii

Attention: Mr. M. Kaya

Gentlemen:

Subject: Environmental Assessment and Notice of Preparation of an Environmental Impact Statement for Food Commodities Irradiation Facility

We have reviewed the subject document and have no comments to offer.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

CI:jk

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Teuane Tominaga,
State Public Works Engineer
State of Hawaii
Department of Accounting and
General Services
P. O. Box 119
Honolulu, Hawaii 96810

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Tominaga:

The following is provided in response to your letter of March 30, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Thank you for participating in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

1911 Kalanianaole #603 #706
Hilo, Hi. 96720

APR 18 1988
1. MHK
2. GOL/BB

4-14-88

Dear Mr. Kaya,

We are very concerned about the building of an irradiation facility on the island of Hawaii or any other place.

Why do the fruits on the mainland need to be irradiated?

Why would anyone think of building a facility here with tsunamis and earthquakes so common?

The state has outlawed the sale of irradiated food and some produce markets will not sell it.

We believe there are so many reasons for not having it.

Sincerely,
Mrs. Evelyn Kay
Lucia C. Marsh

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Ms. Evelyn Kay and
Ms. Lucia C. Marsh
1911 Kalanianaole, #603
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Kay and Ms. Marsh:

The following is provided in response to your letter of April 14, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Irradiation is one method of meeting the fruit fly quarantine regulations mandated by the U.S. Department of Agriculture for fruit transported to the mainland U.S. Other alternatives will be discussed in the EIS. In addition, the purpose and need for the proposed irradiation facility; the possible effects of tsunamis, earthquakes and other natural hazards on the facility; and market acceptance of irradiated products will also be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 18 1988
1. MHK
2. GOL/EG

Maurice Kaya
DBED - Energy Division
335 Merchant St. #110
Honolulu, HI 96813

Aloha Maurice,

Here's a couple of questions I have about the Food Irradiation Plant (FIP) that the government plans on building here on the Big Island.

1. Is there a ny evidence of FIP's effecting the fertility of women who work in or near such facilities? How far do these studies go back, if there have been any?

2. In the FIP'S normal operating conditions, would what it emits effect air quality in Kona as the VOG has recently? How about if there's an accident?

3. What would this FIP emit -- fumes, steam, contaminated water, or what?

4. Will this FIP be cost-effective? Or will it be a future burden. to the taxpayers?

5. Will local people of color, i.e., not haoles, be hired in management or in high-tech positions? What percentage of people who have lived here 5 years or longer, haole or not, will be hired in management or high-tech positions?

6. How does an irradiated papaya taste? Will papaya farmers and the public be given samples to eat before the FIP gets built here on the Big Island?

7. Would the State of Hawaii send a delegation of papaya farmers and other citizens to a FIP on the mainland for a tour of inspection of their facility and discussion groups of locals there and locals here be organized?

8. What will be done with the radioactive waste material? How will it be transported to the disposal site?

Thank you very much, Maurice, for answering my questions.

Alana Gay 4/8/88
Alana Gay
P. O. Box 1244
Pahoa, HI 96778
[redacted]
8 April 1988

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Ms. Alana Gay
P. O. Box 1244
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Gay:

The following is provided in response to your letter of April 8, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the possible health and safety effects of the irradiation facility on people, plants or other objects outside the irradiator facility will be discussed in the EIS. In addition, the potential effects, if any, on air quality, will also be discussed. As presently known, there would not be any emissions of any kind from the facility. The economics of irradiation will also be discussed in the EIS, as will employment factors, the effects of irradiation on the taste of the products, the experiences of other irradiation treatment facilities and the transportation and disposal of radioactive waste materials.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 SOUTH KING STREET, ROOM 104
HONOLULU, HAWAII 96813

MARVIN T. MIURA, Ph.D
DIRECTOR

TELEPHONE NO.
548-6915

APR 18 1988

1. MHK
2. GUL/BJ

April 8, 1988

State of Hawaii
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813
Attn: Mr. M. Kaya

Dear Mr. Kaya:

Subject: Comments on the Preparation Notice for the Food Commodities Irradiation Center

We have reviewed your environmental assessment for the proposed Food Commodities Irradiation Center; and request that the following items be addressed in the draft Environmental Impact Statement:

1) discussion of how the Cobalt 60 will be transported and the safety precautions that will be used.

2) discussion of how the Cobalt 60 will be contained in the water bath or casing and the possibility of an accidental release of the radioactive material.

3) discussion of how the Cobalt 60 will be disposed of after it has decayed beyond effective irradiation levels.

Thank you for providing us this opportunity to review your proposed project.

Sincerely,

Marvin T. Miura
Director

cc: WESTEC Services, Inc.
0892A

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Dr. Marvin T. Miura, Director
State of Hawaii
Office of Environmental Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Dr. Miura:

The following is provided in response to your letter of April 8, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Per your request and in accordance with applicable EIS rules, environmental factors affecting the transport of the radiation source, Cobalt 60, the containment of the Cobalt 60 in the water bath and the integrity of the bath structure, the safety and emergency procedures that will be followed and the disposal of the radiation source following its useful life will be discussed in the EIS.

Thank you for participating in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APR 18 1988
1. HHKul
2. GUL / fg

April 6, 1988

M. Kaya
DBED - Energy Division
335 Merchant St., Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya:

This is in reference to the Environmental ~~Impact~~ Impact Statement on a Commodities Irradiation Facility in Hilo.

1. Will the safety of our drinking water be absolutely, unconditionally safe from contamination? This includes, rivers, catchment, or wells.

2. What is the half-life of the radioactive materials to be used in the Irradiation Plant?

3. Why did Californians and Japanese make an announcement that they would not buy irradiated papayas; on what did they base their statement?

4. What about Maine? The State of Maine outlawed the sale of irradiated food? Does this mean they outlawed plants in their state, too? What did they base this upon?

5. What types of safety devices will be installed for the graveyard shift to prevent sleeping on the job? Scientists are saying that the Chernobyl nuclear accident was the result of sleeping on the job; humans are diurnal, not nocturnal.

6. Who will be financially responsible to all people affected monetarily by any accidential or Intentional radioactive contamination? How many years of monetary retribution will there be for those effected -- 5, 10, a lifetime?

7. Will radioactive materials be transported by air, land, or sea? And what safety measures will be employed during the transport?

8. Who will protect the Plant from terrorists?

9. Who will be responsible for waste disposal?

10. How many ways could a radioactive leak occur and, what are they? Describe in detail what would happen in a 200 mile radius if such an accident occured.

11. What safety measures will be taken to insure that if a leak does occur, our ground water will not be contaminated?

12. Power outages are common here on the Big Island. What safety measures will be used in case of hurricans, lava, earthquakes, tsunamis, etc. heading directly for the plant? How quikly could the radioactive materials be removed and moved to safety? Where would ~~we~~ the radioactive materials be taken, if for example the entire island chain were in the middle of a hurricane? California?

Sincerely,

Noa P. Kristi
Box 1244, Pahoa 96778

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Noa P. Kristi
P. O. Box 1244
Pahoa, Hawaii 96778

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Kristi:

The following is provided in response to your letter of April 6, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential effects of the irradiation facility on potable water supplies; the characteristics of the radioactive source (Cobalt 60); the market acceptance and legal sale of irradiated fruit; the safety and emergency procedures to be in effect at the facility; financial responsibility issues; the transportation of the irradiation source; plant security issues; disposal of waste products; facility structural integrity and design factors; and measures to be taken to protect the facility during potential natural hazard occurrences will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

APR 13 1988

REPLY TO ATTENTION OF:

April 11, 1988

Planning Branch

Mr. M. Kaya
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Dear Mr. Kaya:

Thank you for the opportunity to review the Environmental Assessment and Notice of Preparation of an Environmental Impact Statement for a Food Commodities Irradiation Facility at Hilo, Hawaii. The following comments are offered:

a. A Department of the Army permit will not be required for this project since no construction will take place in waters or wetlands of the United States.

b. According to the Flood Insurance Study for the County of Hawaii, the three study sites are located outside of the 500-year floodplain (Zone X, unshaded).

Sincerely,

Kisuk Cheung
Chief, Engineering Division

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Mr. Kisuk Cheung, Chief,
Engineering Division
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Ft. Shafter, Hawaii 96858-5440

Attention: Planning Branch

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Cheung:

The following is provided in response to your letter of April 11, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Thank you for your information that the proposed facility will not require a Department of the Army permit and that the three study sites are outside the 500-year floodplain.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Honolulu at the State Capitol Auditorium on May 3, 1988 at 7:00 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

4-10-88

To Maurice Kaya
DBED Energy Division

APR 13 1988

Concerning The Environmental Impact for a commodities Irradiation facility in Hilo:

I am a citizen who is very much opposed to bringing this highly radioactive material to our Island.

I Question the safety of:

Transporting it
Storing it
The workers handling it
The eventual disposal of it.

If you are familiar with R.P.s (Radiolitic Particles) you, no doubt, know that volatile R.P.s had not been present in foods before irradiation.

Does anyone know if food containing R.P.s is safe?

Why does the Irradiation industry so vigorously oppose labeling requirements?

Will the FDA's labeling law always be in effect?

What alternative methods of eradicating fruit flies have been explored?

Has the budget for this (the alternative methods) been as large as that for irradiation otherwise known as B.U.P. (Biproducts Utilization Program)

Yours Sincerely,
Eleanor T. Cate
1807 Waianuenue
Hilo, Hi., 96720

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Ms. Eleanor T. Cate
1807 Waianuenue
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Cate:

The following is provided in response to your letter of April 10, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the EIS will include discussions regarding the safety measures to be followed during transportation, storage, use and disposal of the radioactive source material (Cobalt 60); the effects of irradiation on food products; product labeling requirements; alternative treatment methods; and the financial and economic aspects of the proposed irradiation treatment facility.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

Olivia Cockcroft
P.O. Box 1035
Kurtistown, HI
96760
(808) 966-6592

4/13/88

Dear Sir,

As a biologist an infinite number of questions come to mind concerning the proposed use of a Commodities irradiator in Hilo, Hawaii. However, I have confined my inquiry here to the following:

1.) What will the effect of controlled or other exposure of Cobalt-60 be on an area that receives 150 inches of rain a year, being that rainfall facilitates atmospheric fallout? Further, how will Cobalt-60 elemental or otherwise interact with Vog (Volcanic Fog)?

2.) How can a level of safety be determined or extrapolated for foods exposed to ionizing radiation when the health effects of food exposure (eg. unique radiolytic particles, etc.) require long term epidemiological studies?

3.) What marker or monitor is available to regulate the technology? How will irradiation dosages be verified? What safeguards will be in place to prevent contaminated or spoiled food from being irradiated to enhance marketability? What about making sure unapproved Commodities or substances are not irradiated?

4.) Are there increased toxicity or harmful side effects associated with foods exposed to particles coupled with irradiation? If so, how will the problem be dealt with cost effectively?

5.) What insurance or compensation will be available to cover costs or expenses incurred should adversities associated with the irradiation facility arise, such as unintended contamination of the surrounding environment, waters, etc.?

Thank you,
Olivia Cockcroft

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

April 25, 1988

Ms. Olivia Cockcroft
P. O. Box 1035
Kurtistown, Hawaii 96760

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Ms. Cockcroft:

The following is provided in response to your letter of April 13, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the potential effects of radiation leakage and the safety and emergency measures to be employed in the design, construction and operation of the proposed irradiator facility; air quality and emission factors; effects of irradiation treatment on food products; radiation monitoring requirements for the plant and plant workers; product marketability and acceptance; economics and cost factors associated with the proposed facility; and insurance and financial liability factors associated with the proposed facility will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. As a reminder, a public information meeting regarding the EIS will be held in Hilo at the Naniloa Hotel on May 4, 1988 at 6:30 pm. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

UNITED STATES DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE — P. O. BOX 50004, HONOLULU, HAWAII 96850

APR 29 1988

April 18, 1988

Mr. M. Kaya
Department of Business and Economic Development
Energy Division
335 Merchant Street, Room 110
Honolulu, HI 96813

Dear Mr. Kaya:

Subject: Environmental Assessment and Notice of Preparation of an Environmental Impact Statement (EISPN) - Food Commodities Irradiation Facility, Hilo, HI

We have no comments to offer at this time, however, we would appreciate the opportunity to review the draft EIS.

Sincerely,

RICHARD N. DUNCAN
State Conservationist

cc:
Mr. James Frolich, Sr. Project Manager, WESTEC Services, INc./ERCI, 3049 Ualena Street, Suite 1217, Honolulu, HI 96819

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 10, 1988

Mr. Richard N. Duncan
State Conservationist
U. S. Department of Agriculture
Soil Conservation Service
P. O. Box 50004
Honolulu, Hawaii 96850

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY EIS PREPARATION NOTICE

Dear Mr. Duncan:

The following is provided in response to your letter of April 18, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

HOUSE OF REPRESENTATIVES
THE FOURTEENTH LEGISLATURE

STATE OF HAWAII
STATE CAPITOL
HONOLULU, HAWAII 96813

1. APR 28 1988
2. [illegible] 1/88

April 27, 1988

Mr. M. Kaya
Dept of Business & Economic
Development
Energy Division
335 Merchant Street, Rm. 110
Honolulu, HI 96813

Dear Mr. Kaya:

This letter is to express various concerns about a food irradiator facility which should be among the issues addressed in the EIS. These concerns have been repeatedly brought to my attention by residents of the Big Island.

1. What structural modifications to the facility will be required considering the seismic activity of the island?
2. If there is a natural calamity such as a tsunami, hurricane or volcanic activity, how would an evacuation or clean-up of the area be conducted.
3. What danger is posed by the close proximity of the site to the airfield?
4. What protective measures will be required of the employees of the facility?
5. How will the waste material be disposed of?
6. What are the safety measures to be taken during the transporting of the active material?

I would appreciate your addressing these concerns in the EIS.

Sincerely,

Virginia Isbell
Virginia Isbell
State Representative - Kona

EVI:ek

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 10, 1988

The Honorable Virginia Isbell
House of Representatives
State of Hawaii
State Capitol Building, Room 427
Honolulu, Hawaii 96813

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Representative Isbell:

The following is provided in response to your letter of April 27, 1988 to Mr. Maurice Kaya, DBED, Energy Division regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules, the required facility design, construction and operation standards applicable to the proposed radiation facility; the potential environmental impacts on the facility due to natural hazards such as earthquakes, tsunamis and lava flows; the potential risks of each of the three possible locations of the facility relative to aircraft accidents; the protective measures that employees would be required to follow during the operation of the proposed facility; and the transportation and disposal of the radiation source will be discussed in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

Dear Mr Frolich

RECEIVED MAY ; 6 1988

May 10, 1988

I received your letter of April 27.

Unfortunately I could not attend the Hilo public meeting as I planned.

As you announced in your letter, I did receive a copy of the EIS Preparation Notice but not until Monday May 9.

Mr Ulveling's coverletter was dated April 27, but the envelope from the Energy Division was dated May 6 (~~Monday~~ Friday)

I hope this delay does not make it too difficult to include my letter in the EIS.

Sincerely,

Henry A Ross

Henry A. Ross
P.O.Box 99
Kapaau, HI, 96755

Phone (808)
889-5587.

Henry A Ross

P.O.Box 99
Kapaau, Hawaii 96755

To: State of Hawaii - Energy Division of the Dept of Business & Economic Development,
335 Merchant St. Honolulu Hawaii 96813.
Attention Mr Maurice Kaya.

and Westec Services Inc./ERCI, Consultant,
3049 Ualena St. Honolulu Hawaii - 96817.
Attention Mr James Frolich.

RECEIVED MAY ; 6 1988

Re. Environmental Impact Statement for Food Commodities Irradiation Facility

10 May 1988

I just received the undated Environmental Assessment and Notice of Preparation from the DBED and hasten to bring the following to your attention for consideration and inclusion in the above EIS.

Food irradiation must meet 3 criteria to become acceptable here:

A) Each individual fruit or item must be labeled so consumers can choose to buy the product or not because of real or imagined dangers of poisoning etc. As some papayas are now labeled to distinguish them from others (brandname) this should not be a burden to packers.

B) The process of irradiation, transportation of source material, and the facilities must be absolutely safe technically, operationally, and under local conditions.

C) Irradiation may not artificially distort the economy of the market place.

Item A needs no further elaboration but should be dealt with in the EIS.

For Item B the EIS should consider all the dangers connected with a Cobalt-60 source use for irradiation including air and surface transportation. The criteria for safe transport as mentioned in CH2M Hill's report (stipulated by the Federal Government) are not sufficient, the containers not safe enough for common civilian transportation, the impact dangers on the road and in the air not adequately countered by present law and regulations. The dangers from earthquakes, tsunamis, lavaflows and exceptionally corrosive conditions in Hawaii must not be underestimated. These dangers are so real and opportune, especially when aggravated by human error and nonchalance, that for the chosen site locations in direct proximity of population centers nuclear source materials must be ruled out because of possible unpredictable complications, more so because viable and cheaper alternatives are available.

One such alternative is to use an X-ray source for the irradiation.

This is not mentioned in the assessment but has already been discussed between the DBED, the State Legislature and Lawrence Livermore Laboratory at Livermore CA. The latter has developed high-powered X-ray machines for other purposes that can rather easily be adapted for use in food irradiators. The time required for such adaptation is about a year once money is being made available; a good talking figure is a million dollars, which does not have to be borne by this one irradiator of course.

The time factor is acceptable because at present only the papaya industry would use an irradiator for years to come. (if near Hilo) The quantity of papayas to be irradiated (only mainland export) is so small that for now an irradiator, whether Cobalt-60 or X-ray, would not be economical because of its minimum size and cost. Even if the crop of papayas doubles in the next 5 years, the capacity of an irradiator would be more than 5 times bigger than required even if all growers would use it, which is questionable because of anti-radiation-customer rejection on the mainland.

If the papaya growers will be charged, as should be the case, the actual cost of such a process, there would be no takers at all for now. There are acceptable cheaper processes (vapor and double dip) available that are adequate for at least 5 years to come. Further it must be considered that it is unlikely that Japan will accept irradiated papayas for many years to come, and that possible boycot elsewhere against irradiated foods would render the process still more expensive. Government subsidies whether initial or perpetual have no impact on these negative factors.

Another drawback is the limited production of Cobalt-60, the rising world demand and the monopoly position of the Canadian producers. It may become scarce, unavailable at times and certainly the price will rise, maybe too much for economical use on papayas ever. This is no factor with an X-ray source as it only uses electrical power to run the plant and for the same money can irradiate 3 times as many papayas as Cobalt-60, based on today's prices. It is the only option that can eventually become economically feasible when enough demand for irradiation develops. It should also be mentioned that a plant built for Cobalt-60 use and later to be converted to X-ray would be unnecessarily expensive because the waterpit and mechanisms for Cobalt-60 are very costly and not of any use for X-ray. The money saved from building a cheaper facility could be used toward more rapid development of the X-ray technique.

As to item C above the cost of irradiation per pound of product should be projected in the EIS against the cost of present methods with a timecurve over the next 10 years or so. Individual papaya growers should then be asked for their preference. The question may also be posed if at any time an irradiator would be built by private industry in the indicated locations, or even if private industry would venture after 3 years to take over the facility at no cost and run it, because if after 3 years it would shut down because of insufficient business, the 5 million dollars of taxpayers money will have been wasted. It is not necessary to build an experimental irradiator to boost the papaya industry on the Big Island by way of trial and error. This can be worked out with pencil and paper and a telephone only. It might for example be found that location on Oahu as more central for the state-wide papaya industry and for ancillary use like medical desinfection applications - is far more economical.

There seems to be a pervasive notion among papaya growers that there would be no charge at all for irradiation for 3 years because the plant is labeled as a demonstration project, funded totally by the

Federal and State Governments. And this would explain some acceptance among the growers, although this is not universal as the Papaya Growers Association wants one to believe. There are cautious growers who fear product rejection, especially if it should not properly be labeled. The EIS should evaluate this particular impact, which is important if the papaya industry is to survive this experiment.

It would be frivolous if a plant is built because some in the industry want a free ride for 3 years and then they can always see whether to go back to the old and cheaper methods of desinfestation. The old methods may not be around any more because the experimental irradiator put them out of business. This impact should be fully highlighted in the EIS as an economic consequence because taxpayers money should not be used to kill an existing useful industry for the sake of a trial balloon.

An alternative scenario would be to let things be as they are but instead of "no action" it could be suggested that available moneys be used to to work toward final adaptation of the X-ray application as a viable, useful and non-controversial irradiation procedure, that has many more applications than just for papayas if placed in the proper location. This will also change the impact on taxpayers money from a potential hazardous one into a useful development. I suggest that the EIS dwell on this aspect of its subject matter in extenso and support it with sufficient technical and economical data that are either already available or can be gathered within the timeframe set for the EIS.

I would like to point out that I have no personal interest in any irradiation project, nor would I be impacted by having a plant in the vicinity of Hilo, I am a retired engineer, living in Kohala, and I do not mind eating irradiated papayas. I am merely trying to put my personal experience and knowledge of radiation technology to use as a neutral observer of a controversial project.

Maybe I should point out here that the biochemical contents of papayas and other foods is indeed to a degree changed by irradiation, but this need not be hazardous at all. Proteins, lipids, carbohydrates and enzymes are all to a certain extent subject to breakdown, as is also effected by cooking, microwaving, canning, drying, storing and chemical additives. If an EIS would have been required before any canning took place we would not have had a canned vegetables and other foods, which apart from denaturation contain lead from can soldering as an added poison; and this is just one example of many. Only if anybody can show that detrimental chemicals are formed in the irradiation process to an extent that cannot be tolerated, similar to the danger of soldered cans and the like, would I for myself decline to eat irradiated food. I see the irradiation process as the food preservation method of the future.

If any further elaboration, data or source material is needed, please feel free to call on me.

Henry A Ross

WESTEC Services, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

May 23, 1988

Mr. Henry A. Ross
P. O. Box 99
Kapaau, Hawaii 96755

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Ross:

The following is provided in response to your letter of May 10, 1988 regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules and regulations, the topics noted in your letter will be discussed in the appropriate sections of the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII

25 AUPUNI STREET • HILO, HAWAII 96720

March 31, 1988

WESTEC Services, Inc./ERCI
ATTENTION: MR. JAMES FROLICH, SR., PROJECT MANAGER
3049 Ualena Street, Suite 1217
Honolulu, HI 96819

FOOD COMMODITIES IRRADIATION FACILITY
ENVIRONMENTAL ASSESSMENT/EIS PREPARATION NOTICE

The anticipated maximum daily and peak hour water demand requirements for the proposed facility should be stated in order that water availability from the Department's existing water system facilities can be evaluated.

For your information, there are 12-inch and 8-inch waterlines in the vicinity of the three alternate sites. The area is served from our Panaewa deep well sources.

William Sewake
H. William Sewake
Manager

QA

... *Water brings progress*...

WESTEC Serv' es, Inc.
1221 State Street, Suite 200, Santa Barbara, CA 93101
(805) 962-0992

RECEIVED MAY 27 1988

May 23, 1988

Mr. H. William Sewake
Manager, Department of Water Supply
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

SUBJECT: HAWAII COMMODITIES IRRADIATION FACILITY
EIS PREPARATION NOTICE

Dear Mr. Sewake:

The following is provided in response to your letter of March 31, 1988 regarding the subject EIS Preparation Notice.

In accordance with applicable EIS rules and regulations, the projected maximum daily and peak water demand requirements for the proposed irradiation facility will be given in the EIS.

Thank you for the information regarding the source of water and the sizes of the waterlines that will service the three alternative sites. This information will also be included in the EIS.

Thank you for your comments and participation in the EIS Preparation Notice consultation process. Your letter and this response will be appended to the Draft EIS.

Sincerely,

for James W. Frolich,
Senior Project Manager

cc: Mr. Roger A. Ulveling, Director
Department of Business and Economic Development

APPENDIX D

SITE EVALUATION REPORT:

HAWAII COMMODITIES IRRADIATION FACILITY SITE EVALUATION REPORT

BY: WESTEC SERVICES

HAWAII COMMODITIES IRRADIATION FACILITY
SITE EVALUATION REPORT

Prepared for:

State of Hawaii
Department of Business and Economic Development
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Prepared by:

WESTEC Services
3049 Ualena Street, Suite 1217
Honolulu, Hawaii 96819
(808) 836-3036
Attention: Jim Frolich

With:

Belt Collins & Associates
and
Gordon Chapman

Project Number: 38-018-001

June 1988

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

D-3

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

SECTION 1
INTRODUCTION

1.1 Introduction and Purpose

The State of Hawaii Department of Business and Economic Development (DBED) has studied the feasibility of constructing a fruit commodities irradiation facility to meet quarantine requirements for fruit, mainly papaya, shipped to the mainland U.S. and Japan. The proposed facility would be a U.S. Department of Energy and State of Hawaii government-sponsored demonstration facility for 3 years, after which the facility would be commercially operated or decommissioned, depending on results obtained during the demonstration period.

Following the determination that an irradiation facility is feasible (CH2M Hill 1987), the DBED has been directed by the legislature to prepare an environmental impact statement (EIS) (required under Act 216, Section 281, Session Laws of Hawaii 1987, to be prepared in accordance with Chapter 343 Hawaii Revised Statutes and Chapter 200, Title 11, Administrative Rules of the State of Hawaii Department of Health). To conduct this task, a project site or sites must be identified.

The purpose of this site evaluation report is to identify and prepare development concepts for three alternative project site: for the proposed commodities irradiation facility. Specifically the report will:

1. Allow the EIS to be prepared by providing adequate information about the project and site. Additionally, it will allow EIS assessment of more than one site, thus providing for selection of an alternative if a preferred site becomes unavailable, and allowing public review and comment on the environmental effects of more than one site.

2. Provide further documentation of the site selection process for inclusion in the project development record.
3. Summarize the relative desirability of sites with regard to specific engineering, environmental, and transportation concerns.

Additionally this investigation has identified additional information on fruit transportation and logistics that can assist decision makers in developing the irradiation facility.

1.2 Irradiation Facility Description

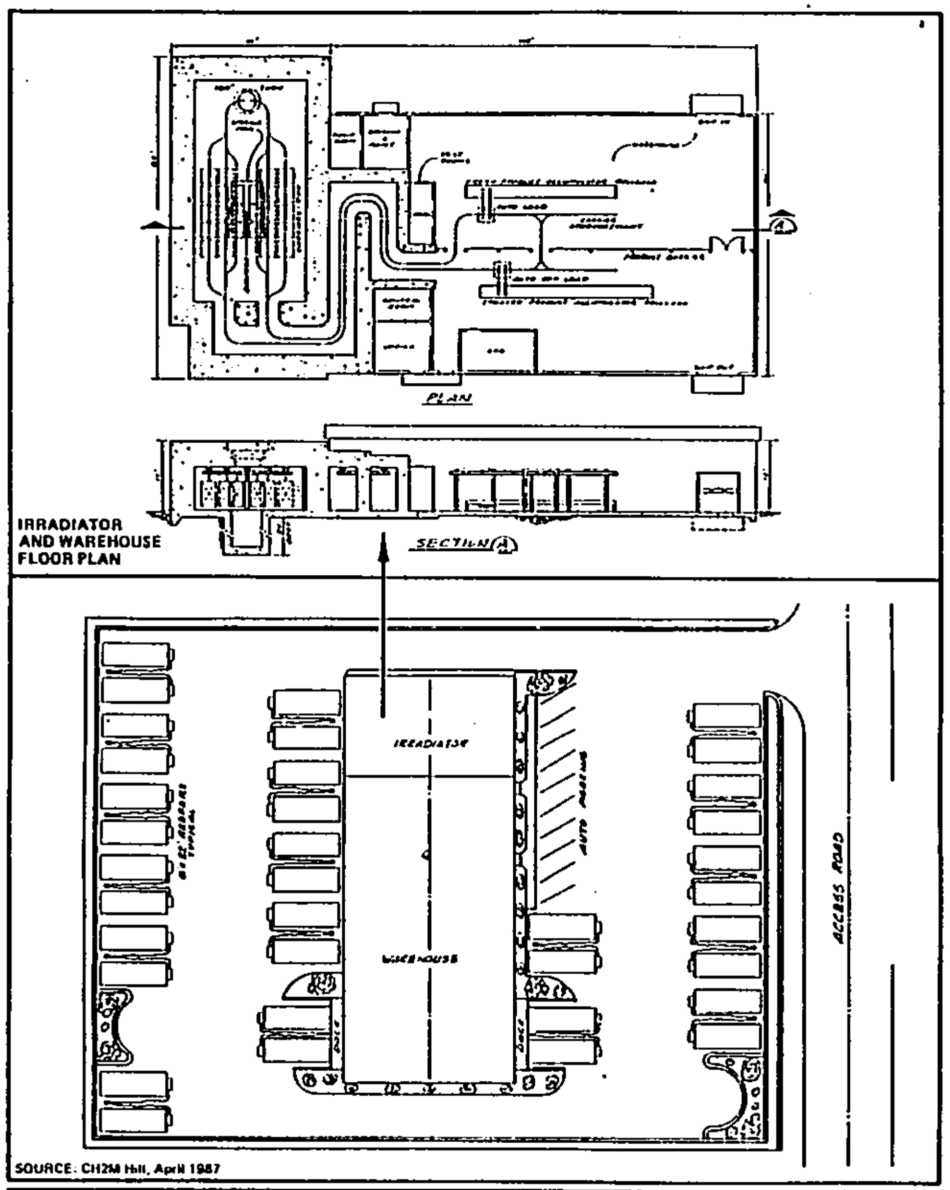
This site evaluation report is based on the project concept described as "Option 2" in CH2M Hill's 1987 feasibility study for the commodities irradiation facility. Figure 1-1 is a generic plot plan and building layout for the irradiation facility recommended in the CH2M Hill report.

The proposed irradiation facility would use gamma rays emitted by the radio-isotope Cobalt-60 as a radiation source to treat fruit commodities. The irradiation facility would be a multi-purpose facility designed to handle pallets of papayas primarily, with the capability to also treat mangoes, lychees, and other tropical fruits. The minimum absorbed dosage given the fruits would be 150 Gray (Gy) for papayas and 300 Gy for mangoes, as required by the U.S. Food and Drug Administration (7 CFR Part 318). (A Gray is the International System Unit for an absorbed dose of radiation; one Gray is equal to the energy imparted by ionizing radiation to a mass of material corresponding to one joule per kilogram.). A dosage criteria has not yet been developed for lychees. Absorbed dosages would not exceed the allowed maximum of 1000 Gy for fruits and vegetables. Throughput capacity of the facility is estimated to be 22,500 pounds of papaya per hour, but no throughput estimate has been established for the relatively small mango or lychee industries. The facility could be modified to allow treatment of other fruit and agricultural commodities by changing pallet equipment and handling operations.

Fruit would flow through the proposed facility as follows:

- Pallets of boxed and sealed fruit would be delivered from the packing houses to the irradiation facility by flatbed trucks.

- The pallets would be unloaded from trucks into a receiving area.



Generic Facility Plot Plan from Feasibility Report

FIGURE 1-1

WESTEC Services, Inc.

- From there they would be placed onto an automatic conveying system which transports the palletized fruit through the irradiation room, exposing the fruit to the gamma ray emissions from the radiation source. Source exposure and treatment time would be the same for each treatment lot.

- Following treatment, the conveying system would deliver the processed fruit to a product holding area, where recording and certification would take place (CH2M Hill 1987).

- The processed fruit would then either be picked up by truck for return to a packer's warehouse, delivered to the airport, or stored at room temperature for 12 hours, then chilled, ready for delivery in refrigerated containers for barge shipments, or by truck or loader for palletized air shipment. Chilling the fruit prior to sea transport is apparently necessary since the refrigerated containers of the type used by Young Brothers cannot efficiently chill, but only maintain the temperature of the fruit (Amfac-Wallis consultation; Young Brothers consultation).

1.3 Methodology

In preparing this report, we have utilized information from three basic sources: interviews with government and papaya industry representatives, review of relevant documentation, and site investigations.

Interviews with packers, cargo handlers, airport officials, and other regulators helped to determine the operational requirements for and limitations on the proposed irradiation facility (organizations consulted are listed in Appendix B). The information obtained provided a basic understanding of how the irradiation facility would be used by the papaya packers. This understanding is discussed in Section 2, Operational Requirements, and provides guidance to where the facility should be sited.

We also reviewed literature and documents relevant to the proposed facility (e.g., feasibility study report) and to the Hilo community (e.g., the Hawaii County General Plan, The General Lyman Field Master Plan). This information contributed further to the discussion in Section 2, and to the subsequent engineering and environmental assessment in Section 4.

Section 3 identifies current project site status. Field investigations of engineering constraints (e.g., access and utilities) and environmental issues (e.g., biology, archaeology, traffic, land use) were conducted for the potential project areas. These investigations form the foundation of Section 4, Site Assessment, and were intended to provide direction on where the irradiation facility should not be sited. After all of the information on operations and constraints was analyzed, specific sites in each area were identified and site-specific concept plans for the commodities irradiation facility were prepared. These specific sites are identified in Section 4. Conclusions on the sites are summarized in Section 5.

SECTION 2
INDUSTRY OPERATIONAL REQUIREMENTS

2.1 INTRODUCTION

This section discusses the operational factors assoc ted with fruit handling and disinfestation that have a bearing on the location of an irradiation facility. Such factors include packing house location, truck transportation routes, inter-island and overseas transportation routes/modes/facilities, product handling requirements (e.g., refrigeration), packaging, future changes in transportation links (e.g., commencement of overseas cargo shipping from General Lyman Field), and the irradiat n facility's consistency or conflict with other land uses or activities (e.g., airport clear zone requirements). This review provides the framework for identifying suitable sites in each area for the proposed facility.

2.2 FRUIT INDUSTRY LOGISTICS

Initially, the proposed irradiation facility will be used primarily to treat papaya. This is because papaya is, at 45-50 million pounds per year exported (PAC 1987), by far the largest export crop requiring quarantine and because the papaya industry is large and well organized to participate in the DOE's demonstration irradiation program. Consequently, this report focuses on that crop. Other candidate fruits, such as mangoes or lychee, are discussed where information is available and relevant.

2.2.1 Packing House Locations

There are currently eight papaya packers in Hawaii:

1. Pacific Tropical Products (formerly Mr. Papaya Co-operative Inc.)
   871 Iolani Street
   Hilo, Hawaii 96720

2. Del Monte Corporation
   30 Makaala Street
   Hilo, HI 96720

D-7

3. Ono Pac Corporation
   100 Kukila Street
   Hilo, HI 96720

4. Hawaiian Host Chocolates
   215D Railroad Avenue
   Hilo, Hawaii 96720

5. Amfac Tropical Products
   P.O. Box 210
   Keaau, HI 96749

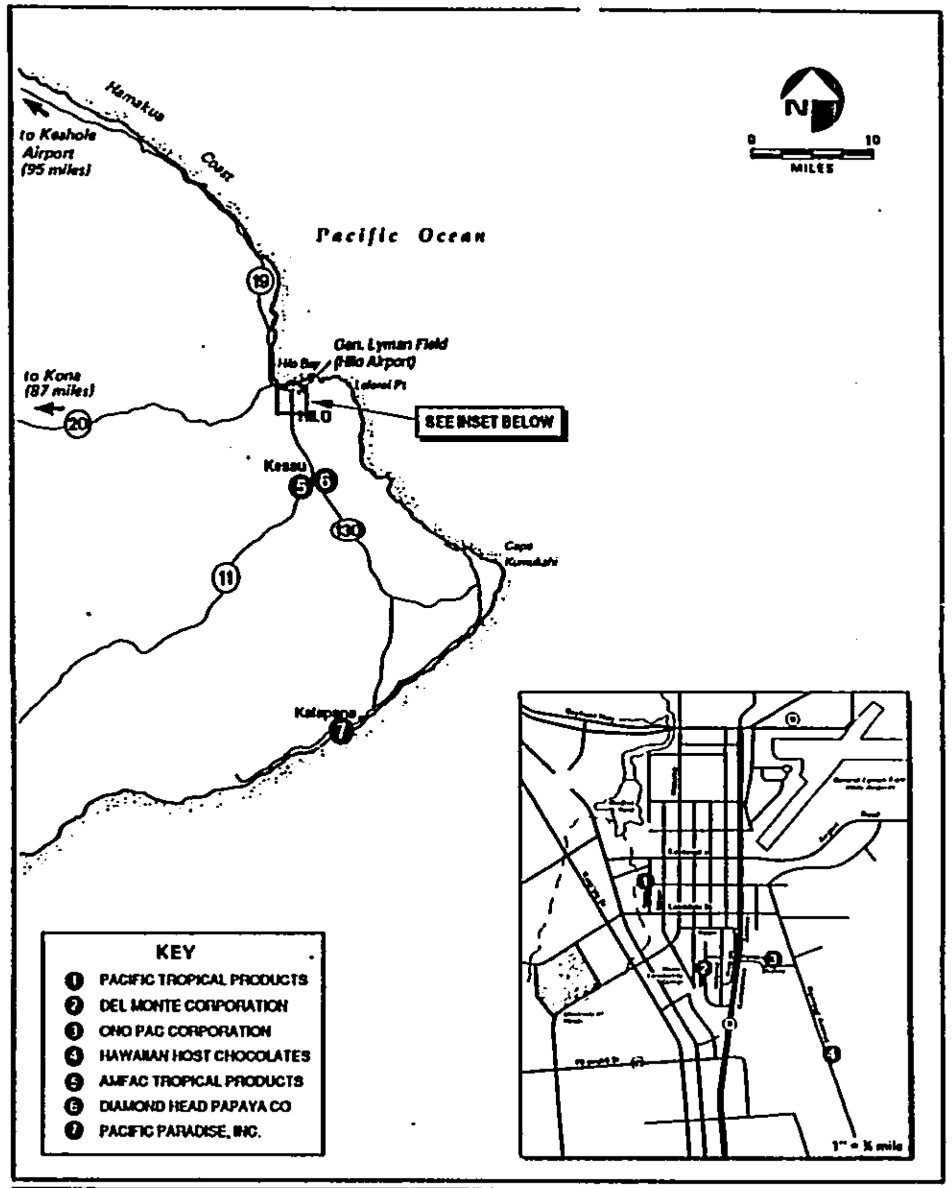
6. Diamond Head Papaya Company
   P.O. Box 1569
   Keaau, HI 96749-1569

7. Pacific Paradise, Inc.
   Box RR1 - 5700
   Kalapana, HI 96778

8. Best Fruits, Inc. (Kauai)
   5611 Kawaihau Road
   Kapaa, HI 96746

(Source: PAC consultation)

Seven of the eight packers are located on the island of Hawaii (see Figure 2-1); four of them (Del Monte, Hawaiian Host, Ono Pac, and Pacific Tropical Products) are located in Hilo within 1-1/2 miles of Hilo Airport. All have easy access to Areas A and B, both of which are on the transportation route from the packing houses to Hilo Airport and Hilo Harbor. Area C is also nearby (and actually closer) but not as convenient for the packers (with the exception of Ono Pac and Hawaiian Host). Two packers (Amfac and Diamond Head) are located in Keaau, approximately 7 miles south of Hilo. Both are adjacent to Highway 11, which provides direct access to Hilo Airport. Pacific Paradise is located at Kalapana, 30 miles south of the airport on Highway 13.



Packing House Locations on the Island of Hawaii

FIGURE 2-1

WESTEC Services, Inc.

All the Hawaii Island packers currently ship most of their fruit through Hilo Harbor to Honolulu for transshipment to the mainland. Smaller quantities are shipped by air from General Lyman Field to Honolulu and then on to the mainland (generally by air, but also by ship). A few of the packers also transport fruit approximately 90 miles west to the Keahole Airport for shipment by air on passenger planes direct to the mainland. Nevertheless, the great majority of the Hawaii papaya shipments move through the vicinity of Hilo airport.

Due to its location, the lone Kauai packer (Best Fruits) is not expected to use the proposed irradiation facility (PAC-Souza consultation).

2.2.2 Current Treatment and Transportation Logistics

At present, there are two types of insect disinfestation treatment methods being used commercially by Hawaiian papaya packers: double hot water dip and vapor heat. Double hot water dip-treated fruit is generally shipped to mainland U.S. markets while vapor heat treated fruit is primarily shipped to Japan, with some fruit going to the mainland U.S. market. Regardless of the type of treatment or packer, the fruit generally moves through the same types of steps from grower to market. There are slight variations due to different packer's methods of operation and equipment.

The following description is based on consultations with various packers (Amfac, Ono Pac, etc.): In general, the fruit moves from the grower's field to the treatment/packing house via the grower's trucks. The fruit is offloaded onto wooden pallets (skips), graded, sorted, treated, packed into shipping boxes, sealed, stacked on wooden skips, and stored in refrigerators to chill the fruit (to about 50° F) by the packer. The fruit is then either stacked into refrigerated containers at the packer's plant or trucked to and stacked in refrigerated containers at Hilo Harbor if it is being shipped by barge. The fruit is barged to Honolulu and transshipped to the mainland U.S., generally in the same container for overseas surface transport. Fruit that is being shipped by air is restacked into air freight containers (LD-7 or LD-3 containers) at the packing house or at the airport, loaded onto the aircraft, and shipped to Honolulu for transshipment in the same container to the mainland U.S. or Japan. Fruit barged to Honolulu then air shipped must be unloaded from refrigerated containers and loaded into aircraft containers at Honolulu.

Slight differences in handling and shipping occur as a result of the size of the refrigeration units any one packer may have, shipping schedules (air or barge), and the type of treatment used.

2.2.3 Treatment and Transportation Logistics for Irradiated Fruit

The establishment of the irradiation treatment facility will require changes in the flow of fruit from the packer's plants to the shipment point. There will be two basic flow paths that the fruit could take, depending on the individual packing house and the course that packer may choose to follow. In both cases fruit would continue to be delivered to the packing house by the growers and the initial steps of the process would be the same, i.e., the fruit would be sorted, graded, packed, and sealed at the packing house. (In contrast to other methods, irradiation treatment occurs after the fruit is boxed and sealed, since water and heat are not required for treatment.) The fruit would then be stacked on wooden pallets, transported to the irradiation treatment facility, treated, and either stored in refrigeration units at the treatment facility or returned to the packer for refrigeration prior to shipment via barge or air. If fruit is stored at the treatment facility, storage and refrigeration space would be required. It is likely that distant packers, at least (especially Pacific Paradise at Kalapana), would prefer to store at or near the irradiation facility, depending on costs.

Should air freight shipments increase dramatically and the irradiation treatment facility have direct or relatively direct access to the aircraft, it is unlikely that the fruit would be chilled or returned to the packers, but instead would be loaded directly into air freight containers then delivered to the aircraft for shipment to Honolulu or possibly overseas. In some instances, for example during peak seasons, it is possible that a combination of the two possible flow paths would be necessary due to limited storage capacity at the treatment facility and limited capacity of the various transportation modes.

Dr. Robert Paull of the University of Hawaii, Manoa, is currently conducting research on the effects of refrigerating irradiated papaya. Using absorbed dosages of 10-40 krads, preliminary study has shown that papaya which is green and one-quarter ripe or less experiences scalding and discoloration when refrigerated within 12 hours after irradiation treatment. Also a concern is the tendency for such fruit to soften upon developing 40-50 percent of its yellow color, although the softening problem is intermittent. At the present time it is uncertain whether fruit damage results from irradiating pre-chilled papaya. Further research is necessary to explain the variance of fruit softening and to determine if a problem exists when chilled papaya is irradiated (University of Hawaii, Dr. Robert Paull consultation). As a consequence of these developments, space for the fruit to "rest" prior to chilling may be required, unless fruit is relatively ripe when irradiated.

2.2.4 Quarantine Packaging and Inspection

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), regulates the handling and packaging of treated products to prevent reinfestation. Guidelines for packaging irradiated papayas are discussed in 7 CFR Part 318. In brief, these guidelines specify that the packer must seal shipping boxes with permanent tape to keep fruit flies from entering and contacting the fruit. Treated boxes must be stamped "Treated-USDA, APHIS." Treated and untreated fruit must be kept in areas separated by a permanent physical barrier, such as a wall or fence to prevent commingling of irradiated and untreated fruit. Completely sealed boxes are required to prevent reinfestation of packed and treated fruit.

Inspection of current disinfestation methods (i.e., vapor heat treatment and double hot water dip) is carried out by an APHIS inspector at each packaging facility. Inspection procedures vary for each treatment. Basically, inspection of the vapor heat method consists of verification that heat probe sensors are inserted into about 10 of the largest papaya in each lot, which are then distributed in regions which were predetermined to be potential cold spots; verification that the chamber is loaded correctly and then completely secured; and certification of computer records to verify that the treatment process operated correctly. After processing, papayas destined for U.S. mainland markets are "spot checked" for procedural compliance; 5 percent of all papayas bound for Japan are inspected for insects other than fruit flies and plant diseases.

Supervision of the double dip method is comparable to vapor heat but more complicated due to the system. The protocol requires the fruit to be treated within 18 hours of being picked. The fruit is immersed in two hot water baths with no more than 3 minutes between the dips. The fruit is generally hydrocooled before packing. As the fruit proceeds through the packing line it is observed by the inspector who visually chooses a minimum of 24 samples every 20 minutes. The six ripest appearing fruits are checked with a colorimeter. Water temperature, treatment time, and colorimeter readings are electronically recorded. After the fruit is packed, the box is sealed and stamped. Treatment records and shipping

documents provide verification that a lot has been accurately treated (APHIS, Uyeda consultation).

APHIS inspectors are not required to inspect all irradiated products. Rather the operator of the irradiator must maintain and keep records on lot identification, scheduled process, evidence of compliance with the scheduled process, source calibration, and dosimetry. APHIS inspectors will periodically monitor facility operation and review records.

In addition to APHIS inspectors who certify treatment for fruit fly pests, State inspectors check for quality and grade (APHIS, Fons consultation).

2.3 Current and Planned Cargo Operations

Fruit grown and packed on the Island of Hawaii is transported to the mainland and foreign countries by air and/or sea. Fruit is generally first moved to Honolulu (by barge or airplane) then sent on to the mainland (by airplane or ship). These transportation routes and methods are discussed below.

2.3.1 Current Barge and Ship Activities

2.3.1.1 Inter-Island Barges

Current barge transport for Hawaiian papaya is provided by Young Brothers Limited and Matson Navigation Co.

Young Brothers provides the only regularly scheduled year-round, inter-island barge freight service between the six major ports in the state (including Honolulu and Hilo), but does not provide transport to the mainland. Young Brothers transports fruit either in refrigerated containers (20 feet long x 8 feet wide x 8-1/2 feet high), which carry about 10,800 pounds of papaya (and have a maximum capacity of 40,000 pounds) or on wooden pallets under cover for one day trips. Scheduled barge service is provided on twice weekly night service between Honolulu and Hilo. Sailings are subject to cancellation if the scheduled trip falls on a holiday or if sea conditions do not allow safe passage (Simat 1986). Young Brothers' cargo rates for fruits and vegetables depend on density, cubic measurement, and revenue ton but generally range from about $200 to $350 per refrigerated container for island products (Young Brothers, Char consultation) plus $50 per container for truck delivery (Amfac, Wallis consultation). This amounts to about 3.5¢ per pound. Young Brothers will deliver to both air cargo and sea cargo terminals in Honolulu (Simat 1986). Direct barge service lines between the neighbor islands are virtually nonexistent.

Matson operates inter-island barges only for cargo connecting through to overseas Matson ships. Facilities are similar to those of Young Brothers barge costs are included in the overseas tariff.

2.3.1.2 Overseas Shipping

Primary service for surface freight between Hawaii and the U.S. mainland is currently provided by Matson Navigation Co. which operates a minimum of two to three sailings per week between Honolulu and the U.S. mainland West Coast (Los Angeles, San Francisco, and Portland/Seattle) (Simat 1986). Papaya is shipped in 24-foot long refrigerated containers to Honolulu; there it is transferred to Matson container ships for overseas transport to the mainland (Matson, Shigemitsu consultation). The trip from Honolulu to the U.S. West Coast takes between 5 and 7 days, depending upon the West Coast destination. Additional sailing time to and from the neighbor islands requires about one day.

Presently, about 35 percent of the mainland-bound Hawaiian papaya (or 17 percent of total worldwide exports) is shipped as surface freight from the state (PAC 1987).

2.3.2 Current Air Cargo Operations

2.3.2.1 Inter-Island Service

There is currently no direct overseas air cargo transport from Hilo. All freight must be hauled first to Honolulu where it is transferred to overseas aircraft.

Aloha Airlines is the only bulk air freight handler operating, although Hawaiian Airlines can carry some freight in its passenger planes. (Mid-Pacific Airlines, now in bankruptcy, previously competed in the air cargo market using a fleet of YS-11 turboprops.) Aloha Airlines presently schedules three flights between Hilo and Honolulu every night except Saturday, using two Boeing B-737QC ("quick-change") jets and a Convair prop-plane.

(The B-737QC aircraft transport passengers during the day; at night seats are removed and the plane is used for freight service.) Aloha is planning to add a third B-737QC ; this will result in addition of a fourth Hilo-Honolulu flight (Aloha, Tagudin consultation). Each plane can carry approximately 28,500 pounds of freight (net), thus current weekly capacity is 513,000 pounds, going up to 684,000 pounds with the addition of another aircraft (Aloha, Tagudin consultation). (Note that complaints about nighttime airport noise could limit increased night freight flights (DOT, Balbarino consultation). Thus, only about 50 percent of the average annual production and less than 30 percent of peak production can be accommodated by Aloha, even if all Hilo service were dedicated to papaya.

Aloha uses standardized, roller-mounted equipment for freight shipping. Its preferred container equipment is the A-3 container and LD-7 88 inch x 125 inch pallet. Each 737 can carry seven of these units. The LD-7 pallet can hold four 40 inch x 48 inch skips. Maximum height for palletized goods is approximately 58 inch, or eight to nine 6 inch high papaya boxes. Thus, approximately 350-400 papaya boxes can be carried on each LD-7 pallet. LD-3 containers can be used but result in inefficient use of B-737QC cargo space, due to the container's dimensions. The LD-3 pallets require cargo to be removed from the skips (Aloha, Tagudin consultation).

On the ground, the pallets and containers are transported by standardized loaders, pulled by tractors. Forklift-type equipment is used for nonstandardized loads. Aloha's cargo operations in Hilo are currently located in a warehouse adjacent to Area B - Old Terminal. They are space-limited and probably cannot be expanded beyond current facilities without relocation (DOT consultation).

UPS is currently investigating the stationing of a freighter aircraft at Hilo. This plane would provide connections between neighbor islands and the Honolulu-mainland UPS 747 cargo flights (DOT, Balbarino consultation). Such service could assist in meeting papaya freight demand, although capacity would be limited.

Currently, Diamond Head Papaya Company and Hawaiia[illegible] lost use Aloha for shipment of vapor heat-treated papayas to Honolulu for air transshipment to Japan. Approximately 80,000-120,000 pounds of papaya (3-4 plane loads) are shipped weekly. Diamond Head uses LD-7 pallets owned by Japan Airlines. Other growers use Aloha on occasion, depending on barge space availability and market conditions.

Costs for airshipping of papayas between Hilo and Honolulu are approximately $0.08 to $0.11 per pound plus $0.05 per pound for handling at airport, depending on the day and flight (Amfac, Wallis consultation).

2.3.2.2 Overseas Service

Approximately 83 percent of papaya exports (65 percent of mainland-bound fruit) is shipped by air, even though most fruit is transported inter-island by barge (PAC 1987). Hawaii's overseas air cargo services are provided almost exclusively through Honolulu International Airport, and primarily as a by-product of passenger airline services (Simat 1986). Current air transport of Hawaiian papaya to the U.S. mainland can be provided by American, United, Delta, Continental, UPS, and Emery, with UPS and Emery being the only all-cargo operators.

United Airlines provided overseas passenger service to Hilo from the mainland West Coast until a few years ago. Service was terminated because of Hilo's limited draw of tourists, as compared to Honolulu, Oahu, and resort centers near Kona, Hawaii and on other neighbor islands.

Although Hilo airport is designated as an international airport, it is not served by customs and immigration services required for international service (Hawaii County, Shintani consultation). One customs agent serves the Hilo pier. This agent could possibly expand responsibilities in Hilo to include airport inspections. However, additional customs staffing would require congressional approval (Hawaii County, Shintani consultation). APHIS inspectors are onsite.

Amfac has, until recently, shipped papaya to the mainland via United Airlines from Keahole Airport on the Island of Hawaii, approximately 3 hours by truck from the packing house. The papayas were handled as belly-cargo on LD-3 pallets in DC-10 passenger planes. United recently changed to DC-8 service from Keahole. The LD-3 pallets cannot be handled by the older DC-8s; thus shipping from Keahole is no longer feasible (Amfac, Wallis consultation). However, United may return to DC-10 service in the summer (high tourism) months (United consultation). This variability in service obviously limits the viability of regular shipments from Keahole. (Also, the long truck trip could subject the fruit to unacceptably high temperatures during the summer months (Amfac, Wallis consultation).)

2.3.3 Planned Hilo Airport Cargo Service Expansion

Expansion of air cargo service from Hilo can take the form of increased inter-island (i.e., Hilo to Honolulu) flights, re-establishment of overseas passenger service that can carry freight, or the implementation of overseas cargo-only service.

Planned expansion of Aloha Airlines inter-island service is discussed in the previous section. It appears that Aloha could increase its schedule if there was demand without insurmountable problems, although the expensive addition of aircraft would be required and airport noise could become a community issue. Additionally, other carriers could begin service, perhaps using equipment and facilities that were operated by Mid-Pacific. No proposals for such service have been announced.

United, American, Continental, Delta, Northwest, and Hawaiian Airlines were contacted. None would state that they have plans to serve Hilo in the future, although development in the eastern part of Hawaii could change this (see Appendix B for consultations). Mixed cargo/passenger planes could help meet the combination of low cargo and passenger demand. However, no airlines said that there are plans for such service.

The County of Hawaii Office of Housing and Community Development commissioned a two-phase study to evaluate the feasibility of establishing a cargo transport and distribution center at General Lyman Field in Hilo (Simat 1986). The first phase concluded that such a facility was economically feasible. The second phase, which outlined a plan for such a facility, concluded that 800 tons of cargo per day could move through Hilo by the fifth year of a cargo facility's operation. This level of freight translates to approximately six B-747 cargo flights per day (Simat 1986). The preferred site for this facility is 25 acres in the Airport Industrial Area, although the Old Terminal area is also under consideration. The facility plan includes provisions for the irradiation facility (Hawaii County, Shintani consultation).

Implementation of the county's plans could greatly facilitate direct overseas air shipment of irradiated fruit from Hilo, depending on costs. It appears questionable, however, that the facility will be built and proven viable, at least during the 3-year irradiation demonstration period.

The County of Hawaii Department of Research and Development is investigating the viability of establishing a foreign trade zone at Hilo Airport. This foreign trade zone would allow storage of foreign goods bound for other countries or the U.S. mainland (thereby avoiding or postponing duty payments) and manufacture of products using foreign materials (again to postpone or avoid taxes). The county is currently preparing a proposal for U.S. Commerce Department approval of the zone. This proposal is expected to be submitted by June 1988 and may take up to 18 months for approval (Hawaii County, Shintani consultation). While the county's program is in the early development stage, current plans call for location of the foreign trade zone at the airport, which is designated an international airport (Hawaii County, Shintani consultation). The county's favored location is in Area B - Old Terminal, although a site in the vicinity of Area A - Airport Industrial Area may also be acceptable. The county feels that the proposed irradiation facility would be compatible with the zone (Hawaii County, Shintani consultation). Co-location at Area B, especially if a major air cargo facility was also constructed there, could be constrained by the limited availability of useable land. Establishment of a foreign trade zone could result in an increase in international trade to and from Hilo, facilitating irradiated fruit export.

2.3.4 Summary

While the majority of the papaya leaving the state goes by airplane from Honolulu, inter-island connections occur by barge. This transportation mix is not expected to change significantly. Expansion of inter-island air service at Hilo is occurring and could meet part of demand for papaya shipment. Overseas passenger service with limited cargo capabilities is not expected to occur from Hilo in the foreseeable future. If the county-sponsored air cargo distribution facility were to be constructed and successfully operated, papaya treatment at the Hilo Airport would be greatly facilitated. The viability of this facility appears questionable at this time.

SECTION 3
SITE SELECTION STATUS

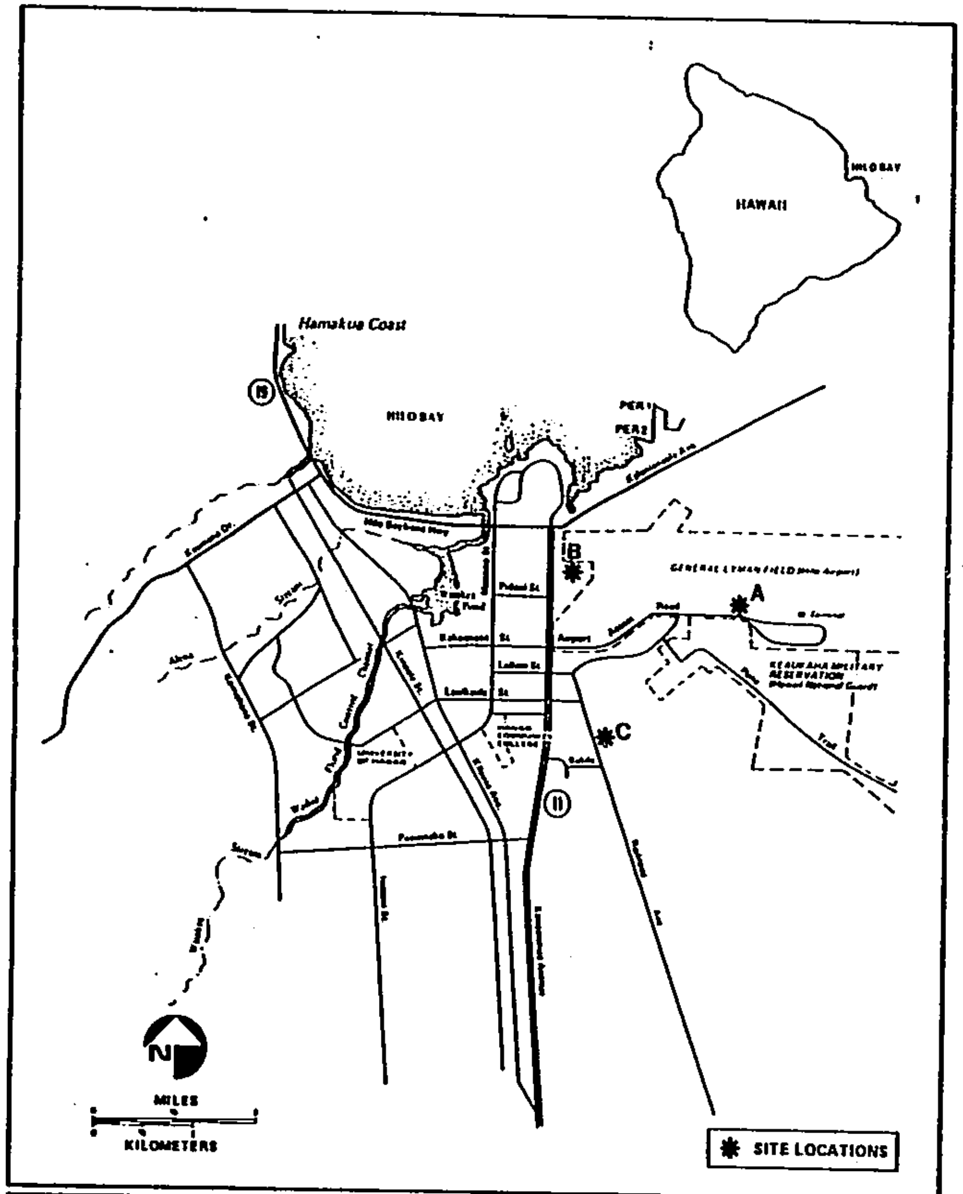
3.1 INTRODUCTION

The 1987 feasibility study prepared by CH2M Hill included a site analysis (included here as Appendix A) which identified feasible locations for a commodities irradiation facility in Hawaii. This site analysis reviewed fruit production areas, transportation routes, land availability, costs, and environmental issues. The analysis first narrowed feasible site locations for an irradiation facility to Hilo, Hawaii; Honolulu, Oahu; and Lihue, Kauai. Further study removed Lihue from consideration leaving Hilo, near most production areas and papaya packers, and Honolulu, where most overseas transportation currently begins.

The CH2M Hill report ranked Hilo and Honolulu nearly equal in terms of site desirability. Subsequently, the state selected the Hilo area for fu.. er evaluation because of land availability, the desirability of having the demonstration facility close to growers and packers, and government policy considerations (see Fi-ure 3-1 for regional location).

Hilo provides the advantages of:

- Proximity to the majority of growers and to 7 of 8 papaya packers in the entire state (the Island of Hawaii provides approximately 80-85 percent of papaya exports (CH2M Hill 1987));
- Proximity to air (General Lyman Field) and sea transport facilities (Prince Kuhio Wharf in Hilo Harbor);
- Tentative plans for a large air cargo distribution and transshipment facility at the airport (Simat 1986);
- Availability of state-managed land, (Because of the project's nature as a government-sponsored demonstration project, state land management was deemed preferable by DBED); and
- Avoidance of extra handling associated with unloading and loading containers that would be necessary if treatment occurred in Honolulu.



Regional Location

FIGURE 3-1

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Following selection of Hilo as a feasible location for an irradiation facility, the DBED determined that the General Lyman Field area was preferable because it contains available state-managed land, provides access to airport cargo service, is close to Prince Kuhio Wharf, and is on the transportation route from packers to shipping points (i.e., airport or wharfs). Therefore, DBED consulted other state agencies and reviewed available state-owned land in the vicinity of General Lyman Field for uti' service, land use consistency, and access.

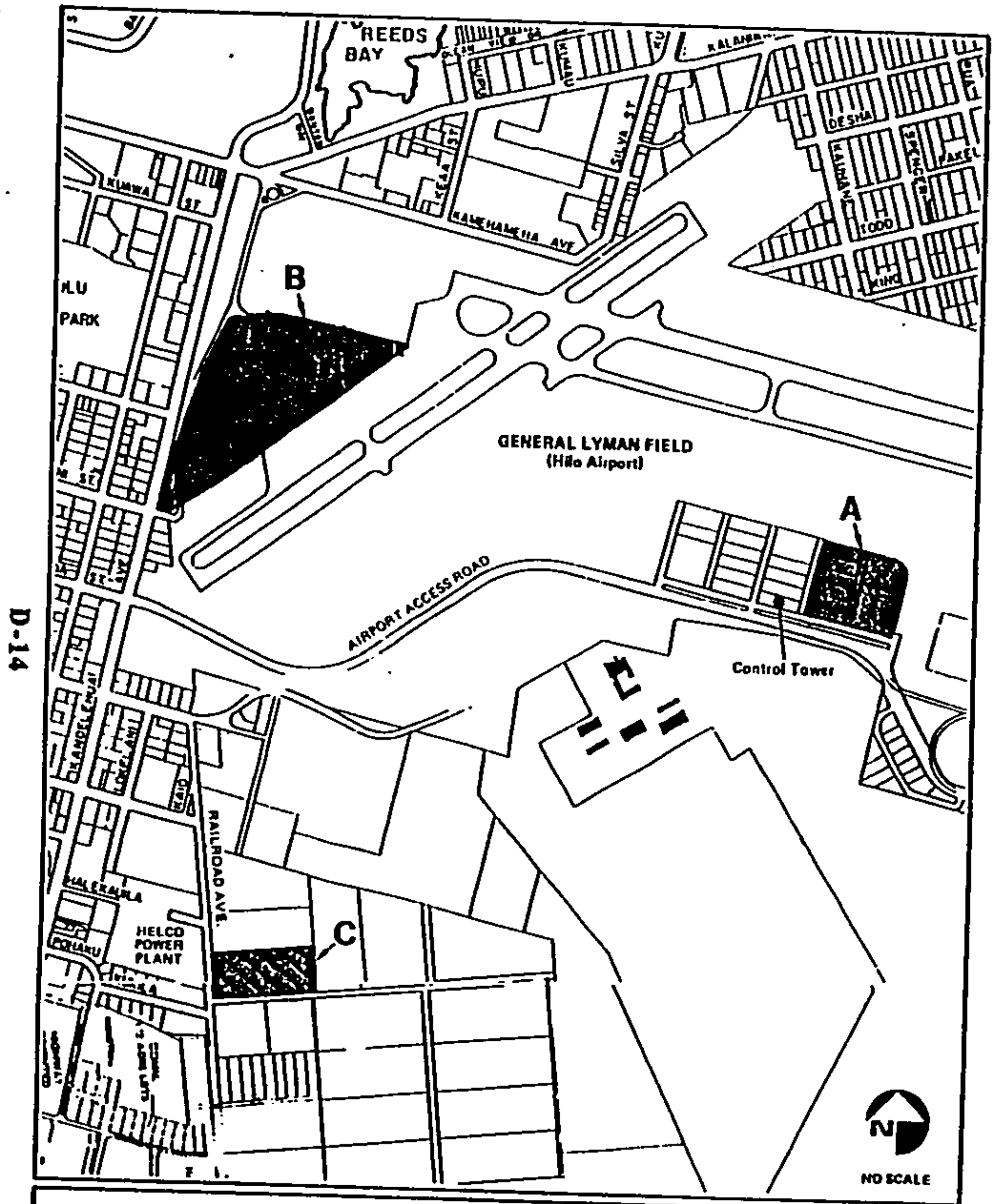
The following five site areas were identified as feasible locations (controlling agency is in parentheses): (1) an approximately 13-acre area at the eastern end of the airport industrial area (Department of Transportation-[DOT]), (2) the old 'rport terminal area (Department of Land and Natural Resources [DLNR] and DOT) (3) an approximately 13-acre parcel on Railroad Avenue, formerly used for a concrete batch plant (Department of Hawaiian Home Lands -[DHHL]), (4) a former quarry south of the airport access road (DOT), and (5) 30-40 acres of undeveloped land southeast of the Railroad Avenue site (DHHL). After review, DBED excluded areas (4) and (5) from consideration due to lack of utility services, potentially high site development costs, potential environmental effects (in the case of area (5)), and DOT recommendations (Hirata memorandum, January 15, 1987 - See Appendix B).

The three remaining areas are the subject of the remainder of this evaluation report. Each area was assessed to further identify the best location for the 4- to 5-acre commodities irradiation facility.

3.2 Site Area Locations

The three areas referred to as Area A - Airport Industri l Area, Area B - Old Terminal, and Area C - Railroad Avenue, are all near Hilo Airpor (see Figure 3-2). The following discussion is a description of each area.

Area A - Airport Industrial Area consists of approximately 13 acres on either side of Leleaoa Street at the eastern end of the subdivided, but undeveloped airport industrial area. It is just east of the airport control tower; direct access to the airfield is available via an existing restricted service road. The area is adjacent to land which has been tentatively identified as the best location for the air cargo distribution and transshipment center



Site Areas A, B, and C

FIGURE 3-2

proposed by the county (Hawaii County, Shintani consultation). If the cargo center is located at this site, direct loading of treated commodities to airplanes would be facilitated (CIMAT, 1986). The site has been graded to two ele-ations to provide for truck loading docks and is identified as TMK 2-1-12:106-112 and 13

Area B - Old Terminal consists of approximately 40 acres near the old airport passenger terminal. Buildings in the area are currently used for air freight and general aviation activities. Area B includes lands within the airport secure fence line (under DOT control) and lands outside the fence (under DLNR management). The area provides easy access to present inter-island air cargo activities. The site is identified as TMK 2-1-12: por. 34, 86.

Area C - Railroad Avenue is a 13-acre parcel across Railroad Avenue from the Hawaii Electric Light Company (HELCO) power plant. The site was once used for concrete and gravel operations and is adjacent to asphalt batching and wood mill operations. The site is centered around TMK 2-1-25:86.

3.3 Land Management Issues

As discussed above, all three areas are being considered as possible locations for the commodities irradiation facility and are under the control of three state agencies:

- Area A - State Department of Transportation (DOT)
- Area B - State Department of Land and Natural Resources (DLNR)
- Area C - State Department of Hawaiian Home Lands (DHHL)

Each agency has a different perspective on the project. DOT essentially favors the proposed project as an airport-related industrial activity that could utilize vacant airport land. As indicated in a DOT memorandum (Appendix B), and as stated by the airport manager, DOT favors Area A - Airport Industrial Area (DOT, Balbarino consultation) for the location of the proposed irradiation facility. While the airport master plan is currently in preparation, it appears likely that any future air cargo development would also occur in the vicinity of Area A, but such development would be compatible with the proposed irradiation facility. In fact, as discussed in Section 2, the irradiation facility is included as part of Hawaii County's plans for a cargo distribution center.

DLNR would be responsible for most of Area B - Old Terminal. DLNR has not officially expressed support or approval of the proposed irradiation facility. DLNR is responsible for the disposition (including leases) of all state land, including that managed by DOT and some of the land managed by the DHHL. The Board of Land and Natural Resources would have to approve any lease of the land to the operator of the irradiation facility if it is on DLNR or DOT property. The lease would have to be by a competitive bid if it is to a private operator of the facility (DLNR, Fukumoto consultation).

DHHL administers Area C - Railroad Avenue. DHHL has allowed the site to be considered by DBED in its studies but has not authorized use for the proposed project (see memorandum in Appendix B). DHHL income property managers appear to approve the irradiation facility (DHHL, Yagodich consultation), however it may face opposition from homesteading advocates. It is currently unclear whether Area C - Railroad Avenue is subject to DLNR approval.

The U.S. Federal Aviation Administration (FAA) stated that any site that would have direct access to secure areas of the airport would have to be under DOT control. This would allow FAA to require DOT to enforce FAA security and land use requirements through lease conditions (FAA, Welhouse consultation).

None of the sites are within the coastal Special Management Area (SMA) zone (Hawaii County, Lyman Consultation).

SECTION 4
SITE ASSESSMENT

4.1 INTRODUCTION

This section summarizes the results of engineering and environmental evaluations conducted for each of the three possible commodities irradiation facility locations identified in Section 1.4. The discussion presents the following for each area:

- An engineering evaluation of the needed utility improvements and site work;
- A review of access considerations;
- An analysis of its compatibility with adjacent land uses and with public and private land use plans;
- A brief description of the biological and archaeological features present;
- A recommended site for the proposed facility within the overall area; and
- A discussion of geologic, hydrologic, and other physical factors bearing on its suitability as a food irradiator site.

4.2 AREA A - AIRPORT INDUSTRIAL AREA

4.2.1 Engineering Evaluation

4.2.1.1 Utilities and Sitework

Water

Estimated average daily water use by the proposed facility is about 1,200 gallons per day. The Department of Water Supply's (DWS) facilities connection charge for serving demand of this magnitude is $1,500. This charge is the same for all of the sites evaluated (DWS, Antonio-Quirino consultation).

Water to Area A is provided through 12-inch diameter mains that are part of the Hawaii County DWS's (DWS's) Hilo water system. The mains run beneath the frontage road on the south side of Area A and beneath Lelelaoa Street which runs north-south through its center. Sufficient surplus source and water main capacity is available to serve the proposed irradiation facility (DWS, Quirino consultation). Because the necessary facilities are already in place, there are no physical or system limitations that make one location within Area A superior to another. The cost of the installation would be slightly more than for Area B but measurably less than for Area C (see Table 4-1).

Electrical Power

The feasibility study for the food irradiation facility (CH2M Hill 1987) estimates that utility costs for the facility will be approximately $7,000 per year. The report does not break this down into separate items for water, electricity, and telephone. However, by subtracting water and telephone costs (which can be estimated with reasonable certainty) from the total, and converting dollars into electrical power usage (kilowatt hours) by dividing this by the dollar per kilowatt hour cost, it was possible to determine the average electrical load assumed by CH2M Hill calculations. Furthermore, this figure must be corrected to account for electrical power use by two components of the project that do not appear to have been included in the CH2M Hill calculations. The first is a 7,000 square foot in-plant cooler absent from the design shown in the feasibility study but needed for effective operation. The second is the refrigerator containers (up to 50) that will be used to store treated fruit before it is shipped.

When all factors are taken into consideration, it appears that average power use by the proposed facility will be approximately 1,200 kilowatt-hours per day. Hawaii Electric Light Company (HELCO), the regulated public utility serving the Island of Hawaii, indicates that it has sufficient generation and transmission capacity to accommodate a load of this magnitude anywhere in Area A using its existing facilities (HELCO, consultation).

The airport industrial area is served by underground electric power lines that were installed when the property was subdivided during the mid-1970s. Service to the irradiation facility would require extension of these underground lines from the street right-of-way to the building housing the irradiator and the installation of a new three-phase transformer. The owner would be responsible for installing the ducts and handholes, and would pay HELCO to install the cables and transformers. The owner would be reimbursed for the cost of the

TABLE 4-1
APPROXIMATE UTILITY INSTALLATION AND SITEWORK COSTS
FOR AREAS A, B, AND C

	Area A	Area B	Area C
Water Supply			
Connection to Existing Mains	$ 2,000	$ 2,000	$ 2,000
4-inch Detector Check Meter	5,000	5,000	5,000
1.5-inch Service Lateral & Type III Meter Box	1,200	0	1,200
6-inch Water Pipe	0	0	10,500
4-inch Water Pipe	5,000	2,500	5,000
Contingency	2,800	1,500	6,300
	$ 16,000	$ 11,000	$ 30,000
Electrical Power			
HELCO 3-Phase Transformer Pad	$ 700	$ 700	$ 600
Ducts	2,400	800	400
HELCO Cables & Transformers	7,000	6,000	6,000
Contingency	1,900	1,500	1,000
	$ 12,000	$ 9,000	$ 8,000
Telephone System			
Pull Box	$ 600	$ 600	$ 600
Duct	2,400	800	200
Contingency	1,000	600	200
	$ 4,000	$ 2,000	$ 1,000
Total Approximate Utility Installation Cost	$ 32,000	$ 21,000	$ 36,000
Site Work			
Grading	$ 50,000	$ 50,000	$200,000

Source: Estimated by Belt Collins & Associates based on information provided by the Hawaii County Department of Water Supply (Antonio Quirino); The Hawaiian Electric Light Company (Ed Nakamoto); and The Hawaiian Telephone Company (Kenneth Tanaka).

overhead system from the revenues generated by power sales during the first 3 years of the irradiation facility's operation (HELCO, Nakamoto consultation).

Telecommunications

The Hawaiian Telephone Company provides telephone service to Area A via both overhead and underground lines. Short laterals would need to be installed to connect the proposed irradiation facility to these service components. All locations within Area A can be served with equal ease.

Sitework

All of the land within Area A is relatively flat. Hence, the sitework needed to construct the proposed irradiation facility would be minimal, moreover, it would not vary substantially from place to place within the overall area.

4.2.1.2 Access

Road access to Area A is via Kanoelehua Avenue (Mamalahoa Highway State Route 11), the Airport Access Road (Kekuanaoa Avenue), the airport industrial area frontage road, and Leleaoa Street (see Figure 3-1). All routes, except Kanoelehua Avenue, are on airport property. The area is approximately 2 miles from Kanoelehua Avenue, somewhat farther than the two other site areas. Hence, an irradiation facility there will have slightly greater ground transportation costs than the others. However, the difference is so small that its effect on the total treatment costs would be insignificant.

Of the roads that would be affected by location of the proposed facility on Area A, Kanoelehua Avenue has by far the highest existing traffic volume (approaching 30,000 trips per day in 1987, according to State Department of Transportation traffic counts). It has three through lanes in each direction and left and right turning lanes for vehicles entering and leaving the airport. A three-phase signal controls traffic at the intersection of Kanoelehua Avenue and Kekuanaoa Avenue.

Existing traffic volume on Kekuanaoa Avenue is light to moderate (about 9,000 to 10,000 vehicles on a typical day). The General Lyman Field Master Plan Report (Belt Collins & Associates, November 1987) forecasts that this will increase in the future to the point

where improvements to the Kekuanaoa Avenue/Kanoelehua Avenue intersection will be needed, but concludes that space for the improvements is readily available.

The road has four lanes in the vicinity of the intersection with Kanoelehua Avenue, narrows to two lanes for almost a mile, and then widens to four lanes again just west of the airport industrial area. Turning lanes are provided at the two entrances to the airport industrial area, and these allow access to the frontage road and Area A. All parts of Area A are equally accessible.

A commodities irradiation facility located in Area A would have direct access to the existing aircraft parking apron and internal service road. This would allow treated fruit to be loaded directly into air cargo containers at the irradiation facility and moved from there directly onto inter-island and/or overseas aircraft.

4.2.1.3 Soils

The U.S. Department of Agriculture Soil Conservation Service (Sato et al., December 1973: Plate 74) has classified the soils on Area A as Papai extremely stony muck. The Papai series consists of thin, well-drained, extremely stony organic soils overlying a'a lava. In a representative profile, the surface layer of the soil is very dark brown and about 8 inches thick. The soil is highly permeable, run-off is slow, and the erosion hazard is slight. Excavation in the a'a lava is typically relatively easy. The potential for agricultural uses is considered low, thus the area has not been designated as "Agricultural Land of Importance to the State of Hawaii."

Area A was rough-graded when the airport industrial subdivision was constructed. Hence, the soil profile in this area is probably somewhat atypical of the Papai series. Nonetheless, its fundamental characteristics are believed to be relatively unchanged. Hence, it presents no special problems or constraints relative to construction of the proposed commodities irradiation facility.

D-18

4.2.2 Environmental Evaluation

4.2.2.1 Biology and Archaeology

Biology

The biological (flora and fauna) characteristics of Area A are typical of disturbed, vacant airport areas in Hawaii. The vegetation is limited to a few grasses and weedy species. Area A consists of a mowed lawn surrounded by chain-link fences. An assortment of grass species which include carpetgrass (*Axonopus compresus*), Hilo grass (*Paspalum conjugatum*), dropseed (*Sporobolus sp.*), foxtail (*Setaria gracilis*), molasses grass (*Melinis minutiflora*), and Natal redtop (*Rhynchelytrum repens*) make up the predominant cover. Weedy herbaceous species common in this area include polygola (*Polygola paniculata*), sleeping grass (*Mimosa pudica*), and beggar's tick (*Desmodium incanum*). Where there are pockets of loose rock and along the fenceline, the grasses become sparse and plants of sword fern (*Nephrolepis multiflora*), white-flowered Spanish needle (*Bidens alba*), and sleeping grass become more numerous.

A few shrubby species occur only on the face of the terrace cut where the rocky surface is exposed, however, the plants do not become very tall as they are cut back regularly by maintenance personnel.

Preliminary field investigations indicate that the fauna in Area A is limited to a few birds and, possibly, small mammals. Bird species commonly found there include the barred dove (*Geopelia striata*), spotted dove (*Steptopelia chinensis*), common myna (*Acridotheres tristis*), house sparrow (*Passer domesticus*) and nutmeg mannikin (*Lonchura punctulata*). It is likely that the golden plover (*Pluvialis dominica*) also frequents the site. Common small mammals that most likely frequent the site include mice and rats, although none were sighted during preliminary site investigations. None of the above listed bird species are known to nest on the site and there are no known threatened, endangered, or otherwise protected species inhabiting or frequenting the site.

Establishment of the food irradiation facility within Area A does not appear to pose any adverse impacts to the flora or fauna of the site.

Archaeology

The archaeological records at the Hawaii County Planning Department and the Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) were consulted. These records indicated that few archaeological studies have been completed in the general Hilo area and that the three alternative parcels under study (Areas A, B, and C) have not been previously surveyed. Earlier work by Hudson (1932) resulted in the recordation of archaeological sites along the coast between Hilo and Leleiwi; but Hudson did not record any archaeological remains in Hilo town. More recent research conducted on Alenaio Stream and the Hilo Boarding School Ditch (Kelly et. al 1981 and Kelly 1982) indicates that no houses or villages are known to have existed in the three areas currently under study. The background research also indicates that there are no Land Commission Awards in the area of the three parcels.

No historic or prehistoric archaeological resources were found during the current investigation (Rosendahl and Talea 1988). While access was restricted and the present evaluation is based on a review of the literature and field observations from outside of a chain link fence, the entire parcel was visible and no cultural resources observed. It is unlikely that a subsurface cultural deposit exists within the parcel of Area A. Nevertheless, in the event that cultural materials are found during grading operations, an archaeological consultant should be contacted to evaluate the deposit.

4.2.2.2 Land Use Compatibility

Area A is within a vacant section of the airport indu[illegible] park, but no part of the area is within a restricted part of the airport (although some realignment of the airport security fencing may be required, depending upon the exact location chosen). Adjacent lands are primarily used for airport operations. The area is far behind the runway building restriction line (750 feet from runway center line), and other a[illegible]s subject to increased danger as a result of aircraft accidents. The area is over 850 feet [illegible]m the edge of the primary surface of Runway 8-26. Hence, building heights of the proposed facility would have to exceed 120 feet to penetrate the 7:1 transitional surface adjacent to the runway. Since the tallest structure in the irradiation facility is less than 25 feet high, it could be constructed anywhere within Area A without conflicting with aircraft safety.

The existing parcelization of Area A does not provide an appropriately sized or oriented site for the proposed irradiation facility; therefore, re-subdivision would be required. Because the land is all under state ownership and the necessary roads and utility lines are already installed, this can be handled as a straightforward administrative matter; however, the DLNR will have to approve the re-subdivision.

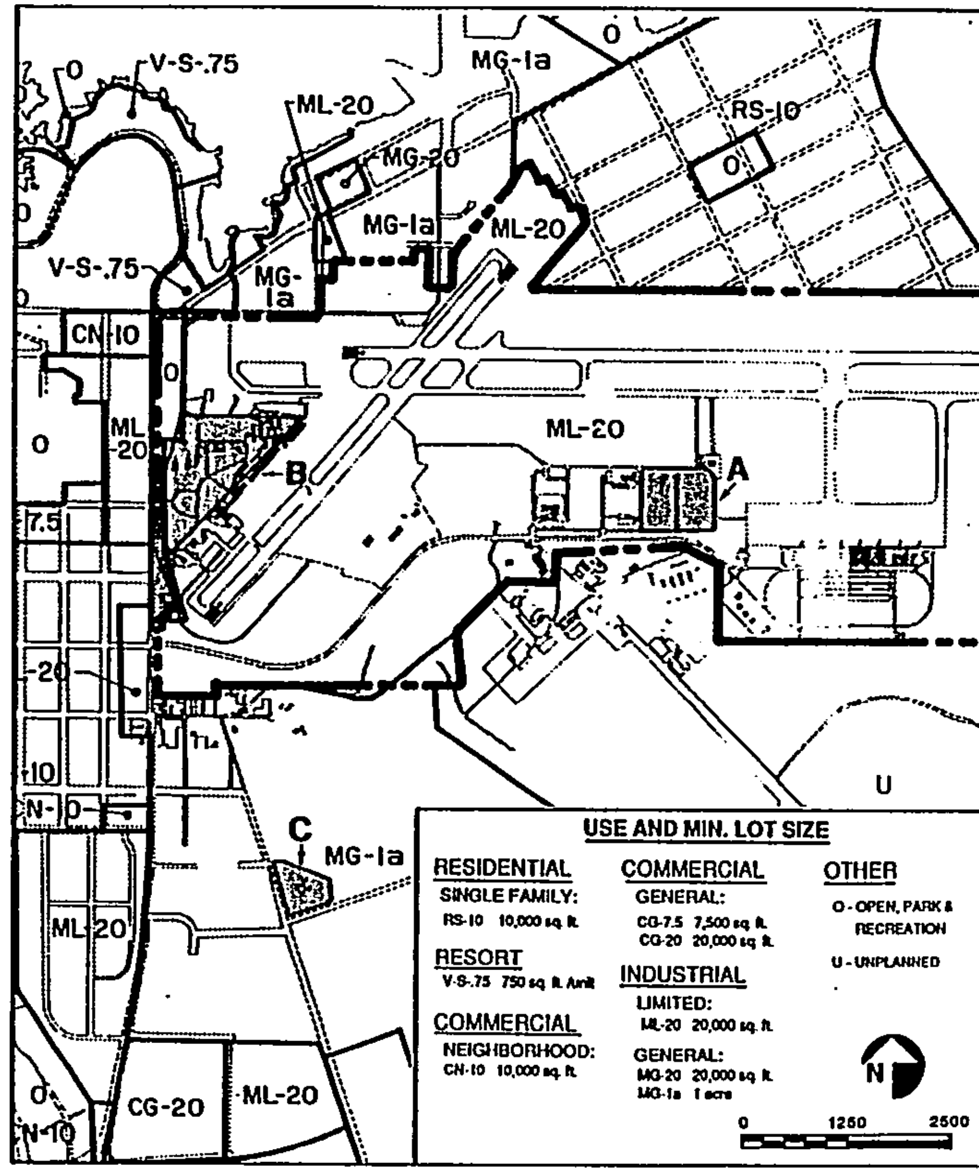
The existing airport master plan designates Area A for airport-related industrial uses, and the northern portion of the area is being considered as a possible location for a large air cargo transshipment and distribution center. Since the irradiation facility qualifies as an airport-related industrial use, according to the state DOT, it could become an integrated component of the planned distribution center (Hawaii County, Shintani consultation). (Note however, that because of possible differences in construction timing, such an integrated facility was not assumed for this study.) The Airports Division has tentatively approved use of Area A for the proposed irradiation facility as long as the specific site chosen is consistent with the airport master plan. The southern portion of Area A meets this condition. However, it should be noted that the DLNR must approve any lease of land in this area.

State Land Use Law

The State Land Use Commission (LUC) regulates land use throughout Hawaii under the provisions of Chapter 205, Hawaii Revised Statutes. Four land use districts (Urban, Agricultural, Conservation, and Rural) and categories of uses permissible in each district have been established by the commission. Area A lies entirely within the Urban District (see Figure 4-1). Only county land use regulations are applicable in Urban Districts. Section 15-15-24 of the LUC Regulations states that, "Any and all uses permitted by the counties. . . shall be allowed within this district. . . .[unless more restrictive rules are] imposed by the Commission pursuant to Section 205-4, Hawaii Revised Statutes". No such conditions have been imposed on Areas A, B, or C.

Hawaii County General Plan

The Hawaii County General Plan contains policies and land use maps showing the location and nature of desired land uses for the island. Area A and the land around it is designated for "Industrial" use. The General Plan defines industrial uses as those involving manufacturing and processing, wholeselling, large storage and transportation facilities,



County Zoning

FIGURE 4-1

WESTEC Services, Inc.

power generation, and government base yards. The following General Plan "Standards" for industrial uses are relevant to the proposed commodities irradiation facility:

Standard: Industrial developments shall be located in areas adequately served by transportation, utilities, and other amenities.

Discussion: Site A is located in an existing industrial area. The area has adequate road access and utility service. Other amenities which it would need are located nearby.

Standard: Industrial development shall maintain or improve the quality of the present environment.

Discussion: The proposed facility is in keeping with the visual character of nearby areas and facilities. It is, in most respects, similar to the existing papaya packing facilities located in the Hilo and Puna areas, the primary difference being the presence of the radioisotope source.

Standard: Topography of industrial land shall be reasonably level.

Discussion: Site A has a slope of between 1 and 2 percent.

Standard: Industrial development shall be conveniently located to its labor source.

Discussion: Site A is located in Hilo, the largest urban center on the island of Hawaii. Skilled labor is readily available.

Standard: Buffer zones shall be established between industrial and adjacent noncompatible land uses.

Discussion: Area A is located in the General Lyman Field Industrial Area. The irradiation facility is compatible with adjacent industrial and airport land uses.

In addition to the general standards discussed above, the General Plan also contains "Courses of Action" for the South Hilo District. The one that is most relevant to the proposed commodities irradiation facility directs the county, through its zoning powers, to encourage the centralization of industrial activities in the Kanoelehua Industrial Area and to direct noxious industries away from residential and related areas.

General Lyman Field is located immediately adjacent to the Kanoelehua Industrial Area and, as indicated by its "Industrial" zoning designation represents a continuation of that land use. The CH2M Hill Feasibility Study for the irradiation facility indicates that it will not be "noxious" in any normal sense of the word. But even if the presence of a Co-60 radiation source were deemed to make it a "noxious activity," Area A's isolation from residential and other related areas appear to make its use for an irradiation facility consistent with the policy recommended in the General Plan.

<u>County Zoning</u>

Area A and most of the surrounding land is zoned ML-20 (Limited Industrial, 20,000-square-foot minimum lot size) by the county (see Figure 4-1). The land directly south of Area A is zoned MG-1a (General Industrial, 1-acre minimum lot size), with more permissive uses allowed than under the ML-20 designation. "Limited Industrial" districts are intended for businesses and industrial uses which are generally in support of, but not necessarily compatible with, uses in surrounding districts. Permitted uses include, among others, manufacturing, processing, assembling, research, laboratory, bottling, or packaging uses which are conducted in a building and from which there is no odor, dust, smoke, gas, noise, vibration, radiation, or other effect which has measurable nuisance qualities beyond the property line (Hawaii County Zoning Code, Section 25-216). Since the proposed irradiation facility constitutes a "processing" activity and radiation from the facility would be confined to the irradiation room, the proposed project is a permitted use in Area A.

The maximum allowable building height in the ML-20 zone is 45 feet. This is considerably above the height for Area A needed for the proposed irradiation facility. However, plan approval from the County Planning Director will be required for development of the facility within this district.

No particular location within Area A is preferred for the proposed irradiation facility from a land use standpoint.

4.2.3 Recommended Site A

It is recommended that a commodities irradiation facility constructed in Area B be located in the southeastern corner of the airport industrial area as shown in Figure 4-2. This location would not restrict other potential airport uses, and it provides ready access to the main entrance road of the airport and to the airport service road and aircraft parking apron.

4.3 AREA B - OLD TERMINAL

4.3.1 Engineering Evaluation

4.3.1.1 Utilities and Sitework

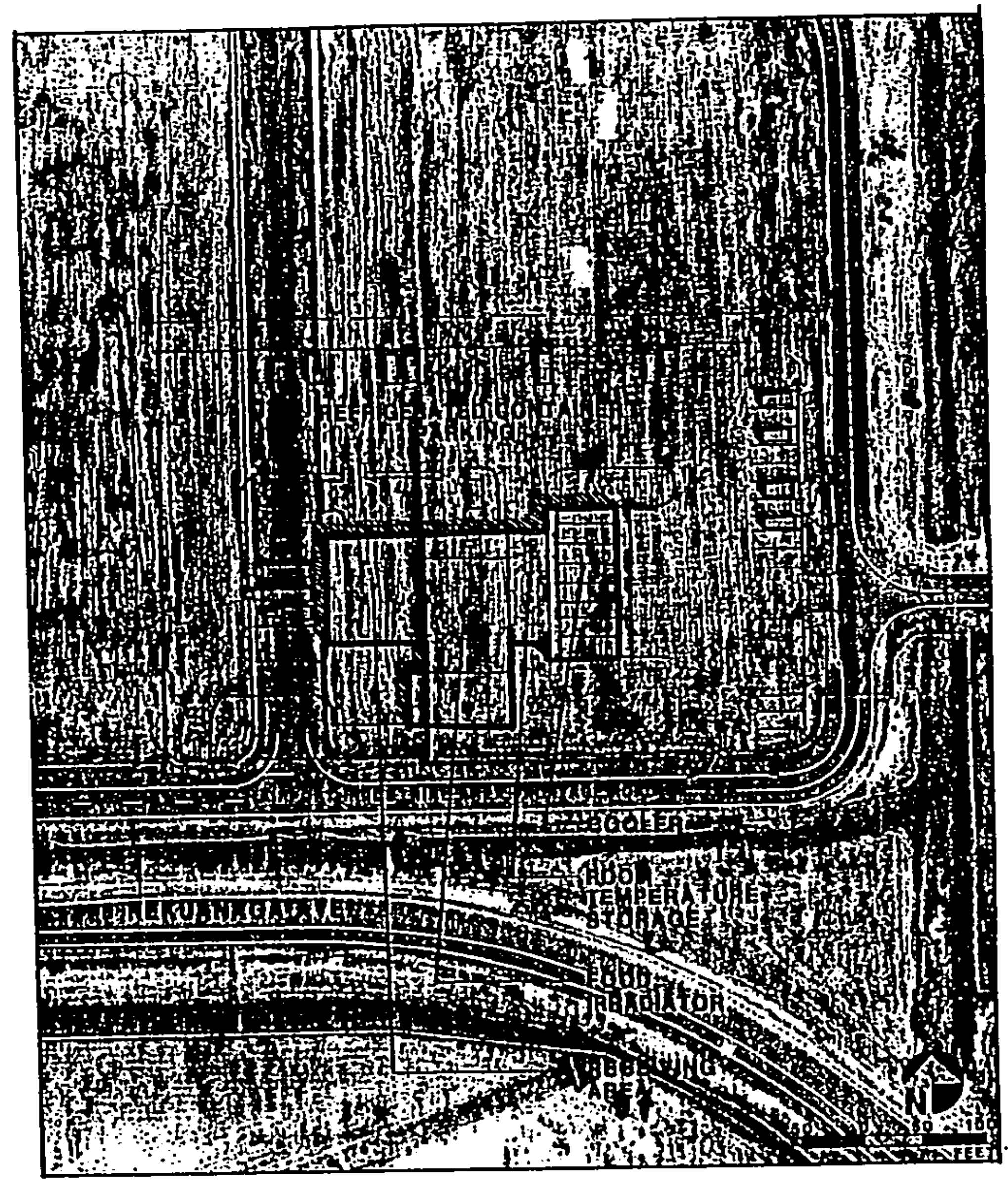
Water

Area B is served by two existing 8-inch water lines which run between the roads along its southern and northwestern boundaries. These are part of the Hawaii County DWS's municipal water system. A representative of the DWS indicated that there is adequate source and line capacity to serve the facility anywhere in this area. Sites within Area B that are adjacent to the existing lines will be slightly less expensive to service than those which are not. However, there are no physical or system limitations that make one location within the site area superior to another.

The estimated construction cost of the offsite water system improvements needed for an irradiation facility in Area B is approximately $11,000. A breakdown of this total is presented in Table 4-1.

Electrical Power

Area B is served by both overhead and underground electric power lines. Service to the irradiation facility would require extension of the underground lines to the selected building site and the installation of a new three-phase transformer. As with Area A, the owner would be responsible for installing the ducts and handholes, and would pay HELCO to



Site A - Airport Industrial Area Conceptual Plan

FIGURE 4-2

WESTEC Services, Inc.

install the cables and transformers. The owner would be reimbursed for the cost of the overhead system from the revenues generated by power sales during the first 3 years of the irradiation facility's operation.

An irradiation facility located in Area B would consume the same amount of electricity as one situated in Area A. According to HELCO, there is sufficient generation and transmission capacity to accommodate the projected load anywhere within the area.

Telecommunications

Telephone service to Area B is provided by the Hawaiian Telephone Company via both overhead and underground lines. Short laterals would be installed to connect the proposed irradiation facility to these components. Virtually all locations within Area B are served equally well.

Sitework

All of the land within Area B is relatively flat. Hence, minimal sitework is needed to construct a commodities food irradiation facility at this location.

4.3.1.2 Access

Area B is accessible from two points. Northbound vehicles on Mamalahoa Highway (Highway 11, Kahoelehua Avenue) can reach it via an intersection opposite Hualani Street. The area is also accessible from Kamehameha Avenue via the entrance road to the old passenger terminal (see Figure 3-1).

The entrance opposite Hualani Street is very convenient for northbound vehicles destined for the proposed facility located in Area B, since an exclusive right turn lane is present. There is an acceleration lane on Kanoelehua Avenue north of the Hualani Street intersection that can accommodate trucks departing the irradiation facility northbound for the harbor or for the Keahole Airport via the Hamakua Coast and Waimea. However, the presence of an unbroken medial strip on Kanoelehua Highway at the Hualani Street intersection makes it impossible for vehicles to exit Area 13 southbound via this route. Hence, trucks returning from the irradiation facility to the packing houses would be forced to exit via Kamehameha Avenue. Because of its proximity to the Kanoelehua Highway/Kamehameha

Avenue/Kalanianaole Avenue intersection, the existing Kamehameha Avenue exit from Area B is less than ideal. This is particularly true for trucks, whose relatively slow acceleration reduces their ability to slip through gaps in traffic.

The problem could be solved by extending Piilani Street which currently terminates on the western side of Kanoelehua Avenue across and into the airport. There is a slight (6 to 8 foot) grade difference between the highway and the airport in this area that must be taken into account, but constructing the road would not be difficult. A traffic light would have to be installed at the intersection if Piilani Street were extended. There is adequate separation from adjacent intersections to permit this, and the traffic volumes following redevelopment of the old terminal area combined with the volumes on Kanoelehua Avenue are probably sufficient to warrant installation of another traffic signal. Although the intersection improvements are desirable, they are not necessary. Hence the cost is not included in this report.

4.3.1.3 Soils

The Soil Conservation Service (SCS) has categorized the soils in Area B as Keaukaha extremely rocky muck (Sato et al. December 1973: Plate 74). Keaukaha series soils are thin organic soils overlying pahoehoe lava bedrock. Bedrock is typically found 2 to 10 inches beneath the surface, and rock outcrops occupy about 25 percent of the area. In a representative profile, the surface layer is very dark brown muck about 8 inches thick. The soil above the lava is rapidly permeable. The underlying pahoehoe lava is very slowly permeable, but water moves rapidly through its many cracks. The run-off potential is medium, and the erosion hazard is slight.

This soil places no significant limitations on urban development, and the presence of a swimming pool in the vicinity indicates that the excavation needed for the facility can be carried out without difficulty. The SCS's overall capability rating for the soil is poor, and the area has not been designated as Agricultural Lands of Importance to the State of Hawaii by the State Department of Agriculture.

4.3.2 Environmental Evaluation

4.3.2.1 Biology and Archaeology

Biology

The biological characteristics of Area B are similar to those of Area A. The flora of the area is characterized by a grassy lawn with scattered trees. The lawn is commonly composed of a mixture of grass species, although, in places, large patches of a single species may be found. The grasses include carpetgrass, Hilo grass, (*Digitaria ciliaris*), dropseed, Glenwood grass (*Sacciolepis indica*), foxtail, and California grass (*Brachiaria mutica*). The more common weedy herbaceous species growing among the grasses in this area are Asian pennywort (*Centella asiatica*), borreria (*Spermococe assurgens*), blue day flower or honohono (*Commelina diffusa*), common plantain (*Plantago major*), and beggar's tick.

A few trees of pandanus (*Pandanus tectorius*), Javaplum (*Syzygium cumini*), gunpowder tree (*Trema orientalis*), African tulip (*Spathodea campanulata*), coconut (*Cocos nucifera*), etc., occur on the site.

Near the central portion of Area B, there is a rocky depression which has been left in a more or less unmaintained condition. It supports a small stand of trees with clumps of guava (*Psidium guajava*) and pluchea (*Pluchea symphytifolia*) shrubs between the trees. California grass, molasses grass, and sword fern form dense mats up to 5 feet tall in some areas. Where the jumble of rocks is exposed, sword fern is abundant.

Preliminary investigations indicate that the fauna of Area B is almost the same as that on Area A. However, in addition to the species of birds found on Area A, Japanese white-eye (*Zosterops japonica*) and house finches (*Carpodacus mexicanus*) frequent the site as does the common small Indian mongoose (*Herpestes auropunctatus*). It is also likely that domestic and feral cats and dogs frequent the site, and that mice and rats inhabit the site. There are no known threatened, endangered or otherwise protected species inhabiting the site. Some species of birds, such as Japanese white-eye, common mynas, house sparrows, and house finches, and the small Indian mongoose mammal may nest and breed on the site.

Based on the long-term history of the area as a center of man's various activities and the relatively common vegetation and fauna of the site, it does not appear that use of Area B as the location of the commodities irradiation facility would adversely affect the flora or fauna of the area. Those species which breed within Area B would be displaced by construction of the proposed project at this location, but these species would still exist as long as nearby areas provide for suitable habitat.

Archaeology

The northern portion of Area B is also occupied by parking lots, the old airport structure, radio towers, and the NAS swimming pool complex. The old airport structures are currently used as inter-island cargo buildings. The southernmost portion of the site is flat and covered with dense vegetation. Numerous concrete pilings and decaying structures, perhaps associated with the earlier military use of the area, scattered debris, and a wrecked van were found in the areas of dense vegetation.

As with Area A, the records at the Hawaii County Planning Department and DLNR-HSS were consulted and no known historic or prehistoric resources exist within the parcel. The records also indicate that there are no Land Commission Awards within Area B.

No prehistoric archaeological sites and no significant istoric structures were discovered during the surface survey of Area B (Rosendahl and Talea 1988). The structures noted are attributed to the military use of the area and are not considered important. While the presence of a subsurface cultural deposit is considered unlikely, an archaeological consultant should be contacted if cultural materials are encountered during grading activities.

4.3.2.2 Land Use Compatibility

The southern and eastern portions of Area B are currently used for airport-related activities. Surrounding land uses include light industrial, open/park/recreational, commercial, and, at some distance, a small amount of residential. Of the three areas under consideration, Area B is the only one with possible constraints due to land use compatibility.

Control of the land at Area B is in a transitional stage. After being under the state DOT control for many years, it was transferred to the state DLNR in 1987 as part of a land exchange involving those agencies and the State Department of Hawaiian Home Lands. The state DOT continues to handle day-to-day operations of airport-related facilities, but lease rents flow to DLNR. The two departments are currently discussing, but have not finalized, a formal agreement which would return a portion of the area to the DOT, including all of the apron area and the land and structures between the apron and the road serving the existing air cargo and general aviation facilities.

The existing building restriction line along the northwest side of Runway 3-21 is only 655 feet from the runway centerline. This is 95 feet less than the FAA's current 750-foot separation criteria. The FAA has indicated informally that substantial new construction must adhere to the 750-foot standard (FAA, Welhouse consultation). Hence, unless an exception is made, no new structures will be allowed in Area B southeast of the access road serving the air cargo and general aviation facilities.

The 7:1 transitional surface adjacent to Runways 3-21 and 8-26 limit the height of buildings that can be constructed in Area B. However, the most severe height limit (approximately 35 feet) is about 10 feet higher than the tallest building in the planned commodities irradiation complex. Hence, the transitional surface will not limit the siting of the proposed project within Area B.

As previously noted, the General Lyman Field Master Plan is currently being updated, and administrative responsibility for Area B is in a transitional state. At present, the DLNR has assumed control of the entire area, but it appears likely that the land southeast of the access road which serves the air cargo and general aviation facilities will be managed by the DOT. The County Department of Research and Development has requested that a Foreign Trade Zone be established within Area B, but the DLNR has not yet acted on this request or developed plans for use of the remaining land. As with Area A, the DLNR will have to approve the re-subdivision and any lease to the operator of the commodities irradiation facility.

State Land Use Law

All of Area B lies within the Urban District. See Section 4.2.2.2. for discussion of the implications of this description.

Hawaii County General Plan

Area B and most of the adjacent land is designated for "Industrial" use on the County General Plan Land Use Map. See Section 4.2.2.2 for discussion of the irradiation facility's consistency with this designation.

County Zoning

Area B and most of the adjoining airport land is zoned ML-20 (Limited Industrial, 20,000 square-foot minimum lot size) by the county. As shown in Figure 4-1, the land between Area B and Kanoelehua Avenue (Hwy 11) is zoned O (Open, Park and Recreation). The area west of Highway 11 is zoned for commercial and residential use and RS-10 (Single Family Residential, 10,000 square foot minimum lot size).

4.3.3 Recommended Site B

If Area B is selected for location of the proposed commodities irradiation facility, it is recommended that the facility be located on the site shown in Figure 4-3. This site is currently vacant, is shielded from Kanoelehua Avenue by a thick band of vegetation, is well-removed from runway setback and safety areas, and is consistent with all possible uses for this area under consideration by the DLNR and the DOT.

4.4 SITE AREA C - RAILROAD AVENUE

4.4.1 Engineering Evaluation

4.4.1.1 Utilities and Sitework

Water

Like the other two areas, Area C is served by the Hav ii County DWS Hilo water system. According to information provided by the DWS, the earest lines are a 12-inch main on Kukila Street west of Railroad Avenue which connects to an 8-inch main running from the Kukila Street/Railroad Avenue intersection southward ng Railroad Avenue. DWS has confirmed that sufficient regional source and water main capacity is available to serve an irradiation facility located in this area.

Site B - Old Terminal Conceptual Plan	FIGURE 4-3

WESTEC Services, Inc.

To provide service to Area C, a 6-inch line must be installed along Railroad Avenue from Kukila Street northward along Railroad Avenue to the middle of the parcel. From that point, a 4-inch diameter service lateral would deliver water to the irradiation facility. If the facility is located adjacent to Railroad Avenue, the service lateral would be about 200 feet long. If it is situated on the eastern side of Area C, a 600-foot long service lateral would be required.

The cost of providing water to Area C would vary slightly depending upon the portion of the area that would be used. This is because of the longer service lateral needed to serve the eastern side of the parcel. The need to extend the existing offsite water mains makes water facilities for this area slightly more costly that for the other two areas considered (see Table 4-1).

Electrical Power

Electrical power could be drawn from existing overhead power lines within the Railroad Avenue and East Kukila Street rights-of-way. As with the other areas, the owner would be responsible for installing the ducts and handholds, and would pay HELCO to install the cables and transformers. The owner would be reimbursed for the cost of the overhead system from the revenues generated by power sales during the first 3 years of the irradiation facility's operation.

An irradiation facility located in Area C would use the same amount of electricity as those at the other locations evaluated, and HELCO has indicated that it has sufficient generation and transmission capacity to accommodate the forecast load.

Telecommunications

The Hawaiian Telephone Company provides telephone service to Area C via overhead lines along Railroad Avenue and Kukila Street. Short laterals would need to be installed to connect the proposed irradiation facility to these comp nents. All locations within the area can be served with equal ease.

<u>Sitework</u>

Beginning at Railroad Avenue, Area C slopes upwards at a 4 to 5 percent gradient for several hundred feet. At that point it levels off before beginning to drop downward towards the northeast. A substantial amount of grading would be required to prepare the site for construction of the irradiation facility. No detailed grading plan has been prepared, but a preliminary assessment suggests that grading for this site could cost about $150,000, more than that needed for sites in Areas A or B (Belt Collins & Associates 1988).

4.4.1.2 Access

Road access to Area C is via Kanoelehua Avenue (Mamalahoa Highway), Pohaku, Kukila, Lanikaula, and Leilani Streets, and by Railroad Avenue (see Figure 3-1). The site is about one-quarter mile from Kanoelehua Avenue, the main route for trucks traveling between the packing houses and Hilo Harbor or General Lyman Field. It is only a block from Ono Pac, one of the three papaya packers located in Hilo proper.

Existing traffic volumes on the portion of Kanoelehua Avenue that would be used by trucks traveling to and from an irradiation facility located at Area C are about the same as those at the Kanoelehua Avenue/Kekuanaoa Avenue intersection described previously. Several of the Kanoelehua intersections are served by traffic signals, hence trucks should find it relatively easy to move to and from the proposed facility.

An irradiation facility located in Area C would have less access to the airport than one located in the other two areas. This places the area at a disadvantage only if a substantial portion of the irradiated fruit is to be transported by air out of General Lyman Field. It is of no consequence if most of the fruit is shipped by sea or trucked to Kona for shipment through Keahole Airport on the western side of the island.

4.4.1.3 Soils

Like Area A, the soil on Area C is classified as Papai extremely stony muck. The characteristics of this soil are discussed in Section 4.2.1.3 above. They pose no special constraints on development of the proposed facility at this location.

4.4.2 Environmental Evaluation

4.4.2.1 Biology and Archaeology

<u>Biology</u>

The biological characteristics of Area C are more varied than Area A or B, primarily due to the fact that the area has had a chance to revegetate (since its use for a concrete batch plant ceased) and presently is subjected to infrequent human use. Roughly one-half of the site is covered by broomsedge (*Andropogon virginicus*) and molasses grass. The other half supports an open woodland of weedy, fast-growing melochia trees (*Melochia umbellata*).

Gravel and rock piles as well as a large open trench are found in the grassy area. Besides the two grasses mentioned above, other plants frequently found here include sword fern, kaunoa'oa (*Cassytha filiformis*), several *Desmodium* species, and seedlings of melochia, 1 to 3 feet tall. Locally abundant, especially near road areas, is wedelia (*Wedelia trilobata*) an ornamental species which continues to persist and spread even if left untended. Melochia trees, 15 to 25 feet tall, form an open woodland with : ;ew, scattered gunpowder trees. The understory layer is dense and species composition varies from place to place. Thorny sleeping grass may form mats up to 6 feet high; in other areas, California grass and comb hyptis (*Hyptis pectinata*) form a different association; and, in some places, sword fern or molasses grass may form dense patches. Climbing un onto the shorter trees and shrubs are maile pilau (*Paederia scandens*), kaunoa'oa, and koai awahi'a (*Ipomoca indica*).

The vegetation on all three areas is composed almost exclusively of introduced species. Of the three Areas, Area C contains the most number of native species (i.e., indigenous and endemic plants), as it has not been maintained for some time. The native species include mamaki (*Pipturus*), koaliawahi'a, kaunoa'oa, and 'uki (*Machaerina mariscoides* ssp. *meyenii*). However, none of these natives is considered a rare, threatened, or endangered spieces. They all occur in similar environmental habitats throughout the islands.

Preliminary site surveys indicate that the fauna of Area C includes the same species as Area B. There are no known threatened, endangered, or otherwise protected animal species inhabiting or frequenting the site. As with Area B, it is likely that Japanese white-eye, mynas, doves, and other bird species and the small Indian mongoose, rats, and mice nest and breed on the site.

Establishment of the proposed irradiation facility on Area C would require regrading the site and repaving the existing access road. These operations would result in the loss of most of the vegetation on the chosen site, thereby decreasing available habitat for resident fauna. However, as the bulk of the biomass consists of introduced weedy species which are widespread in similar disturbed habitats, vegetation removal on the chosen site is not expected to have a significant negative impact on the botanical resources. Furthermore, while use of Area C would displace those individuals inhabiting Area C, it would not result in significant adverse impacts to the fauna of the general area.

Archaeology

The records at the Hawaii County Planning Department and DLNR-HSS were consulted and no known historic or prehistoric resources exist within Area C. The records also indicate that there are no Land Commission Awards within the area.

No prehistoric archaeological sites and no significant historic structures were discovered during the surface survey of Area C (Rosendahl and Talea 1988). The structures noted are the remains of rock quarrying activities by Shield-Pacific, Ltd. Concrete and Concrete Products and are not considered important. While the presence of a subsurface cultural deposit is considered unlikely, an archaeological consultant should be contacted if cultural materials are encountered during grading activities.

4.4.2.2 Land Use Compatibility

Area C and adjacent lands are characterized by heavier industrial uses than Areas A and B, including concrete and gravel, asphalt batching, and lumber mill operations. The HELCO power plant is across the street from the parcel. The proposed irradiation facility is compatible with these uses.

Area C is located entirely off airport property and is outside the approach zone and clear zones as well. Hence, it is compatible with airport operations. The area's only negative characteristic from this viewpoint is its distance from the air cargo handling facilities. This disadvantage is significant only if direct air cargo shipments were to account for an important portion of total product shipments.

State Land Use Law

Area C lies entirely within the Urban District. See Section 4.2.2.2 for discussion of the irradiation facility's compatibility with this designation.

Hawaii County General Plan

All of Area C, as well as adjacent parcels, is designated for "Industrial" use. See Section 4.2.2.2 for discussion of the proposed projects consistency with this designation.

County Zoning

Unlike Areas A and B, Area C, and its environs are zoned MG-1a (General Industrial, 1-acre minimum lot size). Activities allowed in this district include all of those permitted under "Limited Industrial" plus heavier industrial uses such as manufacturing and processing plants, quarries, feedlots, sawmills, sugar mills or refineries, and public dumps. The maximum allowable building heights in the area are 50 feet, or 100 feet if determined to be functionally necessary. Plan approval from the County Planning Director is required for all development within this district.

With respect to land use factors, no particular location within Area C is more favorable for the proposed irradiation facility.

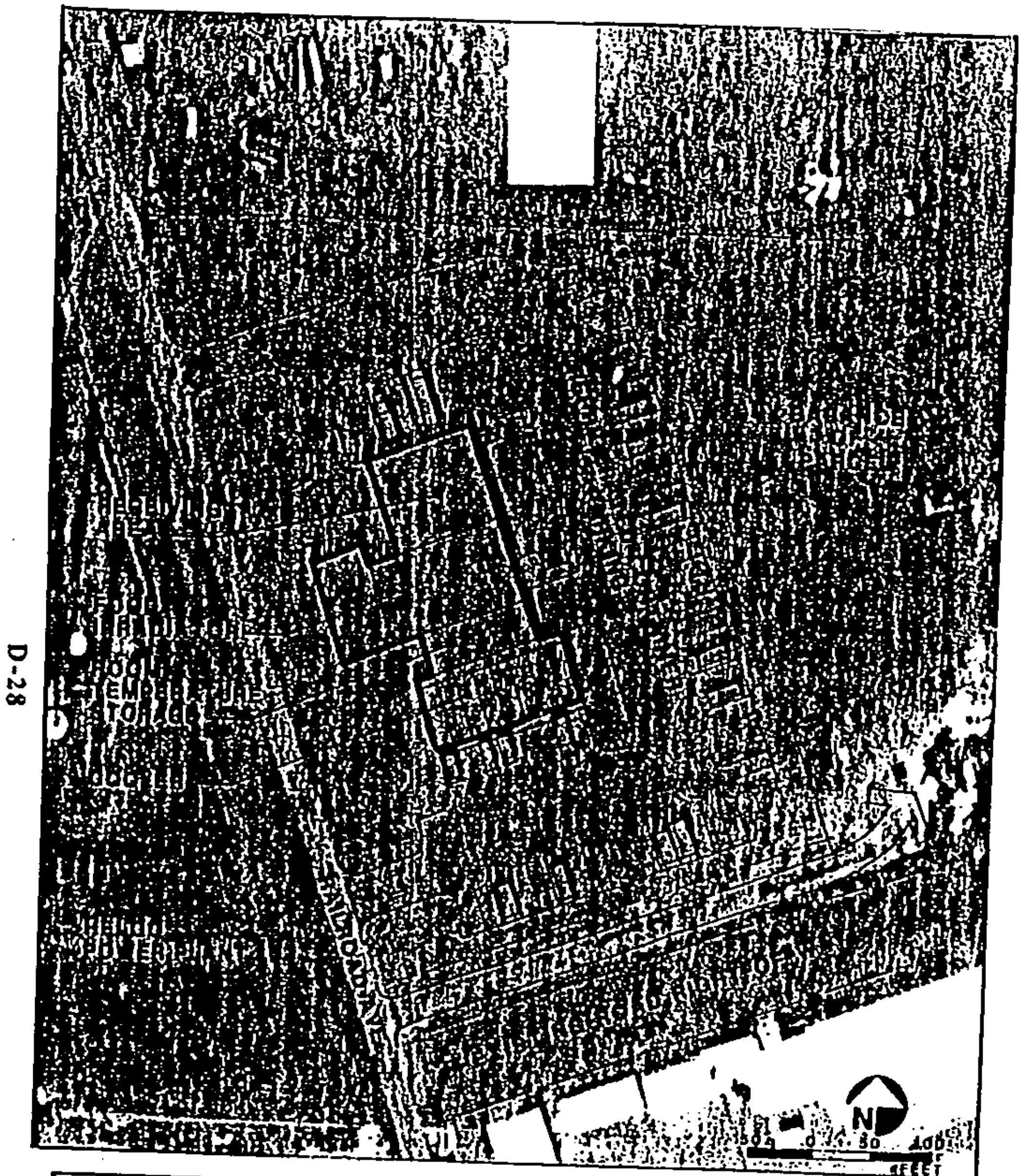
4.4.3 Recommended Site C

It is recommended that a commodities irradiation facility constructed in Area C be located on the western side of the parcel along Railroad Avenue (see Figure 4-4). This will maximize access and reduce the cost of extending utility service to the facility.

4.5 Hydrology and Geological Hazards for All Areas

4.5.1 Groundwater

The rock which forms the base of the island is saturated with salt water from the surrounding ocean. Rain falling on the land percolates downward until it encounters this water-saturated rock. There, the fresh water "floats" atop the salt water, forming a lens-



Site C - Railroad Avenue Conceptual Plan

FIGURE 4-4

shaped water body known as the Ghyben-Herzberg lens. Most of the groundwater beneath Hilo is contained in this basal lens, although in a few localized areas groundwater is "perched" atop layers of fine ash and other relatively impermeable material (MacDonald 1970).

Because of frictional resistance to its lateral moveme·· through rock, the groundwater has accumulated beneath the island. This has created a . ydraulic gradient which causes the slow movement of water outward from its center and into the surrounding ocean. Hence, the basal water table rises as one moves inland from the shoreline. The gradient depends upon local changes in the permeability of the rock and the amount of rainfall recharge, but typically ranges from 1 to 8 feet per mile.

The areas under consideration for the proposed food irradiator are located from 0.5 to 1.5 miles inland. Hence, the general rule of thumb noted above suggests that the water table would be from 1 to 8 feet above sea level. Static water table data from the wells nearest the three areas being evaluated suggest the following approximate depths to water table for each area:

Location	Ground Elevation	Water Table Elevation	Depth to Water Table	Source of Water Table Data
Area A	42'	5'	37'	DLNR Report R34 Page 141
Area B	25'	4'	21'	DLNR Report R34 Page 145
Area C	60'	7'	53'	DLNR Report R47 Pocket Report Map

These data indicate that the water table beneath Areas A and C is well below the 30-foot depth to which excavation for proposed facility would extend (Davis and Yamanaga 1973; State of Hawaii DLNR, 1970).

4.5.2 Flooding

At 130 inches per year, average annual rainfall in Hilo is relatively high (National Oceanic and Atmospheric Administration 1986). Moreover, with 10- and 50-year one-hour rainfalls of 5.0 and 6.1inches, respectively, rainfall intensities can be quite high as well (U.S. Department of Commerce, Weather Bureau). Despite this, the presence of relatively permeable soils and porous lavas has generally limited flooding to coastal areas which are susceptible to periodic inundation by tsunamis and to areas immediately adjacent to defined watercourses.

The Federal Emergency Management Agency (FEMA) has published Flood Insurance Rate Maps for Hilo. The area occupied by the three site areas is contained on maps 155166-0880-B and 155166-0885-B dated May 3, 1982. These maps show that all of the areas under consideration for the food irradiator are within Zone C, "Areas of Minimal Flooding."

4.5.3 Geologic Hazards

Hawaii, the youngest island in the Hawaiian chain, is composed of five large shield volcanos. Two of these, Mauna Loa and Kilauea, are still in the shield-building stage. Two others, Mauna Kea and Hualalai, are in a later stage of development characterized by much less frequent, but more explosive, eruptions. Kohala Volcano, the oldest of the five, is considered extinct.

The town of Hilo is located on the boundary between Mauna Loa and Mauna Kea volcanos. All of the areas evaluated in this report are located within a mile of one another on lava flows originating from Mauna Loa. Due to this and the absence of significant topographic features which might affect the eruptive effects, all are exposed equally to volcanic hazards.

A comprehensive analysis of the risks from this volcanic activity has been prepared by the United States Geological Survey (Mullineaux et al. 1987: 599-621). That report evaluates direct volcanic hazards from lava flows, tephra falls, pyroclastic surges, and volcanic gases, as well as a number of indirect hazards such as earthquakes, ground subsidence, and earth cracks. The remainder of this section summarizes its findings relative to the sites under consideration for the proposed food irradiation facility.

4.5.3.1 Risk from Lava Flows

The chief threat presented by lava flows is to property that cannot be moved. The flows burn, crush, or surround structures that lie in their path. Mullineaux et al. have identified eight levels of relative risk from this source. The greatest danger occurs in Zone 1, which

includes the summits and rift zones of Kilauea and Mauna Loa volcanos. The least risk occurs in Zone 9, the Kohala Volcano.

All three of the potential irradiation facility sites evaluated here are situated in Zone 3. Mullineaux et al. estimated that only 1 to 3 percent of the ground surface in Zone 3 has been covered by lava in historic times (i.e., since 1778), most of it on the upper reaches of the mountain. The same report estimates that approximately 15 to 20 percent of the ground surface within Zone 3 on Mauna Loa has been covered by lava flows within the past 750 years. The risk is not evenly distributed throughout the zone, however. Instead, lava flow frequencies are by far the greatest near its summit and on its northwest flank; it is much lower along the coastline of the volcano's southeastern flank where Hilo is located.

Interpolating from the data contained in Mullineaux et al. (pp. 608-610), it is estimated that approximately 5 percent of the land in and immediately around the town of Hilo has been overrun by lava flows during the past 1000 years. Given this, the probability that a relatively small site such as that needed for the commodities irradiator will not be overrun during the 30-year life of the facility can be calculated as follows:

Probability of not being overrun in 1000 years = 1.0 - 0.05 = 0.95
Probability of not being overrun in 1 year = 1000th root of 0.95 = 0.99994
Probability of not being overrun in 30 years = $(0.9999847)^{30}$ = 09984624
Hence, the probability of being overrun in 30 years = 1.0 - 0998462 or 0.00153

In other words, a regional frequency analysis suggests the probability that the 4-acre food irradiator site located in Hilo on the eastern side of Kanoelehua Highway will be overrun by lava during its 30-year life is on the order of 0.15 percent.

When the individual sites are examined more clo ly with respect to surrounding topography and the paths taken by historic period lava flows, it appears that Site B is probably the most exposed with the probability of being inundated by lava approximating the regional average. By virtue of local topography and greater distance from the line of likely vents, Sites A and C are probably less susceptible to damage from this source. However, the available data do not allow the differences to be accurately quantified.

The available scientific evidence indicates that any flow likely to approach Hilo would move quite slowly. According to AECL, supplier of Cobalt-60, a shipping cask and crew to remove the source could be mobilized rapidly, perhaps within 24 hours. Consequently, if a lava flow threat did develop, there would be adequate time to remove the radioisotope source before the flow reached the facility.

4.5.3.2 Risk from Tephra Falls

Tephra consists of volcanic ash and coarser fragments. In Hawaii it is produced most frequently by lava fountains, but is can also result from explosive magmatic eruptions and by steam blast explosions. Tephra can seriously affect vegetation and manmade structures and machinery, burying, burning, or abrading them. Ash can also smother vegetation.

During historic times, tephra falls in excess of 15 centimeters have occurred within about 2 kilometers of active vents. All of the irradiator sites are several times this distance from the nearest active vents. Mullineaux et al. have placed the areas being evaluated for the food irradiator at the outer fringe of "Tephra Hazard Zone 2." The risk here, which is associated with possible lava fountaining, is considered slight.

4.5.3.3 Risk from Pyroclastic Surges

Some explosive eruptions produce pyroclastic surges. These are clouds of ash, rock fragments, and heated gases that move outward at high speed from the source vent. Although pyroclastic surges tend to move along the ground surface, they may or may not follow topographic depressions. While such surges represent a severe hazard when they do occur, they are much less frequent than lava flows.

Mullineaux et al., conclude that the only evidence of pyroclastic surges that has been found on the Island of Hawaii is immediately adjacent to Kilauea's caldera. However, they note that such surges could conceivably be produced at other locations where ground or seawater can interact with magma. There is no evidence that such activity constitutes a measurable threat to a food irradiator located anywhere in Hilo.

4.5.3.4 Indirect Volcanic Hazards

Ground fractures, subsidence, and earthquakes can occur together as a result of the movement of magma within volcanos. Most fractures in Hawaii result from lava movement, subsidence of landslide blocks, or earthquake shaking. The two largest

earthquakes to affect the island during historical times occurred in 1868 and 1975. They had magnitudes greater than 7.0 on the Richter scale, and were probably caused by the movement of magma into the rift zones of Mauna Loa and Kilauea, respectively, followed by a sudden collapse. As a result of the earthquake potential, the County of Hawaii Building Code bases its structural design standards on Seismic Zone 3 forces, and the proposed irradiation facility would be designed to this standard.

Approximately 50 tsunamis have struck the island of Hawaii during historic times; several of these have extensively damaged structures along the Hilo shoreline. However, as discussed above, none of the areas evaluated for the proposed irradiation facility are at risk of tsunamis because of their ground elevation and distance from the shoreline.

Finally, Mullineaux et al. have divided the island into four hazard zones for fracture and small-scale subsidence. All of Hilo is located in Zone 4, the area which is least susceptible to damage from this threat.

SECTION 5
SITE EVALUATION ANALYSIS

5.1 INTRODUCTION

In the course of our investigation, we identified a significant amount of information on the project sites related to engineering, operational, and environmental issues. In reviewing this information as a whole, no one site was clearly identified as preferable; all seem about equal. In each specific area, however, there was often a difference. Table 5-1 summarizes those areas, in quantitative measures and in terms of "evaluation factors." Each site's relative merits, as interpreted by these evaluation factors, is identified in qualitative terms.

5.2 EVALUATION FACTORS

The evaluation factors selected consider plant locational characteristics, physical setting of the sites and environmental (natural, physical, biological, and social) characteristics of the sites. The factors have been derived from previously prepared reports; discussions with papaya packers, growers, transportation (air and sea) personnel and government agency contacts; and the consultant's knowledge and experience regarding industrial facility siting and operations.

In general, the factors used in the site evaluation are interrelated, thereby allowing comparative analyses to be performed. No one factor in and of itself is sufficient to determine the optimum plant location. Because of the qualitative nature of many of the factors, the complex interactions which occur between them, and the difficulty and subjectivity in attaching relative importance (weight) to the various factors, it was deemed inappropriate to try to translate these ratings into a numeric score. For similar reasons, no attempt was made to characterize each site using a single numeric score. Rather, all of the factors need to be considered collectively to determine the relative merits and desirability of each site. The following describes the evaluation factors and the characteristics of each factor. Each of the factors listed have been evaluated qualitatively and the relative importance of each factor is discussed.

Table 5-1

HAWAII COMMODITIES IRRADIATION FACILITY
SITE EVALUATION FACTOR MATRIX

Evaluation Factors	A	B	C	Remarks
Plant Operational Factors				
Access	Good	Fair	Good	Four packers close to all sites, three packers 10 to 30 miles from Hilo. Site B requires travel through a sub-standard intersection.
Proximity to Air Cargo Facilities	At Airport Good	At Airport Good	.05 Mile to Airport Fair	
Proximity to Port	2.5 Miles Fair	2.0 Miles Fair	2.25 Miles Fair	
Proximity to Packers	Fair	Fair	Fair	See remarks for Access.
Proximity to UHH Research Facilities	2.5 Miles Fair	2.0 Miles Fair	1.25 Miles Fair	
Physical Factors				
Size of Site Areas	13 Acres Good	40 Acres Good	13 Acres Good	
Land Management	DOT	DLNR	DHHL	
Land Availability	Positive Commitment Good	Possible Use Fair	Possible Use Fair	
Land Use Classification	Airport/Industrial Good	Airport/Industrial	Industrial	All three sites designated Urban by State, Industrial by County.
Past Land Use	Vacant Good	Airport Facilities Good	Gravel Plant Good	

5-4

Table 5-1 (Continued)

HAWAII COMMODITIES IRRADIATION FACILITY
SITE EVALUATION FACTOR MATRIX

Evaluation Factors	A	B	C	Remarks
Visual Attributes/Noticeability	Highly Fishable Fair	Slightly Visible Fair	Barely Visible Good	
Lack of Historical/ Archaeological Sites	None Good	None Good	None Good	
Presence of Threatened or Endangered Plants and Animals	None Good	None Good	None Good	
Proximity to Sensitive Receptors	Good	Good	Good	All sites in industrial/ airport areas.

[1]Area of Minimal Flooding.

5-3

Table 5-1 (Continued)

HAWAII COMMODITIES IRRADIATION FACILITY
SITE EVALUATION FACTOR MATRIX

Evaluation Factors	A	B	C	Remarks
Present Land Use	Vacant	Mostly Vacant	Vacant	
Adjacent Land Use	Airport Facilities Good	Airport Facilities Fair to Good	Lumber yard/ Asphalt plant Good	
Land Costs	Good	Good	Good	Land Costs for demonstration facility to be minimal.
Topographical Characteristics	Flat Good	Flat Good	4-5% Grade Fair	
Site Improvement/Construction Costs	~$50,000 Good	~$50,000 Good	~$200,000 Fair	
Utility Costs	~$32,000 Fair	~$21,000 Good	~$36,000 Fair	
Proximity to Residential Centers	~1.5 Miles Undetermined	~1 Mile	~1 Mile	All sites essentially equivalent; analysis to be conducted in the EIS.
Environmental Factors				
Geological Stability	Seismic Zone 3 Good	Seismic Zone 3 Good	Seismic Zone 3 Good	
Ground Elevation Groundwater Table Elevation Depth to Water Table	~42 ft. ~5 ft. ~37 ft. Good	~25 ft. ~4 ft. ~21 ft. Fair	~60 ft. ~7 ft. ~53 ft. Good	
Susceptibility to Tsunami/ Floods/Hazards	Zone C[1] Good	Zone C	Zone C	All three sites outside tsunami and 500-year flood zone.

5.2.1 Plant Operational Factors

In general these factors are important to ensure the smooth flow of product from the grower's fields to the shipping point on the Big Island. That is, these factors include those which are related to the movement of product from the packing facility to the treatment facility and then onto its ultimate shipping point and give an indication of the efficiency with which the plant would operate. They translate into costs of treatment and revenue to the plant operator, packers, and growers. An efficient and cost-effective operation will increase utilization of the proposed facility.

<u>Access</u>

This factor considers the directness of the route between the packing house, irradiation facility, and shipping point and provides an indication of the relative ease of access from the various packers' facilities. Ease of access will encourage utilization by packers, minimize transportation costs and times, and enhance cost effective operations. This factor is also the expected level of traffic/congestion on that route during time periods when shipments would be made and potential traffic impacts resulting from the irradiation facility.

Sites which lie along the normal route between packers and their shipping points were rated "good;" sites which involved diversions of less than ten minutes were rated "fair;" and sites which would require diversions of more than ten minutes were rated "poor."

<u>Proximity to Air Cargo Facility</u>

This factor is a measure of the ability to load treated fruit onto cargo aircraft using the existing facilities in the old terminal area at General Lyman Field. This factor has limited importance, at least in the near term, due to low current utilization of air transport to produce markets, and lack of planned expansion of transport services in the next 3 years. However, creation of a free trade zone and development of a cargo distribution facility at General Lyman Field would likely elevate the importance of this factor, as air cargo became a more competitive transportation option.

Sites situated such that cargo could be transported directly from the irradiator to the aircraft using on-airport roads were rated"good" with respect to this factor. Sites which would

require transshipment but which were within ten minutes of the air facility are "fair;" sites that require cargo transshipment and were more than a ten-minute drive from the air cargo facilities were rated "poor."

<u>Proximity to Port Facilities</u>

This factor measures that ease with which treated fruit could be move from the irradiator to the harbor. This factor is important given the present dichotomy of transport alternatives, i.e., via air or via ocean barge. Currently, the majority of papaya is shipped via barges to Honolulu for transshipment to ultimate markets, and without extensive expansion of air transport service, will remain the primary mode of transportation from Hilo.

To obtain a "good" rating, the site had to be located ir uch a way that containers holding treated fruit could be moved directly onto the ship/barge using dockside equipment and personnel. A "fair" rating was given to sites which required a ten minute or less drive to the harbor. Sites not meeting either of these criteria were rated "poor" with respect to this factor.

<u>Proximity to Packers</u>

This factor is important because it translates into costs that could be incurred by the packers in transporting untreated fruit and treated fruit between the irradiation facility and their facilities. Sites located within 10 minutes from packers are "good;" greater than ten minutes but less than an hour, "fair;" longer than an our, "poor."

<u>Proximity to Research</u>

As a research and demonstration facility, the location of the plant relative to other researchers and research facilities is a factor to be considered, in this analysis. However, the proximity of the potential sites to one another limit the importance of this factor as a basis for selection among the sites.

Sites located within ten minutes of the University of Hawaii/Agricultural Research facilities in Hilo were rated "good: with respect to this factor. Sites located from 10 to 30 minutes from the research facilities were rated "fair," and sites located more than 30 minutes were rated "poor."

5.2.2 Physical Factors

The physical factors are indicative of the features and limitations of each site area which will affect the feasibility and cost-effectiveness of constructing and operating an irradiation facility on that particular site.

Size of Site Area

This factor is important in providing an indication of spatial limitations or advantages within the area under consideration. Secondarily, it can be used to give an indication of expansion potential for each site area.

Sites which provide adequate space for the proposed facility with potential space for expansion and support services received a "good" rating. Sites with limited, but adequate space for the proposed facility were rated "fair." Sites which have inadequate space available were rated "poor."

Land Management

This factor reflects current land ownership. There is no rating associated with this fact, except as it relates to land availability (see below).

Land Availability

This factor indicated the landowner's present disposition toward use of the land for the irradiation facility. This factor is crucial to successful development of a particular site. Unfortunately, as shown in the correspondence in Appendix B, a firm commitment of availability is unavailable.

A "good" rating was given if the land manager is receptive to the project and the land is not committed for other use. If no opinion is expressed by the land manager and the land is allowed to be considered for study a"fair" rating was designated. A "poor" rating was assigned if the land manager does not favor the project and would not allow land to be considered.

Land Use Classification

This factor indicates the present state and county land use classification and zoning which are relevant to permitting processes and approval. All sites under consideration are similarly and appropriately zoned urban-industrial which reduces the importance of this factor in comparing alternatives.

Sites with no land use restrictions received a "good" rating. Sites with restrictions which might be changed were rated "fair." Sites with restrictions that could not be changed were rated "poor."

Past/Present Land Use

This factor gives some indication of the appropriateness of the site area for use as an irradiation facility.

Disturbed and vacant sites were rated "good." Sites that were disturbed, but developed for other use, were given a "fair" rating and any site that was undisturbed was rated "poor."

Adjacent Land Uses

This factor provides an indication of the relative compatibility of the irradiation facility with adjacent activities provides an indication of the relative compatibility of the irradiation facility with adjacent activities. It is important that site have no present conflict with adjacent uses. In this instance, all sites have approximately similar adjacent uses, so this measure for comparison is low.

Sites which are compatible with surrounding uses received a "good" rating. Sites which are incompatible with surrounding uses, but have available area for establishment of a buffer zone were rated "fair." Sites which are incompatible and have no room for a buffer zone were rated "poor."

Land Costs

In establishing both the demonstration and potential commercial irradiation facilities, this factor is directly related to the cost-effectiveness of the facility.

Sites with relatively low lease costs received a "good" rating. Sites that have a high lease cost were rated "fair." A site with no lease available and requiring purchase of the land was rated "poor."

Topographical Characteristics

This factor, which includes topography and soils conditions, provides an indication of the level of work and structural considerations that may be required to allow construction of the irradiation facility within the site area.

A "good" rating was assigned to sites with only a 1 to 2 percent slope. Sites with a 3 to 6 percent slope were rated "fair." A site with 6 percent or greater slope received a "poor" rating.

Site Improvement/Construction Costs

This factor provides a relative measure of the costs of constructing the irradiation facility within a particular site area, and will directly affect the cost-effectiveness of the facility.

Site improvement costs of less than $100,000 were rated as "good." If site improvement costs were estimated at between $100,000 and $250,000, a "fair" rating was assigned.

Utility Costs

This factor has been used to indicate the costs of utility hook-ups to the facility, which will also be included in cost-effectiveness determinations.

Utility costs of less than $25,000 were rated as "good." If costs were estimated at between $25,000 and $45,000, a "fair" rating was assigned. Utility costs above $45,000 received a "poor" rating.

Proximity to Residential Centers

This factor is important in considering both safety issues and relative public concern that may be present regarding the operation of an irradiation facility in proximity to residences.

D-35

5.2.3 Environmental Factors

The environmental factors consider natural, physical, biological, and social characteristics of the alternative site locations, and will indicate whether or not significant or irreversible impact will result from the proposed facility. With the exception of visual considerations, the environmental factors indicate similarity of impact for all site areas.

Geological Stability

This factor is important from a building design as well as safety standpoint relative to the security of the radiation source. Given that the Big Island is seismically active, and the site of active volcanism, the relative risks of each site from earthquake, lava flow, and related hazards is of critical importance.

Sites in a low risk seismic zone which denotes quite low risks of disturbance by earthquake and sites with low risk of lava flow, were rated as "good." If the seismic zone designation indicates a low to moderate risk or lava potential is greater, a rating of "fair" is assigned. Sites with a moderate to high risk of seismic disturbance or high potential for rapid covering by lava are considered to be "poor."

Groundwater Characteristics

This factor identifies existing and possible future groundwater resources of the site area, an indication of potential contamination of those resources by the irradiation facility in case of catastrophic accident, and the extent to which groundwater affects construction.

A "good" rating was assigned to sites that have adequate elevation for storage pond excavation. Sites in which the elevation of groundwater is above excavation depths, but suitable for construction, were rated as "fair." Sites in which the ground is saturated sufficient to affect construction, a "poor" rating was assigned.

Susceptibility to Tsunami/Flood Hazards

This factor reflects concerns regarding the potential ris' of catastrophic events which could preclude development of a site that is within the inundation zone.

Sites in which danger from flooding is minimal were rated as "good." Sites which are in areas of moderate risk are rated "fair." Sites that have extensive risk of flooding are rated "poor."

Visual Attributes

This factor is important in ..at it presents variation of impacts from site to site, although the subjective nature of the judgement and the adjacent land use compatibility may minimize the perceived impact.

Sites which would result in the project being hidden or blended completely with its surroundings received a "good" rating. If the project would be visible but consistent with its surroundings at a site, the site was rated "fair." A site that is highly visible and the project would contrast with surroundings was rated "poor."

Historical/Archaeological Sites

This factor has been considered given the abundance of historical/archaeological sites on the Big Island and the requirement to protect and preserve those sites in accordance with applicable federal, state, and county regulations.

Sites with no historical/archaeological sites or value were rated as "good." Sites with the potential or likelihood of mitigable historical/archaeological sites were rated "fair." If definite significant sites are present, the site was designated as "poor."

Biological Characteristics

This factor has been considered to assure appropriate sensitivity to the types of habitats within a site area and the potential impacts to the flora and fauna of a site that may result from construction and operation of the facility.

Sites where endangered species or habitat is not present, were rated "good." The presence of broadly distributed endangered species on a site resulted in a rating of "fair." If a localized population of endangered species are present, then the site is designated "poor."

Proximity to Sensitive Receptors

This factor provides an indication of potential air and noise quality impacts resulting from the location of the irradiation facility.

Sites with no sensitive receptors were rated "good." Sites with a buffer zone between it and the receptors received a "fair" rating. Sites with sensitive receptors nearby, and without a buffer zone, were rated "poor."

5.3 EVALUATION RESULTS

As indicated above, the preceding evaluation factors have been employed in a consistent and equal manner for each of the alternative site areas and specific locations within those areas that have been investigated. Table 5-1 provides a brief summary of the relative objective quantitative and subjective qualitative "merit" of each site.

In Table 5-1, the evaluation factors have been "rated" or "scored" based on subjective qualitative terms, i.e., Good, Fair, and Poor.

All of the sites are roughly equivalent; thus minor differences in subjective weightings of each evaluation factor could cause the sites to be ranked in almost any order. Thus such subject weighting is inappropriate in this screening level of analysis.

Site A is preferable at this level of analysis because it ranks as high or higher than the other sites for all factors but one (utility cost). Compared to Site A, Site B falls short in access, commitment of available consistency with adjacent land uses, and depth to water table. Compared to Site A, Site C lacks direct access to the airport, lacks commitment of land availability, and has high site development costs. We cannot distinguish a ranking between Sites B and C.

APPENDIX A

FEASIBILITY STUDY SITE ANALYSIS

APPENDIX A
FEASIBILITY STUDY SITE ANALYSIS

Following is a copy of Chapter 7, Siting Options, of the Final Report, Feasibility Study for a Commodities Irradiation Facility in the State of Hawaii, CH2M Hill, April 1987. That report documents the site selection study up to the point where this review of Hilo airport sites begins.

Chapter 7
SITING OPTIONS

SITE ANALYSIS

BACKGROUND

Several factors must be considered in selecting the most suitable site for locating a central irradiation facility that best serves the industry needs and the State of Hawaii. The State has not pre-established any specific site or sites for an irradiator. The first objective of this chapter is to present the results of a candidate site selection analysis that has been conducted by CH2M HILL to present the more compelling reasons for pursuing a specific site on one of the Islands of Hawaii. The site selection analysis has therefore been conducted for general areas; site selection within a specific locale for a specific parcel of land is considered to be beyond the scope of this analysis.

The selection of any specific irradiator location will affect not only the industry but also various segments of the community. This analysis therefore considers factors that would address community concerns that have been raised by both proponents and opponents of an irradiator to facilitate information exchange and evaluation of information concerning the preferred site. At the same time, the factors must of necessity, consider technical and environmental factors, industry logistics, and potential economies.

SITE OPTIONS

Because of the papaya crop's geographic spread and the complications of overseas and interisland surface and air transportation systems that are used by the papaya and other agricultural industries to get their crop to market, the conduct of a site selection process is not a simple, straightforward one.

Recognizing that the large majority of the papaya crop is currently grown on the Big Island, the current State Legislature appropriation for planning and design of the Hawaii irradiator designates Hilo as the site for the facility.

The analysis has been conducted to define and evaluate considerations for siting a facility within the County of Hawaii as a prime site because of the site's proximity to the majority of the papaya crops. However, to maintain objectivity and to identify the best possible site, the study does not preclude consideration of other sites within the State of Hawaii. Therefore, the analysis includes comparative evaluations of other potential locations in the State.

Morgan (1984), in his study for the Papaya Administrative Committee (PAC), conducted a qualitative comparative evaluation of potential sites within the State of Hawaii. His analysis considered a number of important factors that bear repeating:

1. Papaya is currently produced mainly on two islands, Hawaii and Kauai, located about 300 miles from each other.

2. Air transportation out of the islands originates mainly from Honolulu.

3. Surface transportation from Hawaii to the mainland originates from Honolulu.

4. Interisland transport (surface) could be a constraint in the future due to capacity and/or scheduling.

5. Availability of other crops could make the economics of a potential irradiator more attractive.

Morgan's analysis considered a number of options, including siting the facility in Honolulu, in the cities of Hilo and Lihue or their vicinity, on the U.S. mainland, or in Hilo only, with the crop grown on the other islands shipped to Hawaii for irradiation. A conclusion as to the preferred site was not drawn.

CH2M HILL in its review of the industry (Chapter 3) has had an opportunity to update the information used by Morgan in his analysis. In addition to the industry-related factors, we have attempted to summarize other site-related issues in the ensuing discussion, including land use, geology and geologic stability, tsunami and flood potential, power costs, hydrogeology, proximity to research facilities, and proximity to the crop.

APPROACH TO THE SITE ANALYSIS

CH2M HILL has attempted to quantify some of the industry and site-related factors in a weighted matrix analysis for several sites. The weighted matrix evaluation permits a comparison among the possible sites based on a somewhat subjective assignment of the relative weights of importance among the various criteria of significance in choosing an irradiator site. Both economic and nc economic factors are considered. The information used in the comparison has been obtained from various published sources, discussions with informed persons, personal observations of the irradiation study team members, and experience with similar feasibility studies conducted for other communities in the United States and abroad.

The analysis matrix is generated by assigning an evaluation factor for each of the criterion being considered for each site. These evaluation factors range from an unfavorable rating (-2), to neutral (0), to a favorable rating (+2). Relative importance is assigned to each of these evaluation factors by including a weighting factor to compensate for the degree of importance of the individual criterion.

For example, proximity to most of the crop is considered to be a very significant factor in the site selection, and proximity to research facilities of lesser importance. Therefore, on a scale of 1 to 10, a weight factor of 10 is applied to the former and a weight factor of 2 is applied to the latter.

The preferred apparent alternative site is obtained by multiplying the evaluation factor of each of the sites by the weight factor and then adding the product for each criterion to obtain a numerical sum for each candidate site. The preferred site from the analysis is the site with the highest score.

The matrix evaluation is admittedly somewhat subjective because of the manner of interpreting the relative weights assigned to each of the criterion. Therefore, we have tried to include the rationale for the assignment of the weighted criterion as it appears. The weight factors are intended to represent the average of weights that would be assigned by a cross-section of individuals representing industry, the local community, and regulatory and other governmental agencies.

The evaluation of site-related factors is based on the existing conditions at the various site options. The weighting factor for each criterion is assigned by comparative degree of importance only, and does not evaluate the possibility of mitigating negative factors by proper engineering design of structures or process methods.

A two-level approach to the consideration of potential sites has been conducted. First, an island-by-island comparison of potential sites is described, the results of which are summarized in Table 7-1. After deriving the apparent preferred island location, we conducted a more site-specific comparison of potential sites on that island.

ISLAND-BY-ISLAND COMPARISON

Sites on three islands were evaluated: Hawaii, Oahu and Kauai. A site on Hawaii has the distinct advantage of being close to three-fourths of the current fresh papaya production in the State of Hawaii. The remainder of the crop is produced primarily on the Island of Kauai, so this island

Table 7-1
EVALUATION MATRIX FOR ISLAND-BY-ISLAND SITE COMPARISON

Criteria	Evaluation Factors: Hilo Hawaii	Honolulu Oahu	Lihue Kauai	Weighting Factors
Shipping and Distribution				
Air cargo handling facilities	+1	+2	-1	5
Sea cargo handling facilities	+1	+2	0	5
Land Use				
Land costs/availability	+2	-1	+1	4
Construction costs	-1	0	-1	2
Geologic stability	-1	0	0	10
Tsunami and flood potential	0	0	0	10
Power costs	-1	0	-1	2
Hydrogeology	-1	0	0	10
Proximity to research	+1	+2	-1	2
Commodity Volumes				
Proximity to most of the crop	+2	0	-2	10
Irradiation of other crops	+1	+1	0	5
Total Weighted Factors	21	25	-27	

Notes:
Evaluation Factors
-2--Unfavorable -1--Slightly unfavorable 0--Neutral
+2--Favorable +1--Slightly Favorable

Weighting Factors
Subjective, on a scale of 1 to 10, with 1 being least important and 10 most important.
A value of 8 is twice as important as a value of 4.

was considered for a comparative analysis. Oahu has the distinct advantage of being the current center of commercial trade and the center of both surface and air cargo transportation for the State. A facility on Oahu could also conceivably handle both Hawaii and Kauai products.

Other islands were not considered because they are not major producers of papaya for the export market. Additionally, increased transportation logistics and expense would not favor islands other than the three considered.

SHIPPING AND DISTRIBUTION

Papaya is primarily sold as a fresh product. Therefore, proximity of a central processing facility, whether packing, warehousing, cold storage, or irradiation, to the shipping and distribution network is critical to the success of getting undamaged fresh product to market. This factor is made even more significant because of the perishable nature of the product. Industry logistical factors were described Chapter 3.

Air Cargo Handling Facilities

The industry, especially in Hilo, has been forced to adapt to a dynamic situation with the availability of air cargo facilities out of General Lyman Field in Hilo. In past years, several commercial air carriers offered direct air service to Hilo since that city was being promoted as a direct gateway to the mainland, primarily California, where the majority of the papaya crop is exported. In recent years, the availability of the air cargo service associated with these flights has so severely declined that the only mainland carrier that did provide a direct Hilo-Mainland connection has opted to terminate this service.

Discussion with industry representatives confirmed the importance of air cargo availability to get fruit to market, especially if the market potential in the eastern United States is to be realized. Presently, most of the papayas are shipped in refrigerated containers as surface freight, but several packers still consider it to be cost-effective to ship their produce by air to markets east of the Mississippi River.

Because of the importance of proximity to air cargo facilities, this criterion is assigned a relative weight of 5. A site in close proximity to Honolulu Airport is assigned a favorable rating because most of the papaya crop currently leaves Hawaii using existing air cargo facilities at Honolulu International Airport. Hilo is less favorable for the above reasons. It should be noted that the State and the County of Hawaii are currently studying the possibility of a cargo transport and distribution center at General Lyman Field (Simat, Helliesen, & Eichner, Inc., 1986). If this study proves positive and the State and County ultimately construct this central air cargo facility at the Hilo Airport, the Hilo site would be assigned a more favorable rating.

The site at Kauai is rated unfavorable because the current airport is incapable of accommodating wide-body jets that would be used to transport air cargo.

Sea Cargo Handling Facilities

Surface cargo transportation availability currently plays an important role in getting the papaya product to market. Presently, the crop must be shipped by interisland barge or ship to the export terminals at Honolulu. The carriers are Young Brothers who can deliver to the air cargo terminal or to the sea cargo terminal, and Matson Navigation Company who deliver only to the sea cargo terminal. Both of these carriers provide refrigerated container vans that are loaded at the packer's facility with boxes or pallets of packaged papayas, and transported to the terminal for loading onto the ship or barge. Boxes of fruit that are destined for air cargo shipment to the mainland market are packed into special containers such as the LD-3 container and delivered to the air cargo terminal by Young Brot'ers.

Interisland service is available at all three locations. Matson serves the Port of Hilo, but is constrained in the amount of cargo it can handle at that location because of the nonavailability of major facilities for bulk container handling such as currently available in the Port of Honolulu.

Because the papaya industry relies to a 'arge extent on the interrelationships between surface and a r cargo shipment, proximity of the harbor facilities on the islands to the airport facilities is also a factor that has to be considered. The Honolulu site is rated favorable since the Port of Honolulu is the major overseas surface shipping port for the State. The Hilo location is rated as slightly favorable, primarily on the strength of its close location of the port to Hilo Airport, a point strongly emphasized by Simat, Helliesen and Eichner, Inc. (1986). The Lihue port is assigned a neutral rating. It is not as close to the airport as the Hilo location.

The proximity to and availability of surface transportation facilities is also an important criterion, and equal to that for air cargo. A relative weight of 5 is assigned to this criterion.

LAND USE CRITERIA

Land use criteria considered in this site analysis include land costs and availability, construction costs, geologic stability, tsunami and flood potential, power costs, site hydrogeology, and proximity to research facilities.

Land Costs/Availability

As discussed earlier, specific parcels of land have not been identified for consideration in this siting analysis so consideration of land costs and its availability are discussed in general terms. Availability of suitable lands is a fairly important criterion and is assigned a weight of 4.

Land is generally available at the Hilo, Hawaii site, and for that reason, its cost is more reasonable than could be expected for similar commercial or industrial zoned parcels in Honolulu. The Hilo air cargo study identified several sizable parcels within the General Lyman Field area that could be used for a cargo complex. An irradiation facility could conceivably be sited as part of that central air cargo complex for Hilo, which would significantly facilitate the handling of papaya product. While the feasibility of the central air cargo complex has not been determined at this time, the availability of State lands that could be used for this purpose in Hilo has to be a significantly favorable factor.

In a related matter, CH2M HILL checked with State Department of Transportation and the Federal Aviation Administration (FAA) officials into the advisability or desirability of siting an irradiator facility at the Hilo Airport. At this conceptual stage, we were unable to learn of major difficulties with the siting of a facility on airport grounds. The FAA expressed two concerns (Laschinger, 1986): (1) the potential interference with navigation equipment if machine sources are used since they have experienced interference with x-ray and hospital radiation equipment on radar and (2) they "encourage" locating any hazardous facilities as far as possible from air traffic and flight paths.

After consulting with the Hawaii Airports Division (Miyamoto, 1986), officials expressed opinions that the irradiator could be made a safe part of the air cargo terminal complex as long as adequate assurances are given the State regarding the safety of the facility. The jurisdiction of the FAA, aside from its interest in maintaining electronic navigation instrumentation, would be over physical interference (that is, height and location) with air flight paths.

In addition, other options exist for siting a facility in the vicinity near Hilo, either in Puna where a major existing packing plant is located, and in industrial lands, either publicly or privately owned near industrial areas just outside of the airport. Hawaii County officials have suggested that lands near the municipal solid waste landfill may possibly be considered for this purpose.

On the other hand, lands are generally less available in Honolulu, both at or close to the airport and port facilities. If not already available, land acquisition costs for a Honolulu site would add to project costs. Lands in Lihue are generally more available than in Honolulu, but less so than for Hilo. On this basis, the Hilo site is rated as favorable, the Honolulu site unfavorable, and Lihue, slightly favorable.

Construction Costs

Construction costs are higher throughout Hawaii compared to mainland construction costs. Much of the difference is attributable to both the cost of labor in Hawaii as well as the markup on cost of construction materials that have to be imported from the mainland or overseas. Within the State, material costs are affected by additional transportation and handling surcharges for the neighboring islands of Hawaii and Kauai. For these reasons, a neutral value is given to Oahu and a slightly unfavorable value assigned to both Hawaii and Kauai. The overall weight of this factor is 2 since it is of lesser importance.

Geologic Stability

The matter of geologic stability of the site is important because of the susceptibility of certain locations in the Islands of Hawaii to earthquakes and volcanism. Serious concerns have been raised over any site on the Big Island because of the younger geologic age of that island, making it more prone to earth tremors and active volcanism. Structural considerations for any facility on the Island of Hawaii must account for the seismicity.

The risk is acknowledged by requiring that structural elements be designed for the highest zone of earthquake damage. However, this risk could be mitigated to minimize the potential for damage by the proper application of engineering design.

The Big Island is also an area of active volcanism. Hilo itself has been threatened or affected in historic times from flows originating from the Northwest rift of Mauna Loa. Earlier lava flows from this rift zone have built a broad ridge that also trends toward Hilo. Recent work by the U.S. Army Corps of Engineers (1980) looked at the risk of volcanism affecting the City of Hilo.

Since 1843, there have been seven major eruptions in Mauna Loa's Northeast rift zone, each producing a lava flow containing at least 100 million cubic yards of lava. Of these seven flows, four advanced within 7 miles of the city. Lava from the 1880 eruption came within 1-1/2 miles of the harbor, and portions of Hilo are on the area covered by this flow.

The risk of active volcanism affecting Hilo, while not quantifiable, is considered miniscule and should not deter considerating the merits of constructing an irradiation facility in Hilo. Because of volcanic and the seismic risk, however, the site at Hilo is assigned a slightly unfavorable rating.

In comparison, at any site on Oahu and Kauai the degree of risk from active volcanism is virtually nil. These sites would however still be affected by the seismicity associated with the Islands of Hawaii. For these reasons, both Oahu and Kauai are assigned neutral ratings.

A relative weight of 10 is assigned to the geologic stability factor.

Tsunami and Flood Potential

Siting of any facility in a flood-prone area increases risk. These risks are generally managed by siting the facility outside the zones affected by flooding, or by physically flood proofing the structure. All potential sites could be located in areas that are not in storm-induced flood plains. Hilo, however, has been affected greatly in the past by tsunami-induced flooding. The risk to tsunami damage has been raised as a potential concern affecting the siting of the irradiator facility at Hilo Airport. CH2M HILL has researched official flood maps prepared and maintained by the Corps of Engineers for the FEMA. We have determined that all potential airport cargo facility sites closest to areas that could be affected by any tsunami are out of the tsunami inundation line. Based on this information, the risk of the facility to tsunami damage is nonexistent.

Based on the above, this criterion was assigned a weight of 10, with Hilo, Oahu, and Kauai, given a neutral rating.

Power Costs

Power costs are high on all of the Islands compared to mainland rates, but the rates are higher for Kauai and Hawaii than they are for Oahu. Typically, as a comparison, residential rates are on the order of 12 cents per kilowatt-hour for Oahu and 15 cents per kilowatt-hour for Hawaii and Kauai. Power costs are assigned a relative weight of 2, with a neutral evaluation factor for Oahu and a slightly unfavorable evaluation factor for Kauai and Hawaii.

Hydrogeology

The hydrogeology of the potential sites has been included as a factor because of the possible proximity of the irradiator to groundwater bodies. The potential for contamination of groundwater by the irradiator exists only if the assumption is made that the storage pool water has been contaminated by the radioactive source material, and further, that the pool has developed a leak to the surrounding soils. This assumption is only possible if the following failures occur sequentially:

1. The heavy welded, stainless steel source containment cannister must be compromised in such a way that radioactive source material is allowed to escape the containment.

2. The second heavy welded, stainless steel containment capsule that totally encloses the first cannister must also fail allowing escape of radioactive source material into the surrounding storage pool water.

3. The heavy stainless steel walls that completely line the inside surfaces of the storage pool must fail allowing passage of contaminated water to the surface of the concrete pool structure.

4. The thick reinforced concrete structural walls of the storage pool must fail allowing passage of the contaminated water into the surrounding soil.

The failure of any single plant component, in itself, cannot lead to a release of radioactivity to the environment. These events must occur in very rapid succession for the contamination to build to harmful levels in the storage pool water. This is true because operating procedure requires that the ultra-pure storage pool water be continuously monitored for the slightest trace of radioactive materials.

This monitor will detect radioactive presence before contamination levels are high enough to be harmful. In this case, the radioactive source would be immediately removed and the circulation of pool water through filters would remove the contaminants from the water.

This brief discussion was included as a good example of mitigation of real public concerns by engineering design and construction procedures that are required to satisfy the NRC licensing requirements that the facility will not contaminate the soils or groundwater.

However, because of public concern, this criterion has been included in the site evaluation. See Chapter 5 for more detailed discussion of source capsule integrity and facility safeguards.

Hydrogeology of the site will affect the migration of any released contamination into adjacent groundwater bodies, and determine its effect on drinking water and the difficulty of cleanup operations.

For the sites considered, the risk, if any for the Hilo site is higher than the Oahu and Lihue sites because the Hilo area is underlain with fairly porous basaltic formations which will allow any contamination to reach the groundwater aquifer in a relatively short period of time. Furthermore, the groundwater aquifer underlying the city of Hilo is of potable quality with a thick fresh water lens serving as a source of drinking water for the city of Hilo.

On the other hand, there is no potable groundwater source of water underlying the sites considered for Lihue and Honolulu. In addition, both sites are adjacent to the seashore and any leakage would flow to the sea before contamination of groundwater aquifers could take place. At Lihue, the geology consists of weathered relatively impervious soils and very tight lavas which impedes the flow of the groundwater, a positive time factor when considering contamination control measures. On Oahu, the considered sites are over impervious alluvium or coral reef formations known as caprock which also impedes the flow of the groundwater.

On the above basis, a weight of 10 has been assigned to the hydrogeology factor, with the Lihue and Honolulu sites rated neutral and the Hilo site rated slightly negative.

Proximity to Research

Proximity to research facilities is a factor included because the efficacy of the radiation process for disinfestation, shelf-life extension, sterilization, and other beneficial effects to local commodities must continue to be developed and demonstrated. Proximity to facilities maintained by the University of Hawaii, the USDA, and the Hawaii Department of Agriculture would contribute to the success of the facility. A relative weight of 2 is assigned.

Most of the large Hawaii research efforts and facilities are located on the Manoa Campus of the University of Hawaii on the Island of Oahu. The university also has cooperative extensive service branches on the neighboring islands and a satellite campus at Hilo, Hawaii. Kauai currently does not offer much in the way of research facilities. Therefore,

evaluation factors of +2, +1, and -1 are assigned to the Oahu, Hawaii, and Kauai locations.

COMMODITY VOLUMES

Proximity To Most Of The Crop

Siting a central irradiation facility near the major papaya production and packing areas is critical; thus, it is assigned a weight factor of 10.

Currently the large majority of the papaya crop is produced on the Island of Hawaii. Based on statistics maintained by the Hawaii Department of Agriculture (1986), the 1985 statewide utilized papaya production was about 60,400,000 pounds. Of that amount, about 55,375,000 pounds were produced on the Island of Hawaii. Six of the seven papaya packers in the State are located in the Hilo area, with the seventh in Kapaa, Kauai.

Industry projections based on the acreage planted continue to show predominance of the Puna areas of Hawaii for production of fresh papaya. Because of this predominance, a site on the Big Island is considered most favorable.

By comparison, while most of the remaining commercial production of export papaya occurs on Kauai and there is a packing facility located in Kapaa, the vast majority of the export crops would require additional transportation handling if the irradiator is sited on Kauai. For this reason, the Kauai location is given an unfavorable factor.

An Oahu irradiator location would also require that the product be rehandled for treatment. This factor is tempered somewhat by the existence of the transportation complex on Oahu with the product already going to the Honolulu shipping point. The Oahu site is given a neutral rating.

Irradiation of Other Crops

Since it is the State's desire to consider the potential of this facility to treat crops other than papaya as well as to improve its cost effectiveness, proximity to other potential crops is viewed as an advantage. By comparison, this factor is not nearly as important as proximity to the papaya crop, primarily because at this time there is no commercial crop that has been identified with an existing market as dominant as that of the papaya industry. Mangoes, lychees and other agricultural commodities that could benefit from an irradiation plant are still backyard crops and statistics on Hawaii production rates are generally not maintained. A weight of 5 is assigned to this criterion.

Both the Hilo and Honolulu sites are ranked as favorable, compared to the neutral rating for Lihue because the larger amounts of available land on Hawaii impacts production potential and the center of the produce market being located on Oahu.

APPARENT PREFERRED LOCATION

The evaluation factors for the various sites and the weighting factors for each criterion are summarized in Table 7-1. In this evaluation, safety considerations such as hydrogeology and geologic stability were given a weight of 10 to indicate their importance to the public. The weighting does not take into account safety systems or special facility design which would mitigate the effect of a potential component failure. Such safeguards would essentially reduce the weighting factors for these safety criteria and change the overall site rankings.

The analysis of existing site conditions and constraints indicates that Hilo and Oahu are virtually equal with a slight preference of Oahu as the location for an irradiator. While the site analysis identifies an apparent preferred location based on the selected criterion, it is suggested that other industry and/or State issues may govern the actual selection of the irradiator site. Perhaps this analysis may be best used as an information tool to aid in understanding the requirements for design of a facility at a particular location.

As an example, if a facility located near Hilo would best serve the industry and the needs of research and development activities envisioned by the State, then the site analysis suggests the following concerns:

1. Air and sea cargo should be investigated to see if shipping schedules or routes could be adjusted by the carriers to enhance operations at Hilo.

2. Construction costs will be slightly higher than at Oahu. Perhaps this would be offset by more reasonable land costs at Hilo.

3. The design must consider the geologic stability of the Island of Hawaii and include design and construction measures that will mitigate this concern. This may result in higher construction costs.

4. Design of the facility should consider energy-efficient design due to slightly higher power costs.

5. Due to hydrogeologic conditions at the site, the design and construction must include measures to mitigate the

concern for groundwater contamination. This may include investigation of a facility with a method of dry storage.

6. With the irradiator facility located in Hilo, the needs of ongoing and future research at the various institutions will require special planning, considering the distance from existing research centers.

A similar evaluation can be made for each of the other potential sites.

Table 7-1 was developed from the results of the cursory study authorized by the scope of work for this study. Detailed economic and engineering investigations of the intended site may reveal other conditions not apparent at the study level of examination.

COUNTY OF HAWAII SITE COMPARISON

A similar analysis was conducted for three sites with development potential on the Island of Hawaii. The results of this analysis are presented in Table 7-2. The considered sites were the Hilo Airport site, a site adjacent to the packing plant at AMFAC, Tropical Products, and a third site, unidentified, in the general vicinity within the existing industrial development and close to General Lyman Field (Kanoelehua industrial area). The latter site was discussed as a possibility with County officials and was included for comparison analysis.

By including the AMFAC site, we do not intend to represent that the corporate position of AMFAC is that the site is now, or will be, made available to the State or County.

In our discussions with industry personnel and AMFAC, CH2M HILL has learned that AMFAC once co·sidered developing a private irradiator to be located adjac·nt to its packing facility. Other smaller packers in the Hilo area expressed interest in sending their fruit to the AMFAC irradiator if it materialized. The site is included to provide a basis for comparison with sites located close to the airport but not as close to the papaya fields as the AMFAC site.

Evaluation criteria for the Hawaii sit· comparison are very similar to the island-by-island comparison criteria. These include proximity to most of the crop, proximity to urban areas, existing land use, land ownership, archaeology, site expandability, grading requirements, utilities availability and cost, institutional constraints, and a fairness criteria.

Table 7-2
EVALUATION MATRIX FOR HAWAII ISLAND SITE COMPARISON

Criteria	Hilo Airport	AFMAC Packers	Third Site	Weighting Factors
	Evaluation Factors			
Shipping and Distribution				
Proximity to most of the crop	+1	+2	+1	8
Land Use				
Proximity to urban areas	-1	0	0	10
Existing land use	+2	+2	+2	6
Land ownership	+2	-1	+1	4
Archaeology	0	0	0	5
Site expandability	+1	0	+1	2
Grading requirements	-1	+1	-1	2
Utility availability and cost	+1	+1	+1	2
Institutional constraints	+1	0	0	2
Fairness	+2	-2	+2	2
Total Weighted Factors	26	24	30	

Notes:

Evaluation Factors
-2--Unfavorable -1--Slightly unfavorable 0--Neutral
+2--Favorable +1--Slightly Favorable

Weighting Factors
Subjective, on a scale of 1 to 10, with 1 being least important and 10 most important.
A value of 8 is twice as important as a value of 4.

SHIPPING AND DISTRIBUTION

Shipping and distribution, as well as proximity of the site to the major centers of current production, are major considerations in evaluating potential sites. However, any site in the Hilo or Puna area will be relatively close to the production centers. A weight of 8 is assigned to this criterion.

The Hilo Airport site offers convenience to the air cargo facilities and the shipping port, as would a site in the industrial area nearby. The disadvantage of distance to shipping facilities would be overcome by a site at AMFAC because this site is located closer to where most of the papayas are grown. Additionally, AMFAC has packing contracts with the majority of independent papaya growers on the Big Island; therefore, most of the growers already bring the picked fruit to AMFAC. A favorable evaluation factor of +2 is given to the AMFAC site, and slightly favorable, or +1, to the airport and industrial site.

LAND USE

Specific land use issues that are also considered important for evaluating potential sites are discussed below.

Proximity to Urban Areas

Proximity to urban areas is included as a factor because of concerns previously expressed over siting an irradiator in a residential or heavily-populated area. The Hilo Airport site is rated as somewhat unfavorable because of its proximity to the central urban core of Hilo's population as compared to the AMFAC site, which is located in Keeau, a smaller rural community in the heart of a predominantly agricultural area. AMFAC and industrial sites are assigned neutral factors.

Existing Land Use and Land Ownership

Existing land use and ownership were considered since a site would not only be potentially less expensive but also easier to develop if the lands were owned or controlled by the State. This aspect could be significant were the State to cost share with the DOE in the demonstration irradiator program by offering the land for the project as a services-in-kind contribution.

The site at Hilo Airport is owned by the State; AMFAC lands are privately held and would thus have to be acquired in fee or leased, while both public and private lands are located in or near the airport industrial area. Airport land is suitable for industrial use; the AMFAC lands involve both agricultural and industrial uses.

A weight of 6 is assigned to existing land use, with a rating of +2 assigned to the airport, AMFAC and industrial sites. A weight of 4 is assigned to land ownership, with factors of +2, -1, and +1 assigned to the airport, AMFAC and industrial sites, respectively.

Archaeology

Archaeology may be important in considering of specific sites. At present an archaeological reconnaissance has not been conducted and archaeological finds of significance are not probable at any of the sites because these sites have been improved in recent years for their current purpose. Thus a weight of 5 is applied to equally neutral evaluation factors for all three sites.

Site Expandability

The sites being considered have the benefit of readily available space for expansion. Because lands at the AHFAC site are privately owned, the potential for expanding a State-constructed facility is more limited, so the evaluation factor reflects this disadvantage. A weight of 2 has been assigned to site expansion, with the airport and industrial sites rated as slightly favorable and the AHFAC site, neutral.

Grading Requirements

Grading requirements affect site development costs at each location. The grading at the Hilo Airport site is considered to be potentially difficult because of the dense basalt material likely to be encountered at that site. A similar concern would hold for the airport industrial site. The AHFAC site, on the other hand, is located on a deep soil mantle and excavation at that location would be easier. For these reasons, a weight of 2 is assigned to this criterion, with evaluation factors of -1 for the airport and industrial sites, and a +1 for the AHFAC site.

Utility Availability and Cost

Utilities and their availability would affect each of the site development costs as well. Utilities can be considered to be available at each of the three sites without too much difficulty, thus a weight of 2 is used, and slightly favorable factors assigned to each site.

Institutional Constraints

Considered institutional constraints included the appropriate land use designations and the need to have lands redesignated or zoned, federal and state permitting requirements, and environmental constraints. These constraints would be applicable for all of the sites, but the airport site has somewhat of an advantage because it is adjacent to an existing facility with plans for increased development, and especially so if the irradiation plant is developed in conjunction with the air cargo terminal facility. A weight

of 2 has been assigned, with evaluation factors of +1, 0, and 0 for the airport, AHFAC and industrial sites, respectively.

Fairness

A fairness criterion has also been applied because a site at one of the existing packing plants has been evaluated. Constructing a food irradiator at a specific packer's site may be perceived by other packers and growers as an unfair advantage to AHFAC, a neutral site such as the State-owned property at the airport is better from the standpoint of perceived fairness. For these reasons, a weight of 2 is assigned to the fairness criterion, with evaluation factors of +2, -2, and +2 for the airport, AHFAC and industrial sites.

APPARENT PREFERRED SITE

Given the limitations of the siting analysis used, no one location appears to be preferred at this time. Results of the analysis are summarized in Table 7-2.

ABR1/008

APPENDIX B

CONSULTATION AND REFERENCES

APPENDIX B
CONSULTATIONS AND REFERENCES

B.1 CONSULTATIONS

State of Hawaii

Rep. Andrew Levin

Senator Richard Matsuura

Department of Transportation
- Dean Nakagawa
- Wally Hishimoto
- Frank Kamahele, Hilo Airport Manager
- Larry Balbarino

Motor Vehicle Safety Office

Other Government Agencies

Federal Aviation Administration
- David Welhouse, Airport Engineer/Planner

Hawaii County
- Albert Lono Lyman, Planning Director
- Minoro Shintani, Research and Development Director

U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS),
- James F. Fons, Acting Staff Officer
- Edward Vyeda, Officer in Charge

University of Hawaii, Manoa
- Dr. Robert Paull-Professor of Plant Physiology
- Dr. James Moy

U.S. Nuclear Regulatory Commission, Division of Ra[illegible]iation Safety and Safeguards
- Beth Riedinger

Other Parties

Aloha Airlines, Domingo Tagudin, Manager - Cargo Sales
Aloha Airlines, Fred Spencer, Director - Cargo Services
American Airlines, Steve Anderson
Amfac Tropical Fruit, Charles Wallis, Director of Sales
Continental Airlines, Dorothy Zeno
Del Monte, Lily Arakawa
Delta Airlines, Craig Drum
Diamond Head, Roy Pokpyama
Hawaiian Airlines
Hawaiian Host, Stanley Fujiyama
Matson Navigation Company, Francis Shigemitsu, Customer Service Supervisor
Ono Pac, Richard Sakanashi
Pacific Paradise, Aaron Hagerfeldt
Pacific Tropical Products, Meade Kirkpatrick
Papaya Administrative Committee (PAC), Robert Souza, Manager
United Airlines, Marta Chipi
Young Brothers Ltd. Stephanie Char, Customer Service Representative

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B.3 OTHER DOCUMENTATION

Relevant letters and other documents follow.

JOHN WAIHEE
GOVERNOR

RECEIVED
DIRECTORS OFFICE
JAN 20 9 01 AM '88
BUSINESS AND ECONOMIC DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

DIRECTOR
EDWARD Y. HIRATA

DEPUTY DIRECTORS
JOHN K. UCHIMA
RONALD N. HIRANO
DAN T. KOCHI

IN REPLY REFER TO
AIR 8307

January 15, 1987

MEMORANDUM

TO: The Honorable Roger A. Ulveling
Director, Department of Business & Economic Development

FROM: Director of Transportation

SUBJECT: Proposed Irradiation Site, General Lyman Field

The report transmitted by your memorandum of January 7, 1988 for the proposed Commodities Irradiation Facility at General Lyman Field has been reviewed.

Your memorandum proposed the site for the irradiation facility on four acres of land south of the airport access road. We are opposed to the location which would result in the removal of the natural vegetation which landscapes the access road and would require the construction of an intersection which would seriously affect traffic.

I suggest that a four-acre site north of the access road within the area masterplanned for cargo facilities be used instead. The irradiation facility would be visually compatible with other buildings and a roadway and traffic control system already exists.

Please call Mr. Owen Miyamoto, Airports Administrator, at 836-6432 for further discussion on the recommended site.

EDWARD Y. HIRATA

cc: AIR-H
AIR-E

JOHN WAIHEE
GOVERNOR OF HAWAII

DISTRICT OFFICES
WEST HAWAII OFFICE
P. O. BOX 125
KAMUELA, HAWAII 96743
EAST HAWAII OFFICE
160 BAKER STREET
HILO, HAWAII 96720

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAII 96805

RECEIVED
DIRECTORS OFFICE
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BUSINESS AND ECONOMIC DEVELOPMENT

DISTRICT OFFICES
MAUI OFFICE
P. O. BOX 1000
WAILUKU, MAUI 96793
MOLOKAI OFFICE
P. O. BOX 198
HOOLEHUA, MOLOKAI 96729
KAUAI OFFICE
P. O. BOX 332
LIHUE, KAUAI 96766

December 29, 1987

MEMORANDUM

TO: The Honorable Roger A. Ulveling
Director of Business and Economic Development

ATTENTION: Dr. Tak Yoshihara
Energy Program Administrator

FROM: Ilima A. Piianaia, Chairman
Hawaiian Homes Commission

SUBJECT: Potential Alternative Sites for Commodities Irradiation Facility, Environmental Impact Statement

The Department of Hawaiian Home Lands (DHHL) has no objections to the inclusion of one or more of its land parcels for review in the subject Environmental Impact Statement (EIS).

This is not a commitment by DHHL to the use of Hawaiian Home Lands for this purpose. The EIS is viewed as a useful mechanism to identify and assess the impacts of the subject proposed facility in this region. A conveyance of land requires a Hawaiian Homes Commission decision at the appropriate time with additional analysis and findings prov ded by DHHL.

Before the EIS project commences, please have your staff contact Darrell Yagodich at 548-3261 to discuss potential alternative sites on Hawaiian Home Lands.

cc: All Hawaiian Homes Commissioners

APPENDIX C
SITE LAYOUT ASSUMPTIONS

APPENDIX C
ASSUMPTIONS USED TO SIZE THE RELATED FACILITIES TO THE COMMODITIES IRRADIATION FACILITY PROPOSED FOR THE HILO AIRPORT AREA

1. Design Map of the Irradiation Facility. The design load, according to the CH2M Hill report is 110,000 to 330,000 lbs per day based on 1 to 3 shifts. This works out to approximately 11 pallets per hour assuming 110,000 lbs converts to 84 pallets per 8-hour shift at 1320 lbs per pallet. Each pallet is made up of 132 boxes at 10 to 11 lbs per box. Pallet size is 41 inches deep, 48 inches wide, and 76 inches high. The basic irradiation processing facility, according to the CH2M Hill report is 151 x 82 feet overall.

2. Input. Trucks likely to service this facility range from a flat bed tractor trailer with an 8- x 40-foot bed which can carry up to 20 pallets maximum, or more typically, a flat-bed truck with an 8- x 20-foot bed carrying 8 to 10 pallets, possibly less depending on the gross weight of the vehicle. This would average one truck per hour on a normal day shift with up to three trucks per hour if all three shifts of operation were received during the normal working day. Therefore, at least 3 loading docks would be required, assuming a maximum of an hour to unload each truck.

3. Initial Holding Area. Assuming a holding area requirement of one full day of three shifts, say 250 pallets at 50 percent efficiency. The untreated holding area would require 7000 square feet and need only be a roofed enclosure. No special provisions would be required.

4. Processing Area as indicated in Item 1, an area 151 x 82 feet.

5. Post Processing Holding Area. There are indications that the quality of the fruit is improved if it is held at room temperature for 8 hours after processing prior to cooling. Therefore, the holding area is sized for 8 hours of production, equivalent of 84 pallets which, at 50 percent efficiency, would require 2400 square feet. This area also has no special requirements and can be simply a roofed enclosure.

6. A Cool-down Area. Assuming approximately 24 hours for a cool-down to be accomplished from room temperature to approximately 50°F, the cool-down area would

have to accommodate 3 shifts of production or 250 pallets over a 24-hour period. Also assuming at 50 percent efficiency at lay-down space, a cooler of 7000 square feet would be required, assuming no stacking of pallets. It is recommended that this cooler be divided into eight segments, each with a capacity of 32 pallets with independent controls for each segment so that different areas of the cooler can be opened and closed independently of each other for loading or unloading. The cool-down area would require 8 loading docks, one for each segment of the cooler.

7. Refrigerator Container Yard. Assuming a worst-case of 3 days of storage required due to irregularities in the barge schedule or other unanticipated occurrence, a total holding yard requirement would be for 46 containers. The containers are 24 x 8 feet and contain 16 pallets per container. Three day's production at 3 shifts is 750 pallets divided by 16 per container for 46 containers.

The above information is developed both from the CH2M report and Richard Sakenashi of Ono Pac.

APPENDIX D

REPORT STAFF

APPENDIX D
REPORT STAFF

State of Hawaii Department of Business and Economic Development

Maurice Kaya, Energy Division Administrator
Gerald Lesperance, Alternate Energy Specialist, Energy Division

WESTEC Services

Jim Frolich, Project Manager
Teresa Gutierrez, Environmental Analyst
John Herwig, Hydrologist
Allan Schilz, Archaeologist
Albert Spiers, Vice President
Roger Williams, Honolulu Office Manager

Belt Collins & Associates

Susan Johnson, Planner
Ed Miyashiro, Civil Engineer
Sue Rutka, Planner
Dick Van Horn, Planner
Perry White, Senior Environmental Planner

Gordon Chapman, Senior Environmental Planner

Paul Rosendahl, Consulting Archaeologist

Wanona Char, Botanist

APPENDIX E

BOTANICAL INVESTIGATION:

BOTANICAL SURVEY, HAWAII FOOD COMMODITIES IRRADIATION FACILITY

BY: CHAR & ASSOCIATES

BOTANICAL SURVEY

HAWAII FOOD COMMODITIES IRRADIATION FACILITY

GENERAL LYMAN FIELD, HILO, ISLAND OF HAWAII

by

Winona P. Char

CHAR & ASSOCIATES
Botanical/Environmental Consultants
Honolulu, Hawaii

Prepared for: GORDON A. CHAPMAN
AND
WESTEC SERVICES, INC.

April 1988

Table of Contents

BOTANICAL SURVEY
HAWAII FOOD COMMODITIES IRRADIATION FACILITY
GENERAL LYMAN FIELD, HILO, ISLAND OF HAWAII

INTRODUCTION

An irradiation facility to treat papaya, mangoes, lychee, and other fruit or agricultural products which will be transported outside the state of Hawaii and are susceptible to fruit fly or other insect infestations is proposed by the Department of Business and Economic Development. The proposed facility would consist of a warehouse building housing the irradiator and ancillary operations. Ancillary facilities would consist of office space, dosimetry laboratory, storage space for treated and untreated fruit, etc. The project site would also include truck loading and unloading ramps to the warehouse as well as truck and employee parking areas.

Three sites of about 5 acres each have been proposed for the irradiation facility. All are located within the industrial and/or commercial areas on or near the General Lyman Field.

A survey to inventory and assess the botanical resources on each of the three candidate sites was conducted on 21 April 1988. The primary objectives of the survey were to 1) provide a general description of the major vegetation types; 2) inventory all terrestrial, vascular plant species; and 3) search for rare, threatened or endangered plants on the three sites.

SURVEY METHODS

Prior to the field studies, existing location maps as well as aerial photographs of the three sites and the general area were examined to determine access, terrain characteristics, boundaries, and reference points.

Access onto the sites was by means of adjacent paved roads. Site A is located in the airport industrial area adjacent to the airport access road and on land presently under jurisdiction of the Hawaii State Department of Transportation, Airports Division. After obtaining clearance from the airport manager's office, we were driven to Site A and entered via Leleaoa Street. Site B is located at the old airport terminal, near the air cargo operations. Portions of the site are in active use and the site is bound by a number of paved roads. Site C is located on Railroad Avenue approximately one-half mile from the airport and is presently vacant.

A walk-through survey method was used and notes were made on plant associations and distribution, substrate types, topography, exposure, etc. Species were identified in the field; plants which could not be positively identified were collected for later determination in the herbarium and for comparison with the taxonomic literature.

A total of two botanists was employed to gather the technical data contained in this report.

DESCRIPTION OF THE VEGETATION

Vegetation on all three sites is dominated by introduced species. Two of the sites, A and B, are maintained, while the third, Site C, is overgrown with weedy trees, shrubs, and grasses. Although a few native species occur on the sites, none is considered a rare, threatened or endangered species by the federal and/or state governments (Fosberg and Herbst 1975; U. S. Fish and Wildlife Service 1985; Herbst 1987).

SITE A. Airport Industrial Area

Site A consists of a mowed lawn surrounded by chain-link fences. An assortment of grass species which include carpetgrass (Axonopus compressus), Hilo grass (Paspalum conjugatum), dropseed (Sporobolus sp.), foxtail (Setaria gracilis), molasses grass (Melinis minutiflora), and Natal redtop (Rhynchelytrum repens) make up the predominant cover. Weedy herbaceous species common in this area include polygola (Polygola paniculata), sleepinggrass (Mimosa pudica), and beggar's tick (Desmodium incanum). Where there are pockets of loose rock and along the fenceline, the grasses become sparse and plants of sword fern (Nephrolepis multiflora), white-flowered Spanish needle (Bidens alba), and sleepinggrass become more numerous.

A few shrubby species occur only on the face of the terrace cut where the rocky surface is exposed, however, the plants do not become very tall as they are cut back regularly by maintenance personnel.

SITE B. Old Airport Terminal Area

A grassy lawn with scattered trees characterizes this site. The lawn is commonly composed of a mixture of grass species, although, in places, large patches of a single species may be found. The grasses include carpetgrass, Hilo grass, Digitaria ciliaris, dropseed, Glenwood grass (Sacciolepis indica), foxtail, and California grass (Brachiaria mutica). The more common weedy

herbaceous species growing among the grasses on this site are Asian pennywort (Centella asiatica), borreria (Spermococe assurgens), blue day flower or honohono (Commelina diffusa), common plantain (Plantago major), and beggar's tick.

A few trees of pandanus (Pandanus tectorius), Javaplum (Syzygium cumini), gunpowder tree (Trema orientalis), African tulip (Spathodea campanulata), coconut (Cocos nucifera), etc., occur on the site.

Near the central portion of the site, there is a rocky depression which has been left in a more or less unmaintained condition. It supports a small stand of trees with clumps of guava (Psidium guajava) and pluchea (Pluchea symphytifolia) shrubs between the trees. California grass, molasses grass, and sword fern form dense mats up to 5 ft. tall in some areas. Where the jumble of rocks is exposed, sword fern is abundant.

SITE C. Railroad Avenue Parcel

The site was formerly used for concrete mixing and for a sand and gravel plant. Most of it, except for the service road and building area, is now overgrown. Roughly one-half of the site is covered by broomsedge (Andropogon virginicus) and molasses grass. The other half supports an open woodland of weedy, fast-growing melochia trees (Melochia umbellata).

Gravel and rock piles as well as a large open trench are found in the grassy area. Besides the two grasses mentioned above, other plants frequently found here include sword fern, kaunoa'oa (Cassytha filiformis), several Desmodium species, and seedlings of melochia, 1 to 3 ft. tall. Locally abundant, especially near road areas, is wedelia (Wedelia trilobata) an ornamental species which continues to persist and spread even if left untended.

Melochia trees, 15 to 25 ft. tall, form an open woodland with a few, scattered gunpowder trees. The understory layer is dense and species composition varies from place to place. Thorny sleepinggrass may form mats up to 6 ft. high; in other areas, California grass and comb hyptis (Hyptis pectinata) form a different association; and, in some places, sword fern or molasses grass may form dense patches. Climbing up onto the shorter trees and shrubs are maile pilau (Paederia scandens), kaunoa'oa, and koali-awahi'a (Ipomoea indica).

DISCUSSION AND RECOMMENDATIONS

The vegetation on all three sites is composed almost exclusively of introduced species (refer to Appendix A). Of the three sites, Site C contains the most number of native species, i.e., indigenous and endemic plants, as it has not been maintained for some time. The native species include mamaki (Pipturus), koali-awahi'a, kaunoa'oa, and 'uki (Machaerina mariscoides ssp. meyenii). However, none of these natives is considered a rare, threatened or endangered species. They all occur in similiar environmental habitats throughout the islands.

The proposed project will result in the loss of most of the vegetation on the chosen site. However,as the bulk of the biomass consists of introduced weedy species which are widespread in similiar disturbed habitats, vegetation removal on the chosen site is not expected to have a significant negative impact on the botanical resources.

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APPENDIX A. PLANT SPECIES LIST.
HAWAII FOOD COMMODITIES IRRADIATION FACILITY
GENERAL LYMAN FIELD, HILO, ISLAND OF HAWAII

In the following plant checklist, the plants are divided into three groups: Pteridophytes, Monocots, and Dicots. Taxonomy of the Pteridophytes (ferns and fern allies) follow Wagner and Wagner (1987); the flowering plants (Monocots and Dicots) follow Wagner et al. (in prep.). In most cases, common English or Hawaiian names are in accordance with St. John (1973) or Porter (1972).

The checklist provides the following information:

1. Scientific name with author citation. A few taxa have been identified to the generic level only as material for specific determination, i.e., flower and/or fruit, was lacking.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of each species. The following symbols are used:
   E = endemic, native only to the Hawaiian Islands
   I = indigenous, native to the islands and to one or more other geographic area(s)
   P = Polynesian, plants of Polynesian introduction brought to the islands prior to Western contact (1778); not native
   X = introduced or exotic, brought here by humans deliberately accidentally after Western contact; not native.
4. Presence (+) or absence (-) within each of the three proposed sites (A,B,C)

SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	BIOGEOGRAPHIC STATUS	SITE A	SITE B	SITE C
PTERIDOPHYTES					
Adiantaceae					
Pityrogramma calomelanos (L.) Link	silver fern	X	-	+	+
Pteris vittata L.	brake fern	X	-	-	+
Aspleniaceae					
Nephrolepis multiflora (Roxb.) Jarret ex Morton	sword fern	X	+	+	+
Polypodiaceae					
Phymatosorus scolopendria (Burm.) Pichi Sermolli	laua'e	X	-	-	+
Psilotaceae					
Psilotum nudum (L.) Beauv.	moa	I	+	-	-
MONOCOTS					
Araceae					
Monstera deliciosa Liebm.	monstera	X	-	+	-
Commelinaceae					
Commelina diffusa N.L. Burm.	blue day flower	X	-	+	+
Murdannia nodiflora (L.) Brenan	murdannia	X	-	+	-

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Cyperaceae					
Cyperus haspan L.	cyperus	X	-	+	+
Cyperus polystachyus Rottb.	cyperus	I	+	+	+
Cyperus rivularis Kunth.	cyperus	X	-	+	-
Cyperus rotundus L.	nut sedge, nutgrass	X	-	+	+
Eleocharis sp.	eleocharis	X?	-	+	-
Fimbristylis dichotoma (L.) Vahl	fringe-rush	I	+	+	+
Fimbristylis pycnocephala Hbd.	fimbristylis	I	-	-	+
Kyllinga brevifolia Rottb.	green kyllinga	X	-	+	+
Machaerina mariscoides (Gaud.) Kern ssp. meyenii (Kunth) Koyama	'uki	E	-	-	+
Gramineae					
Andropogon virginicus L.	broomsedge	X	+	+	+
Axonopus compressus (Sw.) Beauv.	carpet grass	X	+	+	+
Bothriochloa pertusa (L.) A. Camus	hurricane grass	X	+	+	+
Brachiaria mutica (Forsk.) Stapf	California grass	X	-	+	+
Cenchrus ciliaris L.	buffel grass	X	-	-	+
Cenchrus echinatus L.	sandbur	X	-	+	+
Chloris barbata (L.) Sw.	finger grass	X	+	+	+
Chloris radiata (L.) Sw.	plush grass	X	-	-	+
Cynodon dactylon (L.) Pers.	Bermuda grass	X	+	+	+
Digitaria ciliaris (Retz.) Koeler	Henry's crab grass	X	-	-	+
Digitaria insularis (L.) Mez ex Ekman	sour grass	X	-	+	+
Digitaria sp.	crab grass	X	+	-	-
Eleusine indica (L.) Gaertn.	goose grass	X	+	+	+
Eragrostis tenella (L.) Beauv. ex R. & S.	Japanese love-grass	X	-	+	+

9

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Eragrostis sp.	love-grass	X	-	+	-
Melinis minutiflora Beauv.	molasses grass	X	+	+	+
Panicum maximum Jacq.	Guinea grass	X	-	+	+
Paspalum conjugatum Berg.	Hilo grass	X	+	+	+
Paspalum dilatatum Poir.	Dallis grass	X	+	+	+
Paspalum scrobiculatum L.	rice grass	X	+	+	+
Paspalum urvillei Steud.	Vasey grass	X	-	+	+
Pennisetum purpureum Schumach.	elephant grass	X	-	-	+
Rhynchelytrum repens (Willd.) C. E. Hubb.	Natal redtop	X	+	+	+
Sacciolepis indica (L.) Chase	Glenwood grass	X	+	+	+
Setaria gracilis Kunth. in Humb. & Bonpl.	foxtail	X	+	+	+
Sporobolus sp.	dropseed	X	+	+	+
Iridaceae					
Crocosmia x crocosmiflora (Lemoine ex Morren) N. E. Brown	montbretia	X	-	-	+
Liliaceae s.l.					
Cordyline terminalis (L.) Kunth.	ti	P	-	-	+
Orchidaceae					
Arundina graminifolia (D. Don) Hochr.	bamboo orchid	X	-	+	+
Epidendrum ibaguense HBK.	epidendrum	X	-	-	+
Spathoglottis plicata Bl.	Philippine ground orchid	X	-	-	+

10

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Palmae					
Archontophoenix alexandrae (F. v.Muell.) H. Wendl & Drude	Alexandra palm	X	-	+	-
Cocos nucifera L.	coconut, niu	P	-	+	+
Pandanaceae					
Pandanus tectorius Parkinson ex Z	hala	I?	-	+	+
DICOTS					
Acanthaceae					
Thunbergia fragrans Roxb.	white thunbergia	X	-	+	+
Anacardiaceae					
Mangifera indica L.	mango	X	-	+	-
Schinus terebinthifolius Raddi	Christmas berry	X	-	+	+
Apocynaceae					
Plumeria rubra L.	plumeria	X	-	+	-
Bignoniaceae					
Spathodea campanulata Beauv.	African tulip tree	X	-	+	+
Tabebuia sp.	tabebuia	X	-	+	-
Buddlejaceae					
Buddleia asiatica Lour.	buddleia	X	+	+	+

11

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Compositae					
Ageratum conyzoides L.	ageratum	X	-	+	-
Ageratum houstonianum Mill.	ageratum	X	+	+	+
Artemisia vulgaris L.	yomogi	X	-	+	-
Bidens alba L.	Spanish needle	X	+	+	+
Bidens pilosa L.	Spanish needle	X	-	+	-
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	-	-	+
Conyza canadensis (L.) Cronq.	horseweed	X	-	-	+
Crassocephalum crepidiodes (Benth.) S. Moore	crassocephalum	X	+	+	+
Eclipta alba (L.) Hassk.	eclipta	X	+	+	+
Emilia fosbergii D.H. Nicolson	emilia	X	+	+	-
Emilia sonchifolia (L.) DC.	emilia	X	+	+	-
Erechtites hieracifolia (L.) Raf.	fireweed	X	-	+	+
Pluchea indica (L.) Less.	pluchea	X	-	+	-
Pluchea symphytifolia (Miller) Gillis	pluchea	X	-	-	+
Sonchus oleraceus L.	common sowthistle	X	+	+	+
Synedrella nodiflora (L.) Gaertn.	synedrella	X	-	+	+
Tridax procumbens L.	coat buttons	X	-	+	-
Wedelia trilobata (L.) A. S. Hitchc.	wedelia	X	+	+	+
Youngia japonica (L.) DC.	youngia	X	-	+	-
Convolvulaceae					
Ipomoea indica (J. Burm.) Merr.	koali awahi'a	I	-	+	+
Ipomoea triloba L.	pink bindweed	X	-	+	+

12

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Euphorbiaceae					
Chamaesyce hirta (L.) Millsp.	spurge	X	+	+	+
Chamaesyce hypericifolia (L.) Millsp.	spurge	X	+	+	+
Chamaesyce prostrata (Ait.) Small	spurge	X	-	+	-
Macaranga grandifolia (Blanco) Merr.	bingabing	X	-	+	+
Phyllanthus debilis Klein ex Willd.	phyllanthus	X	+	+	+
Guttiferae					
Clusia rosea Jacq.	autograph tree	X	-	+	-
Labiatae					
Hyptis pectinata (L.) Poit.	hyptis	X	-	+	+
Lauraceae					
Cassytha filiformis L.	kaunoa'oa	X	-	-	+
Persea americana Mill.	avocado	X	-	+	+
Leguminosae					
Chamaecrista nictitans (L.) Moench	partridge pea	X	+	+	+
Crotalaria assamica Benth.	crotalaria	X	+	+	+
Desmanthus virgatus (L.) Willd.	virgate mimosa	X	+	+	+
Desmodium cajanifolium (HBK.) DC.	desmodium	X	-	-	+
Desmodium incanum DC.	beggar's tick	X	+	+	+
Desmodium tortuosum (Sw.) DC.	beggar's tick	X	+	+	+
Desmodium triflorum (L.) DC.	beggarweed	X	+	+	+
Indigofera suffruticosa Mill.	indigo	X	-	-	+

13

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Leucaena leucocephala (Lam.) deWit	koa-haole	X	-	+	+
Macroptilium lathyroides (L.) Urb.	wild bush-bean	X	+	+	+
Mimosa pudica L.	sleepinggrass	X	+	+	+
Lythraceae					
Cuphea carthagenensis (Jacq.) Macbr.	cuphea	X	-	+	-
Melastomataceae					
Arthrostemma latifolia D. Don	arthrostemma	X	-	-	+
Melastoma malabathricum L.	melastoma	X	-	-	+
Moraceae, s.l.					
Cecropia obtusifolia Bertol.	guarumo	X	-	-	+
Ficus microcarpa L. f.	Chinese banyan	X	-	+	+
Myrtaceae					
Psidium cattleianum Sabine	strawberry guava	X	-	+	+
Psidium guajava L.	guava	X	-	+	+
Syzygium cumini (L.) Skeels	Javaplum	X	-	+	+
Oxalidaceae					
Oxalis corniculata L.	yellow wood-sorrel	I?	+	+	+
Oxalis corymbosa DC.	pink wood-sorrel	X	-	+	-
Passifloraceae					
Passiflora foetida L.	love-in-a mist	X	-	+	-

14

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Plantaginaceae					
Plantago major L.	common plantain	X	-	+	-
Polygalaceae					
Polygala paniculata L.	polygala	X	+	+	+
Polygonaceae					
Polygonum capitatum Ham. ex Don	polygonum	X	-	-	+
Portulacaceae					
Portulaca oleracea L.	common purslane	X	+	+	+
Rubiaceae					
Hedyotis corymbosa (L.) Lam.	bluets	X	-	+	-
Paederia scandens (Lour.) Merr.	maile pilau	X	+	+	+
Spermacoce assurgens Ruiz & Pavon	borreria	X	+	+	+
Spermacoce mauritiana Gideon	borreria	X	+	+	+
Scrophulariaceae					
Castilleja arvensis Schlecht. & Cham.	Indian paint-brush	X	+	+	+
Sterculiaceae					
Melochia umbellata (Houtt.) Stapf	melochia	X	+	+	+
Ulmaceae					
Trema orientalis (L.) Bl.	gunpowder tree	X	-	+	+

15

SCIENTIFIC NAME	COMMON NAME	STATUS	A	B	C
Umbelliferae					
Centella asiatica (L.) Urban	Asian pennywort	X	+	+	+
Urticaceae					
Pilea microphylla (L.) Liebm.	artillary plant	X	-	-	+
Pipturus albidus (H. & A.) Gray in Mann	mamaki	E	-	-	+
Verbenaceae					
Lantana camara L.	lantana	X	-	-	+
Stachytarpheta dichotoma (Ruiz & Pavon) Vahl	stachytarpheta	X	-	+	+
Stachytarpheta jamaicensis (L.) Vahl	stachytarpheta	X	+	+	-
Stachytarpheta urticifolia (Salisb.) Sims	stachytarpheta	X	-	+	-

16

APPENDIX F

CULTURAL RESOURCES INVESTIGATION:

ARCHAEOLOGICAL RECONNAISSANCE SURVEY
FOR ENVIRONMENTAL IMPACT STATEMENT (EIS)
PROPOSED IRRADIATION PLANT SITE

BY: PAUL H. ROSENDAHL, PH.D., INC.

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

Report 352-040888

ARCHAEOLOGICAL RECONNAISSANCE SURVEY FOR ENVIRONMENTAL IMPACT STATEMENT (EIS) PROPOSED IRRADIATION PLANT SITE

Land of Waiakea
District of South Hilo, Island of Hawaii

April 1988

305 Mohouli Street • Hilo, Hawaii 96720 • (808) 969-1763 or 966-8038

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

Report 352-040888

ARCHAEOLOGICAL RECONNAISSANCE SURVEY
FOR ENVIRONMENTAL IMPACT STATEMENT (EIS)
PROPOSED IRRADIATION PLANT SITE

District of South Hilo, Island of Hawaii
(TMK:2-1-12:106 [Potential Site A];
2-1-12:Var. [Potential Site B];
2-1-25:Por.86 [Potential Site C])

by

Margaret L.K. Rosendahl, B.A., S.O.P.A.
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Prepared for

Westec Services
5510 Morehouse Dr.
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April 1988

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INTRODUCTION

BACKGROUND

At the request of Senior Archaeologist Allan Schilz, of Westec Services, Paul H. Rosendahl, Ph.D., Inc. (PHRI) recently conducted an archaeological reconnaissance survey of three parcels under consideration as possible sites for a proposed irradiation plant in Hilo. All three parcels (TMK:2-1-12:106 [Potential Site A]; 2-1-12:Var. [Potential Site B]; 2-1-25:Por.86 [Potential Site C]) are located in the District of South Hilo, Island of Hawaii. The primary objective of the reconnaissance survey was to make a general assessment, in conjunction with the preparation of an Environmental Impact Statement (EIS), concerning the presence or absence of, and potential impacts of the project on, any sites of possible archaeological significance within the immediate project areas.

Approximately 12 man-hours of labor were expended in conducting the field work. Upon completion of field work, findings and preliminary conclusions—including tentative evaluations and recommendations—were discussed with Dr. Ross Cordy, chief archaeologist in the Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) (April 6, 1988), and with Ms. Connie Kiriu, staff planner in the Hawaii County Planning Department (HCPD). Dr. Cordy and Ms. Kiriu will formally review project findings upon submission of this final report.

SCOPE OF WORK

The basic objective of the reconnaissance survey was to identify—to discover and to locate on available maps—sites and features of potential archaeological significance. A reconnaissance survey comprises the initial level of archaeological investigation. It is extensive rather than intensive in scope, and is conducted basically to determine the presence or absence of archaeological resources within a specified project area. A reconnaissance survey indicates the general nature of and variety of archaeological remains present, and the general distribution of such remains; it permits a general significance assessment of the archaeological resources, and facilitates formulation of realistic recommendations and estimates for such further work that might be necessary or appropriate. Such further work could include intensive survey--data collection involving detailed recording of sites and features--and selected test excavations; and possibly mitigation--data recovery research excavations, construction monitoring, interpretive planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The specific objectives of the Proposed Irradiation Plant Site reconnaissance survey were (a) to review and evaluate available archaeological and historical literature relevant to the proposed sites, (b) to conduct a surface reconnaissance survey to determine the presence/absence of significant archaeological sites within the proposed sites, and (c) to assess what effect, in any, the proposed project might have on existing archaeological sites.

The reconnaissance survey was conducted in accordance with the minimum requirements for reconnaissance-level survey as recommended by the Society for Hawaiian Archaeology (SHA). These standards are currently used by the DLNR-HSS and HCPD as guidelines for the review and evaluation of archaeological reconnaissance survey reports submitted in conjunction with various development permit applications.

PROJECT AREA DESCRIPTION

The Proposed Irradiation Plant Site project area is comprised of three sites (Potential Sites A, B, and C) located in Hilo, District of South Hilo, Island of Hawaii (Figure 1). The three sites are within the Land of Waiakea.

Potential Site A (TMK: 2-1-12:106) is a c. 3.5 ac parcel located in the Airport Industrial Subdivision (Figure 2). The parcel is roughly square and measures c. 400 ft on a side. To the west of the parcel is the main post office and the airport tower. The parcel is bounded by an access road on the south, by Leleaoa Street on the west, by another parcel and the main east-west airport taxiway to the north, and by the new airport apron to the east. Potential Site A is fenced-off and access to the parcel is restricted. Thus, the observations presented here have been made from outside the fence. The parcel is generally flat. It appears that the entire parcel has been graded; running along the western portion of the parcel is a c. two foot drop-off, which appears to have resulted from modern grading. There are no major structures present on the parcel. Vegetation at the site is comprised of well-tended and manicured grass, a few scattered ornamentals, and weeds.

Potential Site B (TMK: 2-1-12:Var.) (Figure 3) is roughly triangular; it measures c. 2400 ft (from its northeast corner to its southern corner) by 800 ft (NW-SE). The site is bounded on the north and east by main runways of General Lyman Field; on the west the site is roughly bounded by a portion of a roadway and Kanoelehua Avenue.

Vegetation within Potential Site B is quite variable. The northern portion of the site (the old terminal area) is generally open and devoid of freely growing vegetation. The site is characterized by low manicured lawns featuring a few ornamental trees and shrubs. The southern portion of the site is covered with relatively dense, native and ornamental vegetation. The overstory in the southern portion consists of African

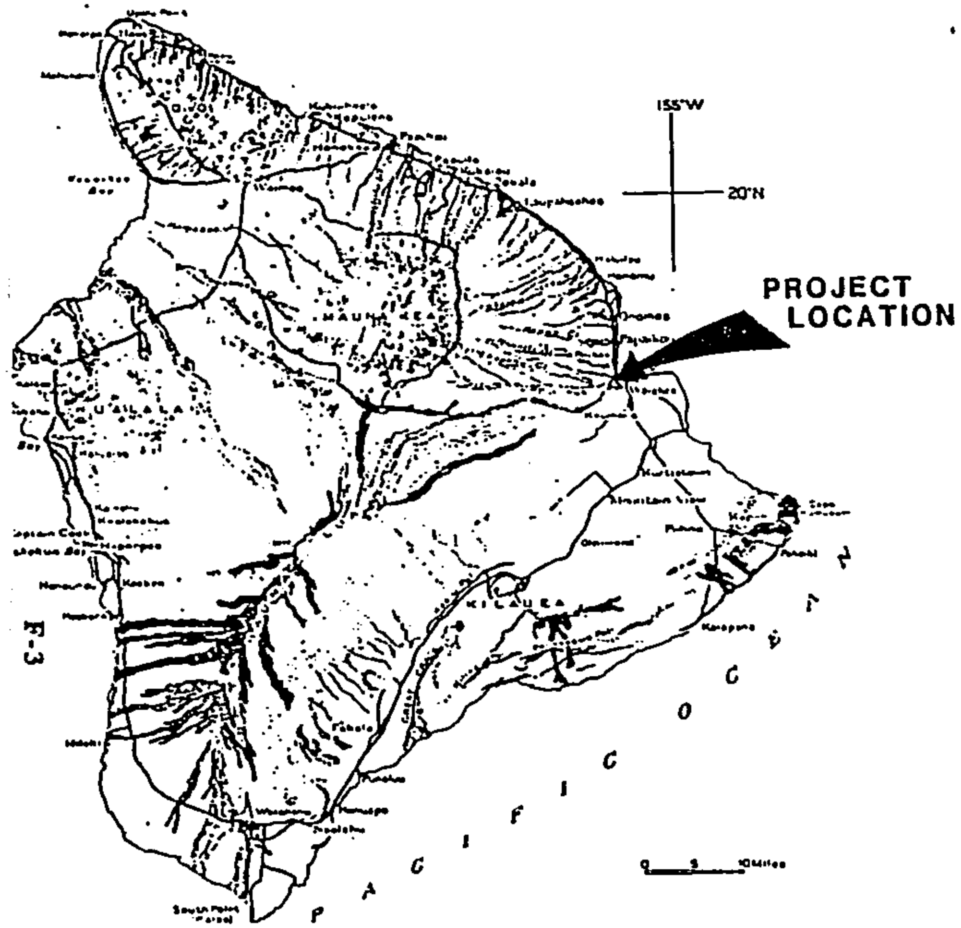

Figure 1. PROJECT LOCATION MAP

ARCHAEOLOGICAL RECONNAISSANCE SURVEY
PROPOSED IRRADIATION PLANT SITE

District of South Hilo, Island of Hawaii
2-1-12:106 [Potential Site A];
(TMK:2-1-12:Var. [Potential Site B];
2-1-25:Por.86 [Potential Site C])

PHRI Project 87-332 April 1988

(Map taken from Macdonald and Abbott 1970:288)

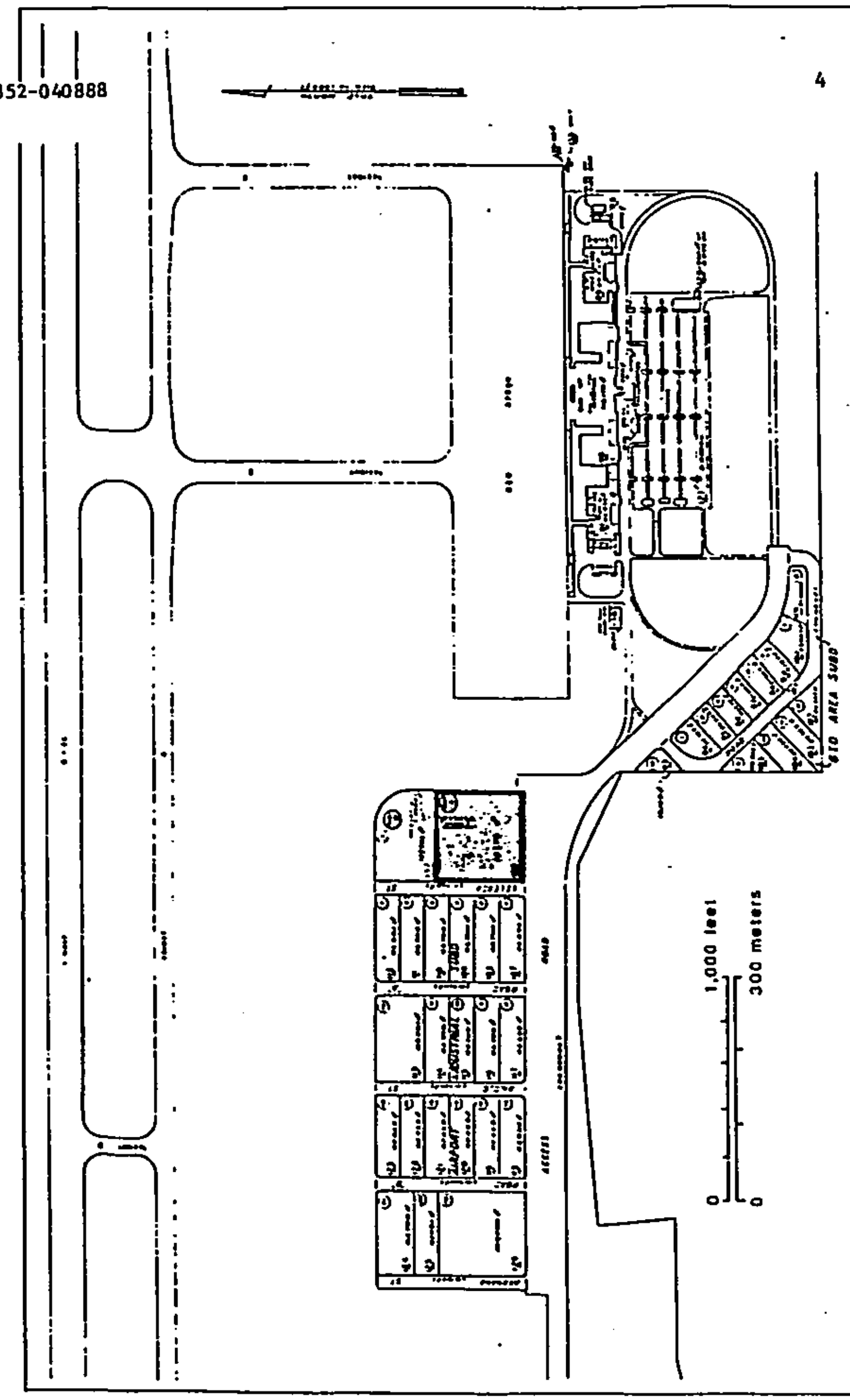

Figure 2. POTENTIAL SITE A

(Tax Map 2-1-12: Por. General Lyman Field (New Terminal Area) Waiakea, Hilo, Hawaii)

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY

SEE FRAME(S) IMMEDIATELY FOLLOWING

352-040888

3

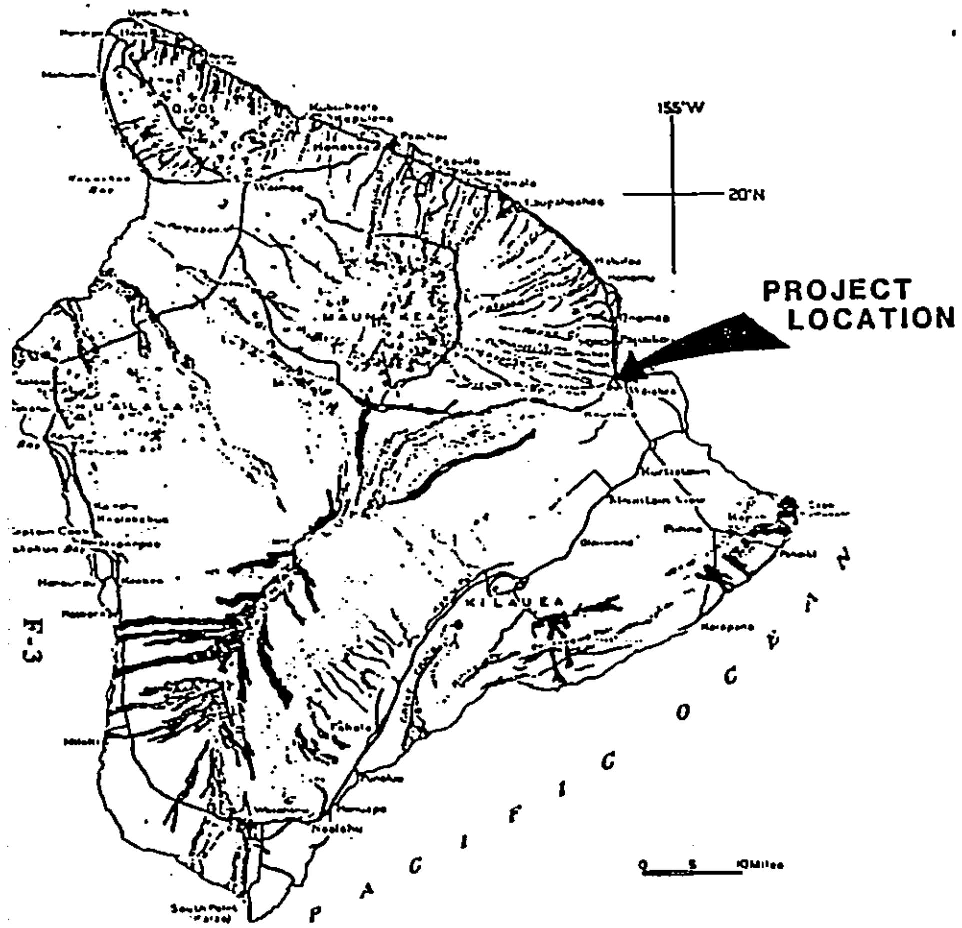

Figure 1. PROJECT LOCATION MAP

ARCHAEOLOGICAL RECONNAISSANCE SURVEY
PROPOSED IRRADIATION PLANT SITE

District of South Hilo, Island of Hawaii
2-1-12:106 [Potential Site A];
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PHRI Project 87-332 April 1988

(Map taken from Macdonald and Abbott 1970:288)

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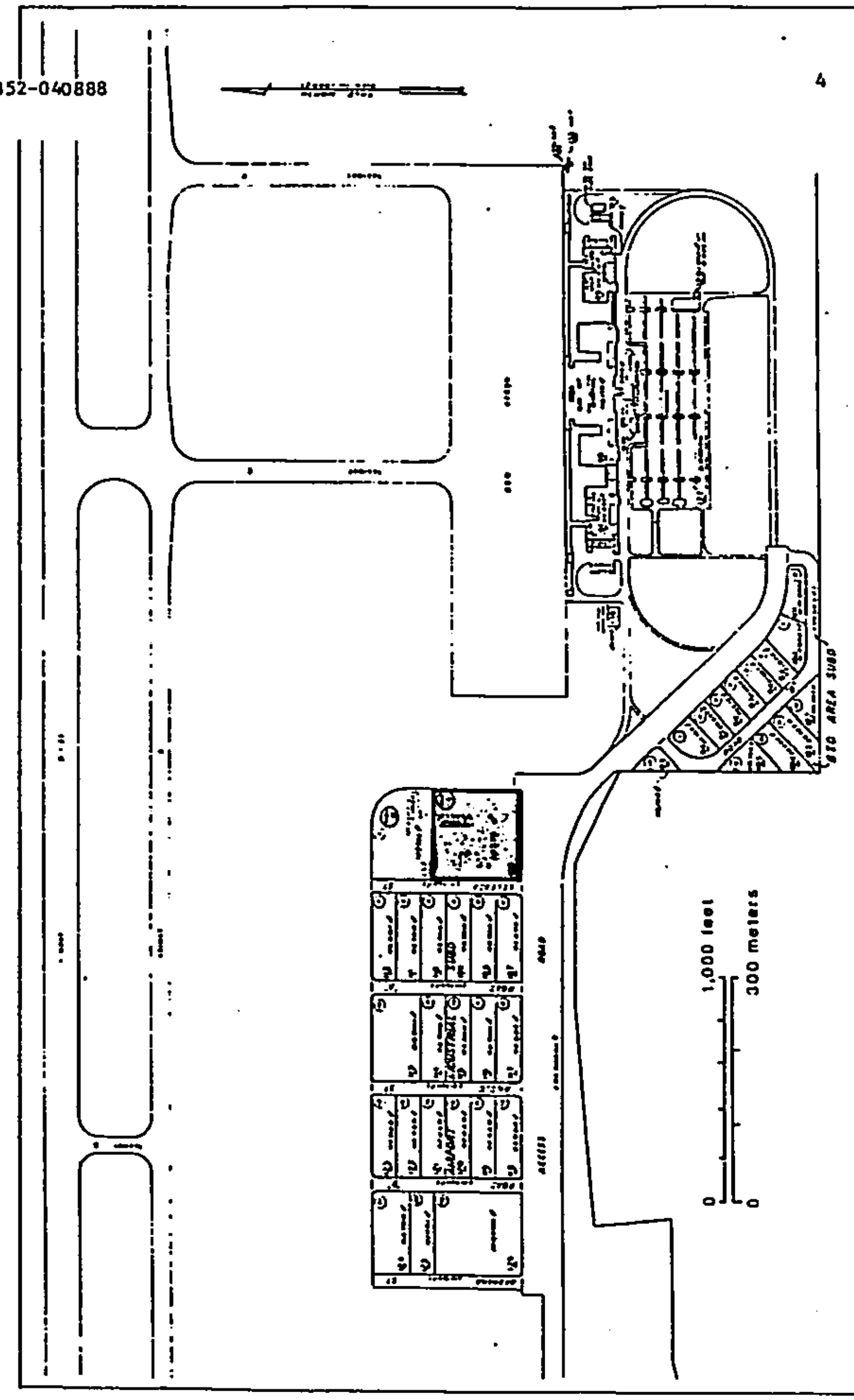

Figure 2. POTENTIAL SITE A

(Tax Map 2-1-12:Por. General Lyman Field (New Terminal Area) Waiakea, Hilo, Hawaii)

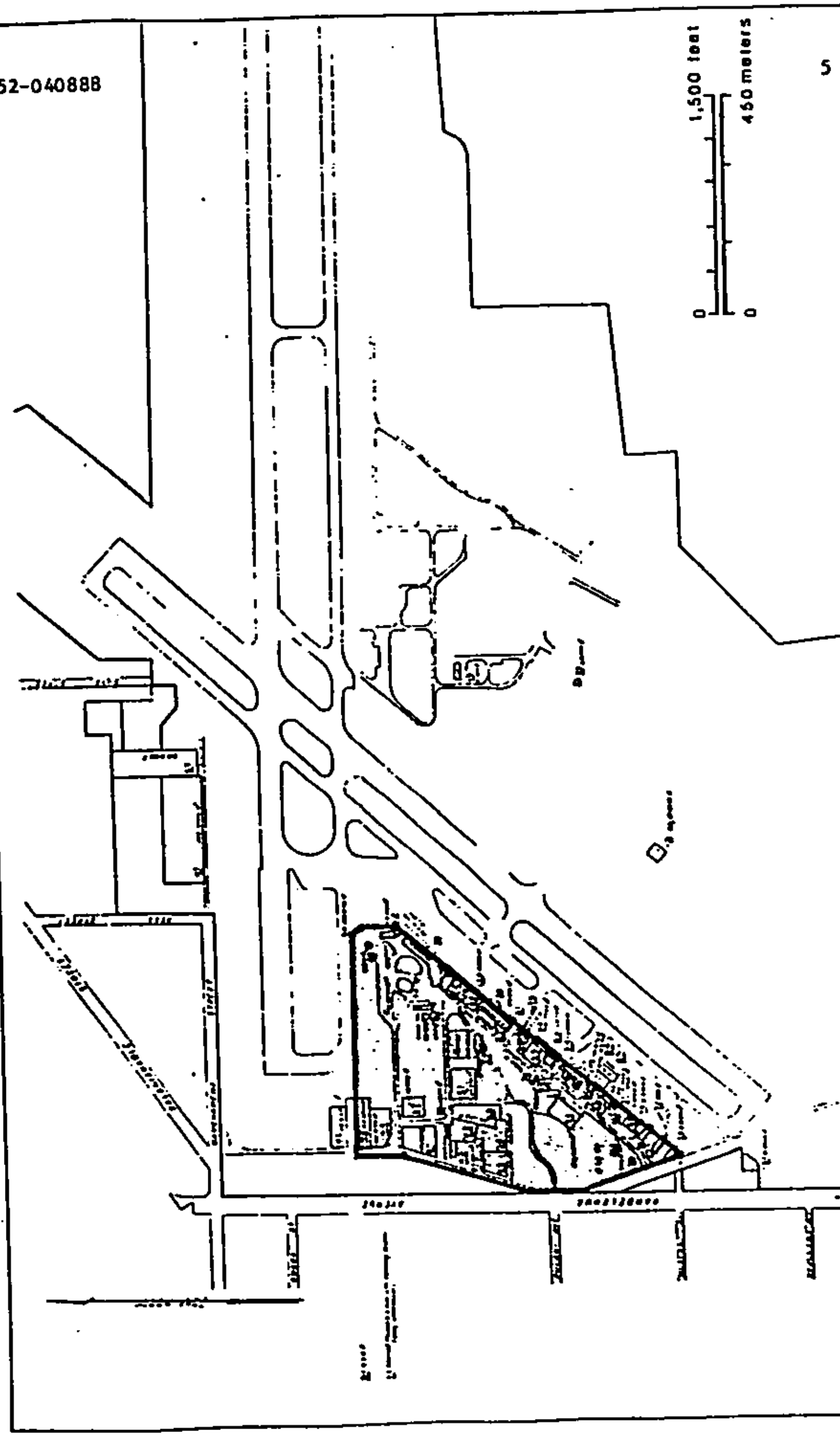

Figure 3. POTENTIAL SITE B

(Tax Map 2-1-12: Por. General Lyman Field, Waiakea, Hilo, Hawaii)

Tulip (Spathodea campanulata Beauv.), guava (Psidium guajava L.), mango (Mangifera indica L.), Indian Banyan (Ficus benghalensis L.), ti (Cordyline terminalis L.), pandanus (Pandanus odoratissimus L.), avocado (Persea americana Mill.), Java Plum (Eugenia javanica Lam.), and clerodendron (Clerodendron fragranus). The understory is comprised of a moderately dense undergrowth of various grasses, koali (morning glory, Ipomoea sp.), pohe kula (Centella asiatica L.), laukahi (Plantago major L.) and other weeds.

The terrain of Potential Site B is uniformly low lying; it is generally comprised of fill from dredging spoils (early to mid 1920s to recent) and histols (organically young soils occurring on forested lava land) (Armstrong 1983:47). The terrain over the years has been heavily modified and occupied.

The northern portion of Potential Site B is occupied by parking lots and open areas. The northwestern portion of the site is occupied by various buildings (Robert's Car Rental and others), the old airport structure, radio towers, and the N.A.S. swimming pool complex. The southernmost portion of Potential Site B, flat and heavily vegetated, retains numerous concrete pilings (perhaps associated with former military use of the area), scattered debris, and a wrecked van. The eastern portion of Potential Site B is mostly occupied by warehouse-type buildings used for handling inter-island cargo. The eastern portion is the area considered to be prime for construction of the irradiation plant--specifically, the area adjacent to Lyman Field Road, fronting the inter-island cargo buildings.

Potential Site C is a trapezoidal parcel located on Shield-Pacific, Ltd. Concrete and Concrete Products land, across from the HELCO complex (Figure 4). Potential Site C measures c. 1040 ft (NE-SW) by a maximum of 711 ft (NW-SE); it is bounded on the northwest by Railroad Avenue, on the southeast by Kukila Street, and on other sides by parcels of land.

Vegetation at Potential Site C consists of an overstory of exotic trees and shrubs (notable are Clerodendron and Pittosporum trees) and an understory of various grasses, exotic weeds, sleeping grass (Mimosa pudica L.), kauna'oa uka (Cassytha filiformis L.), ti, wedelia (Wedelia trilobata L.), and other species. Vegetation is heavier in northern portions of the parcel.

The terrain of Potential Site C has been greatly modified. The terrain appears to have been graded--there is a sloping berm to the southwest of the parcel. Present on the site are rusted pieces of equipment (on northwest portion of the site) and an old concrete roadway (paralleling the southeastern boundary of the parcel) which leads to dilapidated structures.

PREVIOUS ARCHAEOLOGICAL AND HISTORICAL RESEARCH

A review of archaeological reports at Hawaii County Planning Department and DLNR-HSS indicated that only limited archaeological study

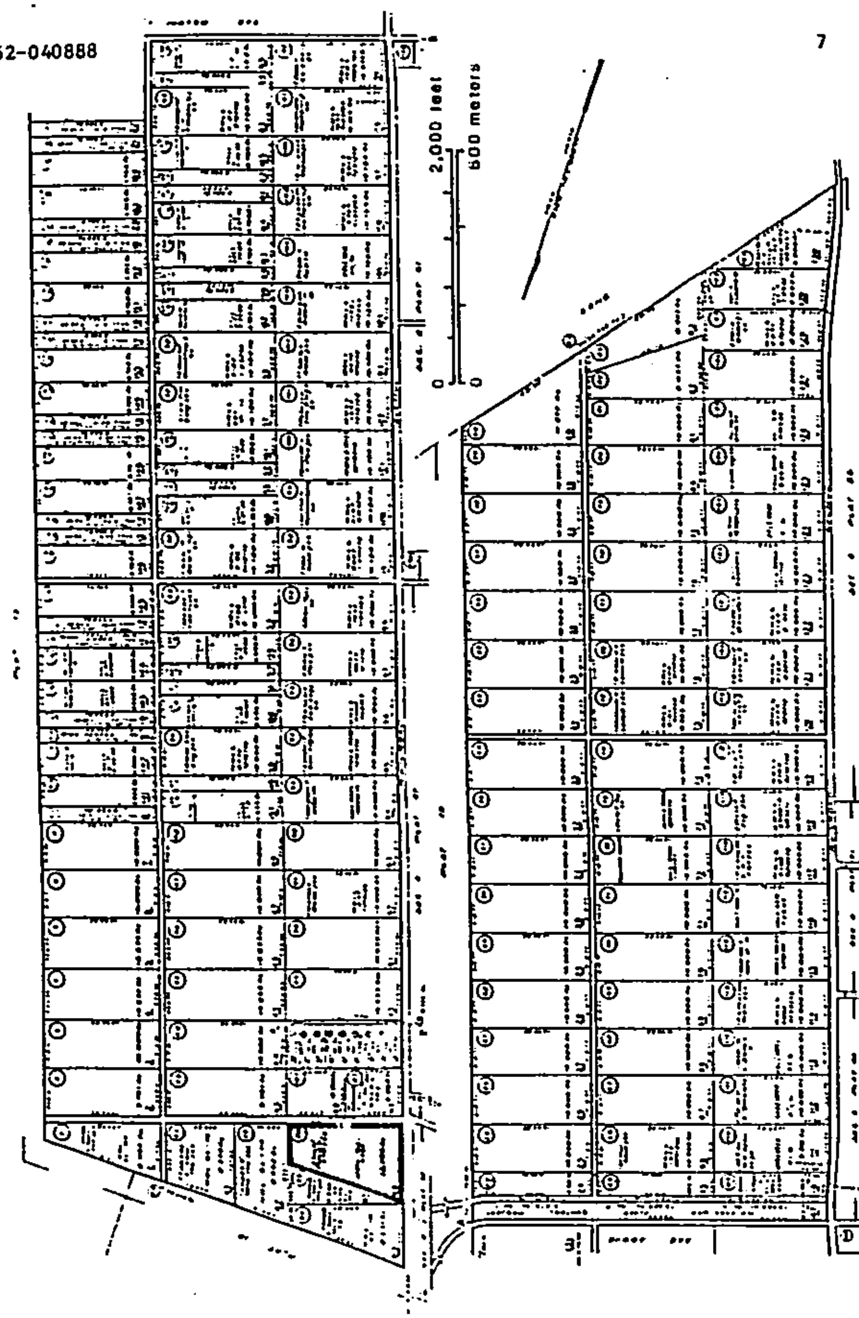

Figure 4. POTENTIAL SITE C

(Tax Map 2-1-25: Por. 'Panaewa House & Farm Lots' Sec. 1, F.P. 1407 Waiakea, South Hilo, Hawaii)

has been conducted in Hilo and that no archaeological work of any kind has been conducted within Potential Sites A, B, and C of the Proposed Irradiation Plant Site. In addition, background research indicates that there are no Land Commission Awards (LCAs) in the present project area.

The earliest archaeological investigation concerning Hilo was conducted by Hudson in the early 1930s (Hudson 1932). In his study, Hudson describes sites in an area north of the present potential irradiation plant sites--an area extending along the coast from Hilo to Leleiwi. Hudson did not identify any archaeological remains in Hilo town.

In 1982 J.S. Athens conducted an archaeological walk-through survey in Hilo for the U.S. Army Engineer Division-Pacific Ocean (Athens 1982). In conjunction with Athens' study, under the same cover, was historical research by Kelly. Kelly conducted research on Alenaio Stream and the Hilo Boarding School ditch, and reviewed Hilo's development (Kelly 1982). The research by Kelly provides some information on the early history of Hilo (a more detailed history of Hilo is presented in "Hilo Bay: A Chronological History" [Kelly et al 1981]). An 1825 map of Hilo by C.R. Melden, included in Kelly's research (1982:4), indicates that the areas of the three potential irradiation plant sites had no specific uses—no houses or villages are depicted within the areas of the sites.

The most recent archaeological study in Hilo was conducted by H.L.K. Rosendahl (1988). Rosendahl conducted a surface survey of five potential judiciary sites. One of the five sites is situated in the general vicinity of the present Potential Site B. No archaeological remains were identified at that potential judiciary site (Rosendahl 1988).

FIELD METHODS AND PROCEDURES

Field work at Potential Sites A, B and C was conducted on March 7, 1988, by PHRI Supervisory Archaeologist Margaret L.K. Rosendahl, assisted by Senior Archaeologist Allan Schilz, of Westec Corporation. Follow-up field work was conducted on March 16, 1988 by Margaret L.K. Rosendahl and PHRI Field Archaeologist Lawrence J. Talea. Field work consisted of conducting pedestrian sweeps at two of the three potential sites (as mentioned previously, Potential Site A was fenced-in, restricted area, and was surveyed visually from outside the fence). The distance between sweeping crew members varied depending on vegetation, topography, and structures encountered. To facilitate the survey, crew members used copies of tax maps (scale 1"=100' and 1"=500') showing parcels, streets, and site boundaries.

FINDINGS

No archaeological sites of any kind were identified within the Proposed Irradiation Plant Site project area. Potential Sites A, B, and C all have been extensively modified and transformed as the city of Hilo has evolved over the years. No traces of prehistoric or early historic land use patterns were present on the ground surface of the sites.

CONCLUSION

Based on the negative results of the present archaeological surface reconnaissance survey, it is concluded that no further archaeological work of any kind is necessary at the Proposed Irradiation Plant Site project area. It is recommended that Potential Sites A, B, and C be granted full archaeological clearance.

It should be noted that the evaluations and recommendation given here have been made on the basis of a surface reconnaissance survey. There is always the possibility, however remote, that previously unidentified subsurface cultural features or deposits of significance might be encountered in the course of subsequent land modification activities. In such a situation, archaeological consultation should be sought immediately.

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APPENDIX G

RISK ASSESSMENT

G.1 HEALTH RISKS OF CONSUMING IRRADIATED FOOD
G.2 EXTERNAL EVENTS RISK ASSESSMENT
G.3 TRANSPORT AND DISPOSAL OF COBALT-60

APPENDIX G.1

HEALTH RISKS OF CONSUMING IRRADIATED FOOD

by

PAOLO RICCI, Ph.D.

TABLE OF CONTENTS

LIST OF TABLES

HEALTH RISKS OF CONSUMING IRRADIATED FOOD

SUMMARY

The safety of consuming irradiated food has been studied for over 30 years. The focus of research has been on chemical changes and production of radiolytic products, the potential for toxicity, and the effect on nutritional value that occur in food as a result of irradiation. Although induced radioactivity in irradiated food is often cited as a consumer concern, the energy levels of gamma rays, accelerated electrons, and x-rays which are permitted for food irradiation by the regulatory agencies are so low that they do not induce measurable amounts of radioactivity.

As a result of irradiation, food molecules undergo various chemical reactions that in turn form minute amounts of new compounds. Similar compounds are present in unprocessed foods and in cooked, smoked, and other prepared foods. In general, the chemical changes induced by irradiation are minor compared to those that occur from conventionally cooked or processed foods. The types of compounds formed from irradiation have not been found toxic to humans. Numerous direct feeding studies have been conducted for irradiated food and have provided no confirmed evidence that consumption of irradiated foods results in cancers, birth defects, or genetic changes. Although some opinions on food irradiation hold that irradiation causes toxic effects in humans, accepted scientific evidence does not support this belief.

Considering that there have been no observed adverse effects associated with the consumption of irradiated food, a quantitative risk assessment to establish human health risks cannot be performed reliably. Quantitative risk assessments require a biologic relationship between measurable and measured cause and effect, i.e., a dose response function. The relevant doses from irradiated food cannot be established, nor can probabilistic estimates of adverse effects be evaluated.

Based upon a review of the available scientific evidence, it is our conclusion that consuming food irradiated at the levels proposed by regulatory agencies for commercial operation presents no unreasonable to human health.

IRRADIATED FOOD

Effects on Food

Although food is consumed for nourishment and to maintain life, ingestion of some foods, which are not of the best quality, may cause serious illness and, in extreme cases, death. The reasons for this are several. Biochemical processes continue in foods long after they are harvested or processed. Food items change because of chemical breakdown and contamination by molds and bacteria is probable as food ages. Additionally, insect infestations may also alter the nature of foods.

Although many post-harvest chemical changes in food are unwelcome from a health perspective, a variety of processes that alter food are comı. . nly employed by man. For example, a large percentage of food is cooked. The cooking process drastically alters the chemical composition and structure of food and also renders some foods edible that would otherwise not be. Other methods that change the chemical composition include curing, culturing, and freezing.

Irradiation brings about comparatively few chemical changes in food when compared to common post-harvesting food processes. The ions produced in food as a result of irradiation undergo various reactions that cause chemical changes. Some of these alterations affect bacteria and mold on the surface of the foods thereby eliminating their potential to attack the food product and extending its useful life. Other alterations occur to the food itself; radiolytic products are formed within the chemical structure of the food. Although the production of ions in food is caused by irradiation, ions are found naturally to occur in food and are found in conventionally processed food (Advisory Committee on Irradiated Foods 1986).

The research conducted to investigate the formation of radiolytic products has made it possible to predict the nature of radiolytic product formation and concomitant yields for certain foods given specific amounts of ionizing radiation and exposure. Current knowledge of food chemistry is such that individual studies for every food to be irradiated are not necessary to predict the formation of radiolytic products.

G-3

Foods of Concern and Potential Radiation Impacts

The food of interest to this study is papaya; a tropical fruit with a high water content (80 to 90%). Because of high water content, the irradiation process is found to largely ionize the water component of the fruit. Molecules may receive energy directly for the incident radiation or indirectly from another molecule. The indirect effect is especially important in aqueous systems, where a water molecule may be ionized and then may transfer its energy to another molecule. In fat containing foods, self-propagating chain reactions are initiated by free radical formation. This process can continue for weeks after irradiation and may lead to higher levels of some radiolytic products leading to rancidity in stored or cooked fats (Wierbicki et al. 1986). Most of the primary ionization in food, however, occurs in the water molecules; this reaction is understood in considerable detail (Casarett 1968). The generally accepted reaction for the radiolysis of water is :

$$H_2O \rightarrow H^{\cdot} + OH^{\cdot}$$

The disassociation of water into two free radicals, $H^{\cdot}$ and $OH^{\cdot}$, first begins when the radiation energy exceeds the energy that binds adjacent atoms in the molecule and causes an electron to be ejected. A positive ion (H_2O^+) is formed:

$$H_2O \rightarrow H_2O^+ + e^-$$

The electron is then picked up by another water molecule forming negative ion (H_2O^-):

$$e^- + H_2O \rightarrow H_2O^-$$

These ions are extremely unstable, with a lifetime of less than one millionth of a second. Each of the positive and negative ions, in the presence of another molecule of water, decompose rapidly into an ion and a free radical:

$$H_2O^+ \rightarrow \text{ with } H_2O \rightarrow H^+ + OH^{\cdot}$$
$$H_2O^- \rightarrow \text{ with } H_2O \rightarrow OH^- + H^{\cdot}$$

The ions H^+ and OH^- do not contain an excessive amount of energy and will recombine to form water. The free radicals, $OH^{\cdot}$ and $H^{\cdot}$, are highly reactive. Commonly, in the

presence of other water molecules, many of the free radicals will react with each other to form H_2, H_2O, and H_2O_2, (hydrogen peroxide), according to the equations:

$$H^{\cdot} + OH^{\cdot} \rightarrow H_2O$$
$$H^{\cdot} + H^{\cdot} \rightarrow H_2$$
$$OH^{\cdot} + OH^{\cdot} \rightarrow H_2O_2$$

These reactions are completed very rapidly; the lifetime of a free radical is usually less than one thousandth of a second. Further reaction between free radicals and water can result in the destruction of the products that were previously formed, as shown below:

$$H^{\cdot} + H_2O_2 \rightarrow OH^{\cdot} + H_2O$$
$$OH^{\cdot} + H_2 \rightarrow H^{\cdot} + H_2O$$

If other molecules are present that can react with radicals there will be competing affinities and hydrogen peroxide may not be destroyed. Any hydrogen peroxide produced, however, would be rapidly degraded to negligible levels by natural enzymes to form antioxidants in the food and other naturally occurring compounds. These reduced levels would be considerably less than those from other food sources, environmental sources, or through other exposure pathways such as exercising which results in larger concentrations of oxygen radicals being formed at the cellular level.

Induced Radiation

Dose

Use of the term "dose" in discussing food irradiation generally refers to the amount of radiation energy imparted to the biological target. The received dose is influenced by many factors such as intensity of the source, distance between ~ get and source, overall length of time of exposure to radiation, thickness and nature of the target, and type of radiation source. Various dosimetric techniques are available to provide reliable measurements of ionizing radiation according to the specific conditions for each case of irradiation.

In a discussion of human health risks, irradiated food is regarded as a potential source of radiation to human tissues, cells, or other plausible biological unit at risk. Biologically effective "dose" is the amount of radiation imparted to the individual unit at risk from ingestion of irradiated food, taking into account the type of radiation and its biological effectiveness. The irradiation facility and operating processes can also be considered potential sources of radiation for humans and thus pose a health risk. These are discussed elsewhere in the EIS. Hence, this appendix will provide a discussion of the relationship between dose and risk in terms of potential exposures resulting from consuming irradiated foods.

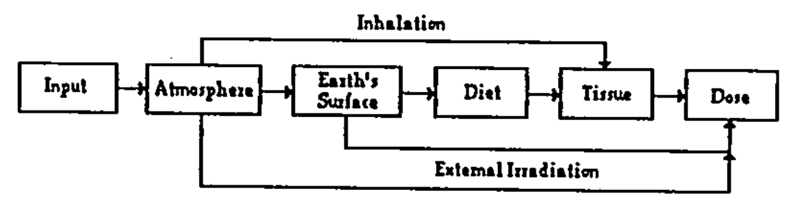
To calculate dose delivered by radiation sources to exposed populations, it is necessary to use models linking the measured, or calculated, amounts of radioactive materials released to the environment, and their pathway (including ingestion), with the resulting dose to the exposed tissue at risk within the human body (or other species). Environmental transport and dosimetric models are used for this purpose. The important quantities to assess when considering affected individuals are absorbed dose from exposure for a year or over an expected lifetime. Dose, however, results from many obvious sources (i.e., getting an x-ray, Radon-222 in the home, etc.) and a variety of not so obvious sources (United Nations Scientific Committee on the Effects of Atomic Radiation 1982). Thus, although it is accurate to think of a total body (or tissue) burden from being exposed to x-rays and other sources of ionizing radiation, what matters is the contribution to risk from each individual contributor. The question is: What is the dose contribution from irradiated foods at the energy levels that will be employed.

Background radiation, to which everyone is exposed, occurs naturally. The sources for this radiation include primordial radionuclides that are emitted from elements present in the earth's crust, cosmic rays which originate outside of the solar system, and cosmogenic radionuclides that are mainly produced through interaction of cosmic rays with target atoms in the atmosphere. Although some of man's activities such as water purification and burning fossil fuel, which reduces the specific activity of carbon-14 in the biosphere, can reduce natural radiation exposure, other activities increase exposure. Air travel, emissions from coal-fired power plants, geothermal energy, and phosphate rock mining are examples of activities that can increase exposure to naturally occurring radiation that would otherwise not exist if these technologies had not been developed. Other activities such as nuclear testing and some medical techniques increase radionuclides in the environment. In comparison, however, radiation in the environment from natural sources is the major source of radiation exposure to man. For this reason it

is frequently used as a standard of comparison for exposure to various man-made sources of ionizing radiation.

Naturally occurring background radiation, which is estimated at 28,000 milli-rem[1] per capita annually, should be considered in establishing contributed dose from ingesting irradiated food. Considerations of external irradiation are relatively simple as absorbed dose is delivered at the time of irradiation. For cosmic rays, such irradiation is continuous, at a specific dose rate, so long as the individual continues to live at that particular elevation (altitude). Internal irradiation, following the intake of radioactive materials whether by inhalation, ingestion, or other means is protracted to some extent and absorbed dose in organs or tissues of any individual after intake will depend on conditions particular to the individual such as metabolism, age, and life expectancy, as well as on more specific factors such as half-life of the radionuclides of interest.

The transfer of radionuclides between the different compartments of the environment and the resulting dose rate to the target tissue or cell can be represented schematically as follows (United Nations Scientific Committee on the Effects of Atomic Radiation 1982).



Transfers between successive steps in this chain are described by transfer coefficients, which relate time integrals of concentration, dose, or other quantities from each step. For example, the transfer coefficient from diet to tissue is the ratio of integral concentration of activity in tissue to that in diet. Transfers linking input to dose are determined by

[1] This value takes into account the altitude distribution of the U.S. population and includes a 10% reduction factor to allow for structural shielding. Cosmic radiation i[illegible] tighly penetrating and the dose equivalent is considered to be uniform throughout the body. Altit[illegible] is a significant factor, with a doubling of the sea-level dose equivalent at about 2000 meters.

sequential multiplication of transfer coefficients. Transfers by parallel pathways are assumed to be independent and are thus additive.

The fundamental quantitative assumption describing the interaction of radiation with matter is that the relevant measure of the interaction is mean energy deposited per unit mass. The energy deposited results from all types of radiation and the quantity used to measure it is absorbed dose, D, defined as $D = \frac{d\varepsilon}{dm}$ where $d\varepsilon$ is the mean energy imparted by ionizing radiation to matter of mass dm. The biological effects also depend on type of radiation; thus, the additional factor needed to relate observed effects of absorbed dose is the relative biological effectiveness (RBE). This is the ratio of absorbed dose of the specific type of ionizing radiation needed to produce a specified biological effect to absorbed dose of the reference radiation that produces the same effect. This reference radiation is usually that which results from x-ray or gamma radiation. The RBE is obtained experimentally (United Nations Scientific Committee on the Effects of Atomic Radiation 1982).

The calculation of absorbed doses in organs and tissues as a result of ingesting radionuclides requires models to describe the transfer of radionuclides between tissues and their eventual elimination from the body as a function of time. The general equation for calculating absorbed dose from internally deposited radionuclides is (United Nations Scientific Committee on the Effects of Atomic Radiation 1982):

$$D(Vq) = \sum_{k} \sum_{i} \int_{t_1}^{t_2} A_k(t)\, dt\, E_i\, \Phi_i\, (V_q \leftarrow V_k)$$

where D(Vq) is mean absorbed dose in a target volume Vq; $A_k(t)$ is activity of the radionuclide considered in source tissue, k, as a function of time. E_i is the mean energy emitted per unit of time integral of activity through ionizing particles of type, i; Φ_i $(V_q \leftarrow V_k)$ is the specific absorbed fraction, i.e., for type of radiation i, the energy imparted to a target volume, V_q from a source volume V_k divided by energy emitted by source volume V_k and the mass of the target volume. (Note: the biologic parameters are assumed independent of age.)

Establishing Safe Radiation Doses

The National Council on Radiation Protection and Measurements and the International Commission on Toxicological Protection have developed recommendations for permissible radiation dose levels for human populations. For the general population, a total body-dose greater than 0.5 rem per year should not be exceeded under ordinary circumstances. This level excludes natural background and deliberate medical exposure and is set to protect against adverse effects likely to be observed during a lifetime and to minimize genetic damage.

Establishing Dose-Response Relationships

As discussed later in the text, the research indicates that food which is irradiated at the levels of energy proposed does not result in measurable levels of induced radioactivity. However, as discussed, radiolytic products are of some concern.

Establishing a dose-response relationship for radiolytic products has been difficult. This arises out of the fact that the results of epidemiologic studies are often unavailable to evaluate the risks from food additives, and laboratory animal testing is most often used to establish a maximum dose free of toxic effects for food additives. The National Cancer Institute/National Toxicological Program protocol for testing chemical carcinogens consists of long-term animal bioassays that require use of male and female rat and mice strains, or occasionally hamsters. The protocol requires groups of at least 50 animals of each sex (100 animals total) be tested per dose level in each experiment; control groups of the same size are also required for each sex. The substance of concern must be administered by a route that closely approximates human exposure at a minimum of two doses: 1) the maximum tolerated dose which is the highest dose that can be predicted not to shorten the animals' life-span from effects other than carcinogenicity, and 2) either one-half or one-quarter of the maximum tolerated dose. Testing must be continued long enough to produce a maximum response (generally 24 months, the expected animal lifetime), after which the animals are killed and autopsied. In practice, a sample of approximately 500 animals is required, including a control group.

To convert the dose-response data from animal tests to humans, the dose amounts used in the bioassay must be adjusted to allow for differences in animal size, physiological differences, and metabolic rates. Several formulae are currently used for this adjustment and assure that animal and human risks are equivalent when doses are measured as mg/kg/day; as mg/kg/sq meter of body surface area; as ppm in air, diet, or water; or as mg/kg/lifetime. Since risks at low dose levels cannot be measured directly by either animal experiments or epidemiological studies, because the sample is too small to detect the effects sought, a number of mathematical models are available to extrapolate from high to low doses. Data at high doses may be developed from suitable long-term bioassays, epidemiologic studies, or both. The effort of extrapolation from high to low dose provides information that aids in determining a "safe" dose of the substance in question for humans.

Theoretical considerations in radiation carcinogenesis suggest that the basic mechanisms of cell damage are linearly or quadratically related to the amount of energy imparted on individual target cells. This suggests a mathematical relationship between dose and biologic effect, effectively reducing the number of functional relationships to a few. For the radiation types considered for food irradiation, the general equation for biologic effect is (Boice and Land 1982):

$$I = c + aD + bD^2$$

where I is incidence of the effect, c is spontaneous rate, D is radiation dose (in rads), and a and b are positive coefficients which are statistically estimated from animal or epidemiologic data on I and D. Further considerations can be included to account for the possible competing effects of cell radiation on the incidence:

$$I = (c + aD + bD^2)\exp(-pD - qD^2)$$

where the exponential term, that predominates at high doses, corresponds to a decrease in incidence after some maximum radiation level is reached because of cell death. In other words, death effectively prevents new cases from arising.

Although these physical models reasonably describe the occurrence of various biologic effects in response to radiation exposure, they are simplifications of a complex carcinogenic process. They do not propose to determine dose or establish a safe dose but can be used to estimate biologic damage for given dose strengths (Upton 1977). The choice of "safe dose" is strictly a matter of policy.

In the case of irradiated foods, this procedure is difficult to implement since a single food product cannot be fed to an animal at greater than 25% of its total diet without causing nutritional imbalance. More specifically, the number of ra olytic products produced is so small that the needed dose values could not be supplied even if the diet were to consist wholly of irradiated food. Thus, the risk assessment of ingesting irradiated foods will be characterized by uncertainty (as most risk assessments are). To detect small effects, the number of animals required would have to be very large. The cost of such an experiment would exceed the cost of the proposed facility many times. As discussed later in this text, the empirical evidence available shows no findings of adverse effects. Thus, a quantitative risk assessment cannot be performed. Simply put, a relationship between dose and response does not exist.

Radiation Doses From Irradiated Foods

The amount of radioactivity induced in foods treated with ionizing energy levels set by FDA regulations for x-rays and accelerators is so infinitesimal that it is beyond measurement. Neither of the approved gamma ray sources (cobalt-60 and Cesium-137) induce detectable radioactivity in food at any dose. The FDA, in the *Final Rule on Irradiated Food*, has determined that "......irradiation of food does not cause the food to become radioactive..." and that ".......the safety of food irradiation below 1 kGy (100 krad) has been established" (51 FR 13377). This limit is conservatively below the level of up to 30 kGy held to be safe by the International Consultative Group on Food Irradiation.

Opponents of food irradiation have questioned regulatory acceptance of the technology. What is not realized is that ionization at these levels does not cause food to become radioactive in any significant or measurable way. Just as normal exposure to medical x-rays does not induce residual radioactivity, such ionized energy levels do not make food radioactive. While some forms of ionizing radiation can induce radioactivity, they are excluded from use in treating foods.

Given current technology, the minimum increase in radioactivity that can be detected reliably in direct measurements is about 1% of natural radioactivity. However, theoretical computations have indicated that the maximum level of ionizing energy (10 MeV) results in an increase in the disintegration of one atom per week per kilogram of meat after 3 months storage. This is in contrast to more than one hundred naturally occurring disintegrations per second per kilogram of meat, and compared with a disintegration of about 10,000 naturally radioactive atoms per second in a human body weighing 70 kilograms (Wierbicki 1986). Thus, the amount of particle disintegration induced by irradiation is negligible compared to the levels which occur naturally. Considering that the regulatory levels have been set for gamma rays at 1.33 MeV for cobalt-60 and 0.66 MeV from Cesium-137, for x-rays up to 5 MeV, and for machine generated radiation up to 10 MeV, disintegration under approval regulatory conditions can be estimated not to exceed one atom per week following 3 months storage.

Facility Specific Radiation Doses

Although food radiation sources vary in character and specified limits, it is not possible to activate or induce radioactivity in any material since the energies are small (Wierbicki et al. 1986). The threshold for activation by x-ray and gamma radiation is above 5 MeV (CH2M Hill 1987), a limit which both of the proposed sources do not exceed[2]. In fact, the maximum credible level of potentially induced activity from 5 MeV x-rays is more than 250 times less than natural levels found in some common foods and is over 12,000 times less than the World Health Organization (WHO) guidelines for drinking water. According to the WHO, there is no significant radioactivity resulting from machine-induced exposure at energies below 5 MeV (Wedeking, Ahlstrom, and Tingey 1987). On this basis, it is clear that levels of concern are de minimis. Although a number of attempts have been made to measure, as compared to calculate, induced radioactivity in foods, these attempts have not been successful. Researchers in England have looked at the effect that ionizing radiation can have on food and concluded that so long as the energies are as discussed above, there is no significant amount of radioactivity induced in foods (Advisory Committee on Irradiated Novel Foods 1986).

The limit for machine-generated radiation is also well below the threshold for activation. Although the nature of radiation makes a considerable difference, quantitatively, in the

[2] A beam of gamma rays differs from a beam of x-rays primarily because the gamma rays are monoenergetic or, in some cases, consist of photons with a limited number of different energies. Gamma rays originate from atomic nuclei whereas x-rays originate outside the atomic nucleus. Without the low energy or "soft" radiation component of most x-ray beams, gamma rays have less surface backscatter and greater penetration capability (Casarett 1968).

biological response produced in a system, even when the same amount of energy has been released or the same number of ion pairs have been formed in the system, neither of the source quantities for irradiation addressed in this report seem to provide unacceptable risks or reason for concern. Thus, each proposed facility alternative, regardless of radiation source employed, presents no potential to induce radioactivity in fruit if operated within the levels discussed and in the prescribed manner, as determined by the cognizant regulatory agencies.

OTHER HAZARDS

Radiolytic Products

One concern of food irradiation is that irradiation creates unwanted radiolytic products in food. The typical formation of radiolytic products is in the order of 1 molecule/100 eV of absorbed energy. Radiolytic products are not unique to irradiation; humans are exposed to radiolytic products through their intake of cooked and other processed food. The list of organic compounds that are present in human daily intakes have been identified and the potential concentrations from irradiation are orders of magnitudes below recorded levels from other sources (Zurer 1986; Wierbicki et al. 1986). For example, benzene, a well known carcinogen, is present in many nonirradiated foods. There is about 2,000 times more benzene in a boiled egg than is produced by irradiation even at high doses needed for sterilization. Also, hydrocarbons, aldehydes, ketones, polymerized fats, and free fatty acids are commonly produced in large quantities by cooking foods, whereas in irradiated foods they are found only in trace amounts (Zurer 1986).

Unique Radiolytic Products

Another concern of irradiation is the formation of unique radiolytic products. These are defined as compounds that are formed by treating foods with ionizing radiation, but which are not present in untreated foods (51 FR 13377). Irradiation of food produces 30 ppm of radiolytic products, per kGy, of which 90% are known radiolytic products and the remaining 10% are said to be unique (51 FR 13378). In the 30 years of research on the formation of radiolytic compounds in food from irradiation, no unique radiolytic products of toxicological concern have been found (Lubin 1985). The FDA has concluded, on the basis of low concentrations of unique radiolytic products, that there is no need for toxicological testing for food irradiated below 1 kGy. Nevertheless,

G-8

opponents of food irradiation have focussed on the concept of unique radiolytic products and argue that every unique radiolytic product should be proven not to be carcinogenic before food irradiation proceeds. Food chemists regard the term "unique" as a misnomer since these products are not unique or uncommon. They assert that food irradiation critics cannot support their claims that these products can cause toxic effects, much less that the products can survive normal digestive process. "Understanding the mechanisms by which radiation reacts with proteins, fats, carbohydrates, and other food components leads to the conclusion that there aren't going to be any products that are unique in a chemical sense" (Merritt, in Zurer 1986). Fundamentally, the existence of these products is below levels of toxicological concern, so far as the facility under discussion is concerned.

QUANTITATIVE HEALTH RISKS

Calculating Aggregate Health Risks

An analysis of health risks requires many steps ranging from identifying hazards to establishing and parameterizing dose-response functions. The analysis begins with judgments about the existence of a potential hazard, in this case, ingesting irradiated food. Although identification of a potential hazard may be easily made, the calculation of dose is more difficult. Dose calculation is essential, however, in order to define individual risks. Foods irradiated at legal limits have no detectable or determinable dose of radiation from which to perform a quantitative risk assessment. Therefore, observed effects at higher, measurable levels would have to be considered and extrapolated to simulate the effect at lower doses. Extrapolation to low exposure levels is the curse of risk assessment. The issue is simple: the relevant range of the data is often orders of magnitude away from dose-rates of interest tc he risk assessor. Because of this, extrapolations cause uncertainty to increase. Thus, the decision maker is placed in the dilemma of having to decide on the basis of very uncertain information. For the purpose of this section we suggest that extrapolations below regulatory limits for irradiation be avoided completely. Should the state of knowledge increase, information updates can readily be accomplished through newly developed probabilistic methods.

The Advisory Committee on Irradiated and Novel Foods has determined that the increased risk of cancer from induced radioactivity caused by heating meat with accelerated electrons is negligible (Advisory Committee on Irradiated Foods 1986). If the

same linear extrapolation that was used to obtain an estimate of an increase of 0.3 to 1% of the cancers from natural background energy is used to estimate the contribution of the induced radioactivity of food to human cancer, one finds that the contribution amounts lie between 0.000000003 and 0.00000001% (Wierbicki 1986). This assumes that all food has the same natural radioactivity as meat and that all food is processed with the maximum permissible energy at sterilizing doses.

Individual Health Risks

Quantitative risk assessments require data to determine the relationship between biologically effective dose and probability of human response on the basis of biological mechanisms. The mutagenic characteristics of irradiated foods have been studied by feeding irradiated foods to lower mammalian species and the results did not indicate adverse effects. Some of the most relevant studies are listed on Table 1[3]. The striking fact is that diets containing irradiated food do not result in adverse health effects. The absence of an effect from a delivered dose makes it impossible to perform a quantitative risk assessment. For example, even in the study involving CD-1 mice, only female mice experienced decreased survival when their diet contained irradiated food. These findings, however, were of borderline significance. Because only females were affected and the low level of significance, the FDA "does not consider this ef. :t to be treatment related" (51 FR 13386). This finding should be understood as indicating that, possibly, chance alone caused the effect. It is theoretically possible, however, that the females were affected by the irradiated food. Since other tests do not show the decrease in survival found in CD-1 females it can be concluded that the diet containing irradiated foods does not contribute to the excess found.

[3] The reader should consult the original references for additional information and the review article by Wedcking, Ahlstrom, and Tingey (1987) for a good summary of current thinking about the potential adverse effects of food irradiation.

Table 1

SUMMARY OF SELECTED STUDIES ON TOXICOLOGICAL ENDPOINTS: HUMAN AND LOWER SPECIES FED IRRADIATED FOOD *

Study and Location	Food and Energy Levels	Unit of Analysis	Type of Study	Results
HUMANS				
(Anonymous), People's Republic of China	60% of foods (treated between 0.1 and 8.0 kGy) in diet	Human volunteers	Case-control: 35 exposed 35 controls	No statistical differences between exposed and unexposed (toxicological, biochemical endpoints).
Dai Yin (1986), as above	Variety of foods (treated at different energy levels, but included between 0.1 to 8 kGy)	Human volunteers	Case control	As above
Bhaskaram and Sadasivam (1976), India	Irradiated wheat	Malnourished Indian children	Case control	Poliploidity (study was criticized as it did not conform with biological knowledge). Not confirmed by other studies involving wheat diets.
LOWER SPECIES				
Raltech (several authors, from 1980 to 1985)	Variety of diets (chicken, irradiated meat at average 59 kGy)	CD-1 mice; male dogs	Long-term bioassay, multigenerational	Toxicity, tumor promoting, etc. not significant. See text for additional discussions. Weight loss in dogs was related to low dietary intake.

* A variety of Russian studies initially seemed to indicate adverse response, in lower species, from diets containing irradiated food. These studies are either not considered particularly good or have not been corroborated.

Developed from Wedeking, Ahlstrom, and Tingey (1987) and FDA (51 FR 13376)

A Russian study, which reports histopathological changes to the kidney and testes of rats fed irradiated food, in which the damage was related to dose, did not withstand close scrutiny partly because of the inability of the reviewers to interpret the Russian micrographs. More importantly, the reported changes may have been caused by age-related kidney disease, which frequently occurs in laboratory rats. Comparable studies by other authors failed to confirm the Russian reports of kidney damage. The testicular differences could also not be ascribed to irradiated diet because of lack of background data in the Russian report. No confirmation of testicular changes could be found in other studies concerned with similar endpoints.

Some irradiated food studies involve microorganisms and insects. Generally, however, results obtained from microorganisms or insects cannot be used for quantitative human health risk assessments. For example, experiments using *Salmonella T.* do not provide the information necessary to perform quantitative risk assessments for humans, nor is the information particularly appropriate for quantitative risk assessments since the endpoint (increased number or revertants) is not convertible to a human endpoint. This information, however, is valuable to establish certain aspects of the biological model which is then used to assess risks.

In the risk assessment of chemical carcinogens, there is debate about the level of information provided by animal studies for extrapolating to low doses and then converting from lower species to man (Ricci 1985; Ricci and Molton 1985). Although properly conducted long-term animal studies have proved useable in risk assessment, health risks cannot be established for irradiated food because neither a dose nor a response can be determined through accepted experimental procedures. Quantitative risk assessment, as commonly performed for exposure to radioactive materials and chemicals, cannot be performed since the data simply do not permit statistical estimation of the dose-response functions; the dose-responses are unavailable for radiolytic products.

QUALITATIVE RISK ASSESSMENT

For the reasons discussed above, a quantitative risk assessment cannot be performed for health risk to humans from ingesting irradiated foods. The most relevant information for health risk assessment consists of data developed in animal studies. Animal studies involving irradiated food were reviewed by the FDA for a variety of endpoints: teratology, chronic toxicity, and genetic toxicity. Of the more than 400 studies evaluated, only 5 passed scientific scrutiny. The reasons range from inadequate sample size to pathology. No adverse health effects were found in any of the valid studies (51 FR 13384). More specifically, although 436 remaining studies were scientifically inadequate, they were nevertheless used to determine certain locally valid information relevant to the determination of aspects of potential toxicological effects. According to the FDA, even when the inadequate studies were dissected to discern whether some portions were usable, the locally valid information still pointed to no adverse toxicological effect (51 FR 13384).

The calculation of risks (in excess of background) from ingesting fruit exposed to the levels of ionization energy specified by the regulations requires representative groups (animal or human) to allow a statistical comparison between the exposed and control (unexposed) groups. The problem with some studies is that the sample size is too low; for example, in one study only three rats were fed irradiated bacon and fruit. Often the number of tumors and decreases in rat survival rates do not depend on dose; the results thus negate a dose-response relationship.

The interaction of ionizing radiation with vitamins and minerals has been thought to enhance adverse effects, including cancer. On review, results were either not considered to be valid or were confou -ded by excess in the nutritional imbalance of diet fed to test animals (Wierbicki et al. 1986). Biologically, there is a relationship between certain nutrients and cancer prevention; however, the nature of the relationship has not been quantified and cannot yet be useful for quantitative risk assessment. Generally, since the level of ionizing energies is low and as such does not interfere with nutrients, the issue is moot.

As a comment to the issue of carcinogenesis, some reports have found cells with a higher number of copies (polyploid cells) than expected. In addition, there is the concern with the interaction by a unique radiolytic product on DNA. The polyploidity of cells was eventually resolved by finding that the variation is apparently within the norm. Metabolic processes aid to restore equilibrium in live organs, and a variety of repair mechanisms (e.g., DNA and cellular) essentially eliminate the problem. However, since the induction of cancer is a stochastic process, the probability that a single minute concentration of a unique radiolytic product can initiate the tumorigenic process remains a theoretical concern. To dispose of the issue of carcinogenicity, it is sufficient to note that the experimental evidence does not show statistical excess of cancer and mutagenic effects.

Even when long-term bioassays of the potential for carcinogenicity and mutagenicity, among other end points, are reexamined, the histopathology turns out to indicate no problem (NTP 1985). Confounding factors, such as high protein content in the diet of experimental animals affected some of the findings of nephropathy, as discussed earlier.

The generic problems affecting animal test results range from small sample sizes to inconsistent reports, even within studies made by the same authors. In other cases, such as in a study that reported morphological changes to the reproductive organs of mice fed irradiated red onions, the results were found to be treatment related. Upon reanalysis, the studies that purported to identify an association between exposure to irradiated foods and toxic responses, including tumorigenic response, are flawed for a variety of reasons discussed in the literature and summarized by the FDA in its *Final Rulemaking* document. In vitro tests on irradiated sugar solutions, however, were not flawed and have shown some chemical effects[4]

For the purpose of risk assessment he biological effects detected in these tests involving sugars in roots and in *Salmonella T.* are not applicable to establish quantitative estimates of human health risk. Nevertheless, the issue must be at least addressed at the qualitative level. In general, the formation of biologically active compounds, if it occurs, may be a first step in the induction of an adverse health effect. The next inquiry is whether that information can usefully be converted for use in predicting human response. In other words, are simple biochemical changes in irradiated sugars which affect some plant media or lower organisms useable for qualitative risk assessment of adverse effects in man? The scientific consensus is that this is not the case. The reasons why are fairly simple. First, because of the chemical and physical variability of food substances, tests involving actual foods have not produced the same effects that occurred with the simple sugar solutions used in the tests (51 CFR 13381). Second, it is virtually impossible, given the current state of biological knowledge, to generalize in vitro test results to in vivo results for risk assessment. When the chain involves plant roots or microorganisms the link cannot be plausibly established.

[4] The primary reaction that takes place involves reaction of the peroxy radicals ($OH^{\cdot}$) with sugar molecules to form radiolytic sugar products. These specific radiolytic products are present in nonirradiated foods but exist at higher concentration in irradiated foods. The formation of these products has been shown to be dose dependent and influenced by oxygen concentration as well as other specific conditions such as the presence of metal ions.

The FDA has discussed this issue and has concluded that the irradiation of aqueous solutions of sugars are "unsuitable models" for determining the mechanism of toxicity of irradiated foods (51 FR 13383). This is evidenced in mangos irradiated at 29 kGy which did not produce mutagenic nor toxic effects (Elias and Cohen 1983). A variety of other references, cited in the FDA document (51 FR 13383), dealing with other fruits, also confirm the lack of toxic effects from direct irradiation.

CONCLUSIONS

The available literature does not provide the information required to develop a dose-response function such that risks from irradiated food can be formulated and estimated. It is also not possible to develop a mechanistic-causal model that captures the biologic basis for an eventual realistic dose-response model. Even if it were possible to outline the basis for such model, the transfer coefficients and the transition probabilities required are not available. Thus, the effort would be futile. Although it is less realistic than hoped for, some quantitative risk assessments can be based on very simple biological conditions; these bases, given this review and the review by many others, are either completely missing or inappropriate for risk assessment for the reasons discussed in this text.

As a last resort, a simple interpolation yielding a positive gradient between exposure and response could be, in principle, used to establish a rough dose-response relationship, specifically, a statistical association. This association, given the data discussed, cannot be developed at this point.

To conclude, the data uniformly negate the existence of adverse effects at the levels of ionizing radiation below 1 kGy. Thus, no dose-response function can be usefully built and parameterized. The results from qualitative risk assessments also indicate that exposure of papaya to ionizing radiation is not likely to cause adverse health effects to humans.

APPENDIX G.2

EXTERNAL EVENTS RISK ASSESSMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

LIST OF TABLES

SECTION I
SITE CHARACTERISTICS

1.1 Groundwater

The hydraulic gradient for the area under consideration depends upon local changes in the permeability of the rock and the amount of rainfall recharge, but typically ranges from 1 to 8 feet above sea level per mile from the shoreline.

The sites under consideration for the proposed food irradiator are located from 0.5 to 1.5 miles inland. Hence, the general rule of thumb noted above suggests that the water table would be from 1 to 8 feet above sea level. Static water table data from the wells nearest the three areas being evaluated suggests the following approximate depths to water table for each area:

Location	Ground Elevation	Water Table Elevation	Depth to Water Table
Area A	42'	5'	37'
Area B	25'	4'	21'
Area C	60'	7'	53'

1.2 Flooding and Tsunami

The average annual rainfall in Hilo is relatively high. However, the presence of relatively permeable soils and porous lavas has generally limited flooding to coastal areas which are susceptible to periodic inundation by tsunamis and to areas immediately adjacent to defined watercourses. The three site areas under consideration for the food irradiator have been identified by the Federal Emergency Management Agency (FEMA) as being in Zone C, "Areas of Minimal Flooding."

Approximately 50 tsunamis have struck the island of Hawaii during historic times; several of these have extensively damaged structures along the Hilo shoreline. However, as discussed above, their ground elevation and distance from the shoreline mean that none of the areas being evaluated for the proposed food irradiator are at risk from this source.

1.3 Volcanic Activity

The town of Hilo is located on the boundary between Mauna Loa and Mauna Kea volcanos. All of the areas evaluated in this report are located within a mile of one another on lava flows originating from Mauna Loa. Due to this and the absence of significant topographic features which might affect the eruptive effects, all are exposed equally to volcanic hazards.

The United States Geological Survey (USGS) has defined eight levels of relative risk from lava flow on the Island of Hawaii. The greatest danger occurs in Zone 1, with the least risk occurring in Zone 9. All three of the potential irradiation facility sites considered are located in Zone 3. It is estimated that only 1 to 3 percent of the ground surface in Zone 3 has been covered by lava in historic times (i.e., since 1778), most of it on the upper reaches of Mauna Loa. The risk of lava flow is not evenly distributed throughout Zone 3. Instead, lava flow frequencies are by far the greatest near Mauna Loa's summit and on its northwest flank; it is much lower along the coastline of the volcano's southeastern flank where Hilo is located.

Tephra, which consists of volcanic ash and coarser fragments, is produced most frequently in Hawaii by lava fountains. During historic times, tephra falls in excess of 15 centimeters have occurred within about 2 kilometers of active vents. All of the irradiator sites under consideration are several times this distance from the nearest active vents. The USGS has placed the areas being evaluated for the food irradiator at the outer fringe of "Tephra Hazard Zone 2." The risk here, which is associated with possible lava fountaining, is considered slight.

Some explosive eruptions produce pyroclastic surges. These are clouds of ash, rock fragments, and heated gases that move outward at high speed from the source vent. Although pyroclastic surges tend to move along the ground surface, they may or may not follow topographic depressions. While such surges represent a severe hazard when they do occur, they are much less frequent than lava flows. The USGS has concluded that the only evidence of pyroclastic surges that has been found on the Island of Hawaii is immediately adjacent to Kilauea's caldera. However, they note that such surges could conceivably be produced at other locations where ground or seawater can interact with magma. There is no evidence that such activity constitutes a measurable threat to a food irradiator located anywhere in Hilo.

1.4 Seismic Activity

Ground fractures, subsidence, and earthquakes can occur together as a result of the movement of magma within volcanos. Most fractures in Hawaii result from lava movement, subsidence of landslide blocks, or earthquake shaking. The two largest earthquakes to affect the island during historical times occurred in 1868 and 1975. They had magnitudes greater than 7, and were probably caused by the movement of magma into the rift zones of Mauna Loa and Kilauea, respectively, followed by a sudden collapse. As a result of the earthquake potential, the County of Hawaii Building Code bases its structural design standards on seismic Zone 3 forces, and the proposed irradiation facility would be designed to this standard.

The USGS has divided the island into four hazard zones for fracture and small scale subsidence. All of Hilo is located in Zone 4, the area which is least susceptible to damage from this threat.

1.5 Aircraft Operations

Two of the sites under consideration (Sites A and B) are physically located within or contiguous to the boundaries of General Lyman Field, while Site C is approximately one-half mile south of the airport proper. Therefore, the hazard of aircraft crashes on the three sites will be addressed in this risk assessment.

General Lyman Field is the Hilo Airport, occupying a 1000-acre site adjacent to Hilo Bay. The main runway is oriented east-west and extends 9800 feet in length. This runway can accommodate all aircraft in regular commercial service, including the B-747, and handles 85 percent of the approximately 60,000 airfield operations that take place during the year. A second, crosswind runway extends 5,600 feet in a southwest-northeast orientation.

The airport contains modern passenger facilities, which now accommodate interisland air carriers only, principally DC-9 and B-737 aircraft, since the termination of direct overseas service. The airport also includes a commuter airline terminal and an air-crash rescue facility, which is manned 24 hours a day. The airport supports general aviation activities as well as small commercial operations (e.g., crop dusting, flight instruction).

In addition, the Keaukaha Military Reservation adjoins General Lyman Field. This reservation is used as a Hawaii National Guard Training Facility for both on-island and off-island units. The Hawaii National Guard utilizes the runways at General Lyman Field for operations in support of the training of Air National Guard units.

1.6 Industrial/Military Activities

In characterizing the proposed site conditions, employees of facilities known to be near the proposed sites and people familiar with the industrial activities in the area were contacted to identify industrial or military activities in the area that could present a potential hazard to the facility. This subsection outlines the information gathered as a result of these contacts.

1.6.1 Airport Fuel Storage

Both aviation gasoline and jet fuel are stored at General Lyman Field in support of aircraft operations. The main fuel tank farm is located north of the airport proper. A 10,000 gallon underground storage tank and several 2,000 to 3,000 gallon aboveground tanks store 100 octane aviation gasoline in the Old Terminal area of the airport, where Site B is located. A 100,000 gallon underground tank stores A-50 jet fuel in the Industrial Area of the airfield, where Site A is located.

1.6.2 HELCO Power Plant

Hawaii Electric Light Company (HELCO) operates a power plant on a site across Railroad Avenue from Site C. The plant consists of several types of generating units. These include steam-turbine, reciprocating engine, and combustion-turbine generating units. The boilers for the steam-turbine generating units burn No. 6 Bunker C fuel oil. The reciprocating-engine and combustion-turbine units burn No. 2 Diesel fuel oil. The No. 6 fuel oil is pumped to the site via an underground pipeline and stored onsite in a 46,000 barrel aboveground storage tank. The No. 2 diesel fuel is trucked to the site and stored in a 10,000 barrel aboveground storage tank. Propane, used for the boiler ignitors, is also stored onsite in a small aboveground storage tank.

1.6.3 Propane Storage

Gasco provides propane service to the Hilo area. Small 500 to 1000 gallon aboveground storage tanks are located at several sites throughout the Hilo Airport and surrounding facilities.

Propane is brought to Hilo Harbor by way of barge. Each barge has a maximum capacity of 9,000 barrels and is off-loaded at the pier facilities approximately one mile northeast of Site B. From the piers, propane is pumped through a pipeline to a bulk storage facility located northeast of the airfield, about 1 mile from Site A. The bulk storage facility contains fifteen 30,000 gallon tanks (each with an 85 percent maximum capacity), and a 10,000 barrel low pressure sphere.

1.6.4 Quarry Operation

A small quarry operation is located adjacent to Site C. It is assumed that explosives are stored at the quarry, most likely in earth covered bunkers. The storage site would be below the elevation of Site C. No information is known about the type or quantity of explosives stored at this site.

1.6.5 Military Facilities

The Keaukaha Military Reservation adjoins the southern boundary of General Lyman Field. The Hawaii National Guard utilizes this reservation as a training facility and maintains warehouses both at the airport and on the reservation. Data on potentially hazardous operations was requested in writing from the reservation; no information has been provided regarding activities or materials stored on the reservation that might represent a potential hazard to the irradiator sites under consideration.

1.7 Transportation Activities

Transportation activities in the vicinity of the sites under consideration and representing a potential hazard to the facilities are characterized below.

1.7.1 Airport Fueling Operations

Fuel trucks load up at the Fuel Tank Farm and drive onto the airport, following the airport service roads past Site B, to the various aviation gasoline and jet fuel storage locations throughout the airfield. An 8,500 gallon fuel truck shuttles A-50 jet fuel from the 100,000 gallon underground storage tank, in the industrial area of the airfield, past Site A to the passenger terminal to refuel aircraft at the gates.

1.7.2 HELCO Power Plant Refueling

The No. 2 Diesel fuel oil, required to fire the reciprocating-engine and combustion-turbine generating units, is transported to the HELCO plant site, across Railroad Avenue from Site C, by 8,000 gallon tanker trucks.

1.7.3 Propane Refueling

Propane storage tanks, at various airport locations and at the HELCO power plant, are refueled by Gasco utilizing 2,000 gallon tank trucks.

1.7.4 Quarry Explosives Transport

Although little is known about the quarry operation adjacent to Site C, it can be assumed that explosives are trucked to the quarry to support the operations.

1.7.5 Military Explosives Transport

It is reasonable to assume that munitions are being transported to the Keaukaha Military Reservation in support of the Hawaii National Guard training activities at the facility.

1.7.6 Radiation Source Transportation

The cobalt-60 radiation source will be shipped in a cask specifically designed for this purpose. The cask will most likely arrive by ship, be off-loaded at the pier and trucked to the appropriate site. The carriers must be licensed by the NRC.

1.7.7 Vehicular Traffic

The vehicular traffic around the three sites under consideration can be characterized as light. All of the sites are located on lightly-travelled roads where vehicle speeds are restricted. Therefore, vehicular traffic is not considered to pose a potential hazard to the safe operations of the irradiation facility.

SECTION 2
PROJECT DESCRIPTION

2.1 General

A cobalt-60 radiation source is proposed for use in irradiating packaged food products at one of three sites identified in the Hilo area. No detailed design has been developed for the facility. Therefore, the following risk assessment has been prepared utilizing the preconceptual facility design developed by CH2M Hill and described in their feasibility study.

A continuous process flow method has been assumed for the facility. This method utilizes an automatic conveying system that carries pallets stacked with boxes of product through an irradiation chamber, exposing the product to the emitted gamma radiation. The continuous conveying system carries product from an incoming preparation area, through the irradiation chamber and delivers it to an outgoing processing area without further handling.

During those times when the irradiator is not treating product, the sealed isotope sources are lowered into the bottom of a storage pool containing water. The water shields the irradiation chamber from the radiation source.

Thick concrete walls, ceiling, and floor of the irradiation chamber will be designed to provide the necessary shielding when the radiation source is out of the storage pool.

2.2 Radiation Source

Cobalt-60 is a manmade isotope. The usefulness of the isotope is indicated by the fact that over 80 million curies of cobalt-60 are currently being used around the world for gamma processing. Approximately half of the world-installed base has been shipped to the United States. The Atomic Energy of Canada Limited (AECL), a Canadian Crown corporation, is the primary manufacturer of cobalt-60, supplying 80 to 90 percent of the world's demand. Approximately 90 percent of AECL's cobalt-60 is used for the sterilization of medical disposables. The balance is used in food irradiation and other applications (Fraser in CH2M Hill 1983; Fraser in CH2M Hill 1985). Other countries, such as the United States and France, have supplied only a small fraction of the world-installed base.

The cobalt-60 source pin dimensions may vary greatly depending on their specific application and the manufacturer. The characteristics of a common cobalt-60 pencil manufactured by AECL is indicated along with cobalt-60 characteristics in Table 2-1.

Table 2-1
ISOTOPE CHARACTERISTICS

	Cobalt-60 (AECL)
Gammas per decay	2.0
Energy (MeV) per gamma	1.33, 1.17
Energy (MeV) per decay	2.5
Half-life (yr)	5.27
Source replenishment (%/yr)	12.32
Capsule dimensions	
Length (in)	17.8
Outside diameter (in)	0.44
Self-absorption factor	0.09
Specific activity (kCi/capsule)	6.0

In a typical cobalt capsule 99.9% pure cobalt-59 slugs are nickel plated and welded into a Zirconium alloy (Zircalloy) "inner capsule." Inner capsules are assembled into Reactor Target Bundles and placed into reactors for activation (conversion of Co-59 to Co-60). After activation, target bundles, now containing approximately 90% cobalt-59 and 10% cobalt-60, are extracted from the reactor into a shielded flask and transferred into a 10 meter deep, water filled storage bay where they are transferred into an approved shipping container. Next, they are transported to the Cobalt Processing Facility, where the bundles are dismantled and the Zircalloy inner capsules are urther sealed in stainless steel "outer capsules." The finished product is most often the C-188 cobalt-60 source pencil. This capsule has become a world-wide industry standard.

Capsules are manufactured to a very strict quality : surance program that includes verification of incoming materials and chemical analys.. of material samples. They are automatically welded in an argon atmosphere using non-consumable tungsten electrodes. In every production run, destructive testing is done on the first and last and one intermediate capsule or at least one in every twenty-five. These extensive quality control measures ensure that the final product meets engineering and safety specifications for federal licensing.

To improve corrosion resistance, the outer capsules are made from ASTM 316 L stainless steel which, due to its low carbon content, permits welding with minimum carbide precipitation. A 150 kCi irradiation source would require 25 source pencils of 6 kCi of specific activity each. These source pencils would be held in a source plaque. The function of the source plaque is to provide a secure metal framework assembly for the cobalt-60 filled gamma-source pencils. Wheels, typically attached to each side of the plaque, would roll on a track. The track would allow movement of the plaque between the storage pool and conveyor areas. The plaque is usually open to enhance heat dissipation by convection.

2.3 Facility Design

In their feasibility study, CH2M Hill conducted a preconceptual analysis of handling techniques, process requirements, and technical solutions to process requirements to form the basis for development of preconceptual lay-outs. These layouts defined a typical preconceptual design conceived to satisfy the process requirements and identify the major elements of cost. The preconceptual designs while appropriate for each application are not detail designs and several process and design assumptions were made. The preconceptual designs selected appear to fall in the median of design possibilities within the range from very sophisticated to the most simple design and variations of the selected layouts have been used in existing irradiators (CH2M Hill 1987).

Several of the design parameters, such as source handling mechanisms or product handling systems, can vary greatly depending on the method and degree of automation selected by the designer. Also, in-depth study and analysis of the process and a US Department of Agriculture (USDA) Animal and Plant Health Inspections Service (APHIS) protocol (presently being proposed) in relation to other project elements yet to be determined, will result in a final design which may differ considerably from the concept that is envisioned at this time.

It should be understood that although an irradiator is simple in concept, and although each irradiator has the same principal components (for example, radiation source and shielding), the design details and types of equipment can vary significantly from plant to plant.

The following assumptions were made regarding facility design:

2.3.1 Shielding

The structure surrounding the source will be a massive, reinforced concrete building. To provide required shielding, the walls and roof will be approximately 6 feet thick with #8 or #9 reinforcing steel bars on 12-inch centers on both faces.

2.3.2 Source Storage Pool and Equipment

The source storage pool will be approximately 25 feet deep with a 5/16-inch-thick stainless steel liner. Support equipment will include pumps, piping, cooling loop and pool water deionizing equipment.

2.3.3 Source Handling Equipment

Mechanisms and controls for handling and positioning the radiation source plaque will include a cable guide system, a hoist mechanism to raise and lower the source plaque, and physical source handling equipment.

2.3.4 Control System

This item depends on the preference of the final design engineer and the degree of documentation and automation desired by the owners. It is assumed that the design would include systems required for facility licensing along with a medium capability level for process monitoring, data collection and instrumentation. Source positioning controls, safety interlock systems, source/product monitoring devices, irradiation detection systems, access interlocks, HVAC controls, storage pool controls, and status/warning systems would be included in this item.

2.3.5 Facility Environment Equipment

This item would include fire warning and protection equipment, lighting, underwater lighting, electric power service, ventilation, and air conditioning of the warehouse area.

2.3.6 Product Handling Equipment

One possible conveying and handling system to handle the process flow would consist of accumulator roll case conveyors, automatic transfer mechanisms, overhead "tote conveyor," individual pallet carriers, position dwell capability, and carrier rotation mechanisms. An alternative system could consist of a "towveyor" with chainways embedded in the floor, towing small carts carrying one pallet each. The cart would have a turntable mechanism to provide a 180-degree turn in the irradiation chamber. Conveying and handling system controls would be included. It is assumed that the product handler personnel at the irradiator facility would unload and reload the refrigerated trailers at the irradiator site utilizing fork lift trucks.

2.3.7 Miscellaneous Equipment

The facility will be appropriately designed with radiation detectors, product barrier, and automatic maze gate.

2.3.8 Warehouse/Office/Laboratory

The facility will have a minimal warehouse area of approximately 5,300 square feet with laboratory and office space included. It is assumed that most product will be transported to the irradiator in a refrigerated truck and will remain in the truck until processed. The fruit will be returned to the truck after processing. Process surge will be provided for in the parking area with electrical refrigerator plug-ins available.

SECTION 3
LICENSING AND REGULATIONS

3.1 Obtaining and Maintaining an Irradiator License

Licensing of an irradiator in the State of Hawaii falls primarily under federal authority. The State of Hawaii does not license irradiators. State regulations (Title II, Chapter 40: Radiation Protection) require only that machine sources and radioactive materials be registered with the Noise and Radiation Branch of the State Department of Health. The applicable federal regulations are discussed below.

Regulations governing radiation protection and safety for radioisotope facilities are promulgated by the NRC and the 28 Agreement States. (Agreement States are those which the NRC has delegated licensing authority.) Since the State of Hawaii is not an Agreement State, an isotope irradiator constructed in the State of Hawaii would be licensed directly by the NRC. The State of Hawaii falls under the jurisdiction of NRC Region V.

Federal regulations addressing isotope transportation, and isotope irradiator design, construction, and operation are listed below (Jarrett in CH2M Hill 1985):

- 10 CFR Part 19--Notices, Instructions, and Reports to Workers; Inspections;
- 10 CFR Part 20--Standards for Protection Against Radiation;
- 10 CFR Part 21--Reporting of Defects and Noncompliance;
- 10 CFR Part 30--Rules of General Applicability to Domestic Licensing of Byproduct Material;
- 10 CFR Part 71--Packaging and Transportation of Radioactive Materials;
- 10 CFR Part 170--Fees for Facilities and Materials Licenses and Other Regulatory Services Under the Atomic Energy Act of 1984, as Amended;
- 49 CFR Part 100-177--DOT Regulations Relating to Transportation.

In the United States, there are approximately 40 licensed commercial irradiators. Most are operated primarily for the purpose of medical product sterilization. Radiation processing is not a new technology, the established licensing and regulatory structure of the NRC has already had many years of experience with operating facilities. The facility owner is responsible for demonstrating to NRC's satisfaction that new equipment or design concepts meet the standards set by the current regulations (Cunningham in CH2M Hill 1984).

The applicant for a license to use sealed sources and devices for gamma irradiation must submit information describing all the design/safety features and operational requirements that must be satisfactorily addressed before the facility can be approved and the applicant can receive a license to receive, possess, and store radioactive materials in his irradiator. The information required in the license application includes the following:

- Location of the facility;
- Description of the irradiator;
- Purpose of the irradiator;
- Radiation detection instruments;
- Leak test;
- Personnel dose monitoring;
- Waste disposal;
- Radiation safety program;
- Operational procedures;
- Training; and
- Emergency procedures.

After receiving the application, the NRC will review the application to determine that: (1) the applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life and property, (2) the applicant is qualified by training and experience to use the radioactive material for food irradiation, and in such a manner as to protect health and minimize danger to life and property, and (3) the application describes a facility and operational plan which will be in compliance with NRC's regulations. If the application is satisfactory, the license is issued (FDA in CH2M Hill 1986).

Once the irradiator has been licensed and put into service, NRC inspectors will make periodic visits (sometimes unannounced, and sometimes as frequently as two or more times per year) to review personnel exposure records, operating records, safety devices and interlocks, source wipe test records, and implementation of administrative controls. The inspectors will critically analyze the equipment and operating procedures to ensure that the conditions of the license are being met (Ridout in CH2M Hill 1980). Violation of the license conditions can result in a fine or closure of the facility.

3.2 Decommissioning

At the end of the facility's useful life, the facility user has the option of either shutting down operation and simply storing the source in the facility, or disposing of the source and decommissioning the facility. Either option will require an amendment to the facility license. The latter course of action, that of source disposal and decommissioning, is usually recommended unless the facility is anticipated to start up again in the near future. DBED intends to require decommissioning at the end of the facility's useful life.

Two documents from the facility user to the NRC are required to decommission an irradiator.

The first document is a "termination amendment" to the license (NRC in CH2M Hill 1985a). This amendment must be sent to the NRC before source disposal and will serve as notification of termination. The amendment should reference attached correspondence, which provides, as a minimum, the following information:

1. Final disposal site of the source;
2. Procedures for removing the source from the facility;
3. Method of transportation of the source to the disposal site;
4. Qualifications of individuals supervising the decommissioning operation; and
5. Extent of facility contamination, and if contaminated, the procedures for decontamination.

The second document is a final report after decommissioning which provides the "close-out" radiological survey of the facility (NRC in CH2M Hill 1982). The types of information required in this second report include the areas that were radiation surveyed, the equipment used, and the levels that were recorded. The facility must meet contamination-free standards before it is released from regulatory control and approved for unrestricted use.

The isotope can only be disbursed to a recipient who has been authorized by the NRC to receive the source. As specified in 10 CFR 20.301, the authorized recipient for the sealed sources could be the original supplier of the isotope, a government agency, another licensee, or a waste disposal company licensed to receive and dispose of the types and quantities of radioactive waste being removed. In practice, sealed sources such as cobalt-60 are usually returned to the manufacturer of the source at the end of their useful life.

SECTION 4
RISK ASSESSMENT

Most of the introductory information (Section 4.1 through 4.4) is from CH2M Hill (1987).

4.1 OVERVIEW

The primary safety and health issue regarding the handling of radioactive materials and operation of an irradiation facility is protection of workers and the public from exposure to radiation.

Potential risks generally associated with a food irradiation facility are related to possible hazards in the operation of the irradiation facility, in the transportation of radioactive source material and in the effects of external forces acting on the facility.

The operation of any irradiation facility poses some finite risk of operator or public exposure to radiation. However, the risk is very small due to the stringent facility licensing procedures that require design specifications and operating practices that reduces risk to reasonably achievable levels.

Facility siting considerations, such as aircraft crash potential, earthquake potential, volcanism, and tsunami threat, are also evaluated in terms of their potential for causing the release of radiation from a facility. The exposure risk associated with these activities is minimized through proper design and operating procedures.

The specific risks and mitigating measures associated with facility operation, isotope transportation and external forces are discussed in the following sections.

4.2 Internal Hazards Assessment

The proposed irradiation facility will contain a radioactive source of 150,000 curies of cobalt-60. Shielding and operational controls must be provided to protect workers and the public from the radiation produced by this source. The source must be designed to maintain its integrity in all operating modes and all credible abnormal environments. Although a detailed design has not been completed for the facility, we have enough information from the feasibility study (CH2M

Hill 1987), and from similar facilities already in operation, to draw some general conclusions about the sources of potential risk associated with the food irradiator.

4.2.1 Hazards

a. Radiation Exposure.

Mankind has evolved to its current status while being exposed to natural radiation from the environment. This absorbed radiation has two sources: cosmic rays (highly energetic radiation from outerspace) and naturally occurring radioactive isotopes. Therefore, total protection from ionizing radiation is not possible.

The determination of what is acceptable to man from artificial sources of radiation is based on an evaluation of risk versus benefit. A clear objective, however, is to keep occupational and public exposure to a practical minimum.

Absorbed doses of radiation are expressed in terms of a unit called the gray (Gy), which is a measure of the amount of energy absorbed in matter. Biologically, not only the amount of radiation is important, but also its type: equal doses of radiation do not necessarily have equal biological effects. Therefore, a second unit which takes these differing effects into account is used in radiation protection work. This unit, used to measure the absorbed dose equivalent, is the sievert (Sv). (The gray replaces the unit used formerly, the rad, which was 100 times smaller. The sievert replaces the rem, which was also 100 times smaller. Both units are defined in terms of the amount of energy, measured in joules, absorbed per kilogram of mass: 1 Gy (or 1 Sv) = 1 J Kg^{-1}. This amount of energy corresponds to the amount of heat energy needed to raise the temperature of a liter of water by 0.00024° C.

The International Commission on Radiological Protection (ICRP) recognizes two categories of persons for the purpose of recommending individual dose limits. For adults who are exposed to radiation in their work, the recommended limit is 50 millisievert (mSv) per year. For the remaining general population the recommended limit is 5 mSv per year. In both cases, doses due to natural background and medical practices (such as the use of x-rays for diagnosis) are

excluded. In evaluating both permissible and projected radiation exposure, knowing the magnitude of the doses that the public receives from natural sources is important.

Table 4-1 presents average individual radiation exposure from various natural and manmade sources.

The design of an irradiator that provides a safe environment for its operating personnel is governed by the regulations of the U.S. Nuclear Regulatory Commission (NRC). The permissible occupational dose for radiological workers is 50 mSv per year (reference 10 CFR 20.101 specifies that the maximum whole body occupational dose is 12.5 mSv per calendar quarter). In U.S. DOE facilities, the policy (DOE Order 5480.1A) is to minimize exposures by following the ALARA principle which is an acronym for "As Low As Reasonably Achievable." In 1978 and 1979, NRC collected exposure data from all licensees. The average annual measurable dose for persons engaged in irradiation operations was 1.6 mSv (Reference 21 CFR Part 179). This exposure is about 30 times less than the permissible radiation dose for radiologic workers.

As a comparison, an individual flying in an airplane above 33,000 feet receives radiation at a dose rate of 0.005 to 0.01 mSv per hour. The radiological worker (assuming average dose of 1.6 mSv in a 2,000-hour work year) receives 0.0008 mSv per hour, or about one-tenth the dose rate received while flying at 33,000 feet. The dose rate increases with higher altitude.

b. Toxic Gas Production

The energy in gamma rays from cobalt-60 is not high enough to cause the production of radioactive material. The radiolysis of air, however, produces certain toxic gases, such as ozone and several oxides of nitrogen. Ozone is toxic to humans and causes oxidation and effectiv. destruction of components of operational and safety electronics.

Table 4-1
AVERAGE INDIVIDUAL RADIATION EXPOSURE

Natural Radiation Sources	Effective Dose Equivalent Per year
From Natural Sources of Radiation in Areas of Normal Background	
Cosmic Rays at Sea Level	0.30 mSv
Radon (^{222}Rn and ^{222}Rn from ^{238}U and ^{232}Th)	1.37 mSv
Potassium (^{40}K)	0.30 mSv
Other	0.02 mSv
Total (rounded)	2.00 mSv
Manmade Radiation Sources	
From Medical Uses of Radiation (corresponds to about 20% of the annual exposure from natural background)	0.40 mSv
From Nuclear Explosives Testing (corresponds to about 1% of the annual exposure from natural background)	0.02 mSv
From Nuclear Power Production (corresponds to less than 0.1% of the annual exposure from natural background)	0.001 mSv

Source: CH2M Hill 1987

Either or both of two techniques, delayed entry and high ventilation rates, would be used to limit the exposure of personnel and equipment to the harmful effects of these gases. Delayed entry is often a natural consequence of the slowly moving shielded doors or other personnel access limitation devices. High ventilation rates result in rapid decrease of the ozone concentrations after source shutdown and also tend to minimize residence time of the gas in the vicinity of the various electronic components.

c. Radioactive Waste

Because the gamma sources are encapsulated (sealed), there is generally no contamination of contact surfaces. Therefore, special storage or disposal of pool water or other materials that contact the source do not have to be considered.

The final disposal of the source would be planned. The normal procedure is to arrange with the source supplier to take back the source when it is no longer wanted. This not only ensures assistance with the transportation of large sources of radiation but also permits the supplier to modify the source and resell it for other purposes.

d. Operational Hazards

The potential operational hazards associated with an irradiation facility project can be classified into three categories:

- Source loading and unloading
- Normal operation of the facility
- Normal maintenance of the facility

This section of the risk assessment identifies possible accidents, mitigation methods and worst-case consequences for operational hazards. An overview of these hazards is presented in Table 4-2.

Table 4-2

POTENTIAL ACCIDENT SCENARIOS

Accident	Mitigation/Worst-Case Consequence
Source Capsule Loading/Unloading	
1. Heavy object dropped in pool	Procedures/Mechanical damage to facility
2. Transportation cask dropped	Licensed cask/Mechanical damage to facility
3. Pool water level below minimum	Interlocks, water level monitors/Potential overexposure
Normal Operation	
1. Source pin leak	Pool contamination detectors, procedures/Water contamination, facility shutdown
2. Conveyor or product jammed against source plaque	Protective shroud/None[a]
3. Source plaque jammed in non-fully shielded position	Design/Facility inoperable
4. Control console failure	Redundancy, plaque returns to pool/Facility shutdown
5. Ventilation system failure	Redundancy, plaque returns to pool/Facility shutdown
6. Mechanical dangers	Operating procedures/Personal injury
7. Fire	Fire Suppressant System, Plaque returns to pool/Mechanical damage
Facility Maintenance	
1. Source plaque raised during access	Mechanical and electrical interlocks/Potential overexposure
2. Pool water level below minimum	Interlocks, water level monitors/Potential overexposure
3. Mechanical dangers	Operating procedures/Personal injury
4. Person fell in pool	Operating procedures, pool access barrier/Potential overexposure
5. Person locked in chamber	Interlocks, water level monitors/Potential overexposure

[a]Based on the testing and licensing regiments of the NRC to ensure public safety in the transportation and use of these isotopes, and as best can be determined from reasonable assumptions about cred. 'e scenarios, the risk approaches zero.

Source: CH2M Hill 1987

4.2.2 Safeguards

Reducing the risk of radiation exposure is achieved through strict design standards and safe operating practices. In the event that radiation would be released from the facility, established emergency procedures would be used to reduce the consequences from such a release. Specific safeguards and protection strategies are summarized below:

a. Shielding

Shielding is used to protect operating personnel from excessive gamma-radiation exposure. For an irradiator, adequate protection can be provided by either water, concrete or lead as the shielding material.

The shielding design allows for replenishment of the radiation source as it decays, for maintenance access to the irradiation zone, and for normal flow of the irradiated product. In most commercially available systems, the radiation source is stored in a clear-water pool to make the irradiation chamber accessible for maintenance and source replacement. To prevent the transmission of high-energy gamma rays along the conveyor path when the source is exposed, the labyrinth changes directions to provide at least three reflections of gamma rays between the source and the entrance-exit. Sufficient shielding is provided by the labyrinth walls along the conveyor path to absorb these gamma rays.

b. Personnel Training

Irradiation facility operators would be trained in facility operation, emergency procedures, radiation biology, chemistry, mathematics, and physics, as well as radiation safety (health physics). High school graduates with an appropriate training course in these areas could serve as technicians in the operation of the irradiator. AECL, Rockwell International at Canoga Park, California, and CGR MeV in France have such training programs in place.

c. Personnel Monitoring

Each individual who enters the facility would be provided with appropriate personnel monitoring equipment. Appropriate monitoring devices are those designed to be worn or carried for measuring the dose received. Examples of these devices are film badges, ring badges, pocket ionization chambers, and thermoluminescent dosimeters.

d. Area Monitoring

Radiation detection instruments are used to measure the levels of radiation in areas in and around the irradiation facility. The usual choices are ionization chambers, compensated Geiger counters, or scintillation-type counters.

In the irradiation cell, during normal operation, the radiation level is extremely high. Therefore, detectors are used to monitor normal operation as well as to assure safe levels of radiation in the cell during source storage.

Several other locations would have radiation monitors. These monitors are designed to trigger some particular response should the radiation level rise above background level. One important example of this type of a monitor location is the storage pool water circulated through a deionizer, filter, and heat exchanger. At any of these locations, a monitor would indicate source leakage if the radiation level should rise above background level.

Similarly, filters in the irradiation room air exhaust system would be continuously monitored to rapidly indicate a leak while the source is in the "irradiate" position. One other location that would be routinely and continuously monitored is the output of the conveyor system.

A routine testing program for all monitors is included in facility operating procedures to ensure their continued reliability.

e. Access Limitation

Access to the source or the product conveyors is required for periodic maintenance. Methods to provide radiation safety during such access would be included in the overall operating plans. The use of large shielded doors and complex maze systems are common access modes.

In addition to physical barriers, personnel are further protected from accidental exposure because the source is automatically lowered if a potentially disruptive condition is created. These conditions could include loss of power, opening of a cell door, entrance of personnel into the maze, conveyor failure, or loss of exhaust system.

Electronic and mechanical interlocks to ensure that the source is returned to a "safe" configuration are used. Such devices are designed to be "fail safe;" that is, they would produce a "no entry" barrier if interlock fails.

The importance of properly functioning interlock systems cannot be overestimated. Therefore, all interlocks are subjected to a routine testing program.

f. Contamination Control

An effective plan to control any incident that might occur during the receipt of the source material would be developed and tested thoroughly. The facility would be designed to permit the isolation of the receiving pool or cell should contamination be noted at any time up to the release-for-return of the shipping cask.

Under normal operating conditions, the continued integrity of the encapsulated source would be monitored. Several techniques are available for this purpose. The integrity of the safety program is maintained by using at least two techniques to ensure rapid detection of leakage. If the sources are stored or used under water, a rapid and inexpensive monitoring procedure could be used. By continuously circulating some fraction of the water through a filter (deionizer or heat exchanger), the radiation level from the filter can be monitored and set to alarm at a level slightly above the normal background fluctuations.

Sources stored in air may be monitored in a similar manner by placing a radiation detector facing the exhaust filter. Because there must be a good ventilating system to ensure the rapid removal of the gases formed by the radiolysis of air, the system is an effective transport of contaminants and facilitates the rapid detection of leakage.

Most often, a combination of these two is used; that is, sources are stored under water and used in air. Monitoring of both locations is then the normal and most effective technique.

g. Emergency Procedures

Radiation monitors, access limiting devices such as electrical interlocks and shielded walls reduce the probability of radiation exposure. However, emergency procedures would be prepared and emergency instruction given to operating personnel, local hospital staff, and civil defense teams. The type of accident that could happen would almost never involve more than one or two people, but all personnel would be trained to respond in the proper mode. Written procedures, including those for evacuation, would be available for use in the event of an indicated over-exposure of personnel.

4.2.3 Facility Safety Records

CH2M Hill (1987) discussed the safety records of many facilities. This discussion follows.

> The past several decades of plant operation have shown that with proper design and operating procedures, commercial irradiators can be operated safely without significant radiation risk to workers or the public (Cunningham in CH2M Hill 1984). Although the overall safety record has been good, this section addresses prior failures of radiation safety programs in large irradiators, and what steps were taken to ensure that the failures did not recur.
>
> In the United States, there have been two personnel over-exposures to radiation occurring in hot cells (research laboratories for remote handling of radiation materials) or irradiators. Both exposures occurred when workers failed to follow proper operating procedures.

> The first incident occurred in 1975 at a hot cell in Parsippany, New Jersey. The hot cell was connected via a transfer tube to a storage pool located in an adjoining room. Cobalt-60 sources were transported back and forth between storage and the hot cell as needed. After one experiment, the operator neglected to put all the sources back into storage. He entered the hot cell with a quantity of the source still unshielded and received a dose of 1 to 4 Sv. The exposed individual survived the exposure and later returned to work (Dietz 1986).
>
> At that time, safety standards for hot cells were less stringent than for irradiators. After the incident, the NRC reviewed the sequence of events and began drafting amendments to the regulations that would prevent a similar recurrence. Before the amendments were incorporated, however, a second overexposure occurred at a different facility.
>
> The second incident occurred in 1977 at a facility in Rockaway, New Jersey (NRC 1988). In this incident, an employee bypassed a safety device in violation of licensed operating procedures by rendering the personnel access door interlock system inoperable. The employee then entered the irradiator chamber to perform maintenance while the radiation sources were unshielded and received a whole-body dose in the range of 1.5 to 3 Sv.
>
> The NRC subsequently issued amendments to the regulations, primarily in the form of subitems in paragraph 20.203(c)(6) of 10 CFR Part 20. These amendments require administrative procedures and automatic systems, including control devices, alarms, and signals, to ensure that a worker cannot enter the irradiation cell when the radiation sources are unshielded. These requirements of the safety systems and radiation control program are also addressed in the NRC licensing guide (NRC 1985a).
>
> Another overexposure occurred at a cobalt-60 irradiation facility in Norway in September 1982 (NRC 1983 and 1985b). This facility operated 24 hours per day with no attendants at night. During one night's operation, the sources failed to retract into the shielded position (mechanical failure) after a conveyor jam. The first worker arriving at the plant in the morning found a green indicator light and an unlocked door interlock (mechanical failure).

He entered the irradiation chamber while the source was in an unshielded position and received a fatal dose of radiation, dying 13 days later. Also contributing to the accident were that (1) a radiation monitor normally located in the maze was out for repair, (2) the worker did not avail himself of a portable radiation monitor, (3) the worker did not monitor other control console indicators which clearly showed that the source was unshielded. Thus, the cause of the accident was a series of mechanical failures and human errors. The lessons learned from this incident are:

- Individual safety features should not be relied upon to the exclusion of other safety features.
- All available information related to source position should be checked before entering the irradiation chamber.

Pool water contamination and pool integrity have occasionally become sources of radiological problems.

In one case, cobalt-60 capsules (pencils) were stored in close proximity to an unlined concrete irradiator pool wall. The wall suffered radiation damage to the extent that some pool water, which was contaminated, leaked out into the soil. Corrective measures now common in the irradiator industry and supported by NRC include adding an inner steel liner to the pool and instituting a groundwater monitoring program (NRC 1985b).

Cases of pool water contamination from cobalt-60 have occurred due to leaking capsules or contact with contaminated shipping casks. These incidents have historically been few in number and presented no significant acute radiation hazards. However, the economic consequences of cleanup have been substantial in isolated cases.

One incident of a leaking cobalt-60 source pencil occurred in 1975 in Rockaway, New Jersey. The leak was speculated to have been caused by a poor weld during pencil fabrication. The licensee attempted to clean up the pool water contamination without notifying NRC. Due to improper handling of the ion exchange resin used to filter the pool water, other areas

in the facility became contaminated. A civil penalty was attached to the licensee by NRC.

A second incident involved the previously mentioned hot cell unit in Parsippany, New Jersey in 1976. A capsule leak was detected when an operator noticed that the radiation level above the pool was slowly rising. The NRC was immediately contacted and all subsequent activities were closely monitored and approved by NRC.

The sources were transferred from the storage pool into the hot cell to isolate them from the contaminated water. The water was filtered through ion exchange units and released into the public sewer system only when the contamination levels of the water fell below NRC's specifications. A short time later, the facility, including the plumbing in the facility, was cleaned up and decommissioned prior to release for unrestricted use. No contamination was detectable in the public sewer system.

A third incident occurred at a plant in Dover, New Jersey, in December 1982 (CRA 1986a; The Energy Daily 1986). Increasing levels of radioactivity in the pool water indicated a leaking cobalt-60 pencil. The NRC was immediately notified of the leak and cleanup efforts were initiated.

During the cleanup, the licensee substituted the NRC-approved filtering system with one of their own that had not been approved. Improper use of the system combined with a break in the system's discharge line during unattended use caused most of the pool water to be pumped out of the pool and onto the floor of the facility. The licensee attempted to conceal the pool water release from the NRC for which the licensee was later indicted and convicted. Some of the contaminated water escaped into the surrounding soil. Although surveys of the soil and the groundwater by the NRC showed no significant radiation hazard, the economic burden to the licensee to decommission the facility was high.

Although source leaks have been known to occur with cobalt-60 pencils, NRC's experience has been that radiation hazard from these events is small if the leaks are reported and proper actions taken. The NRC has been taking vigorous enforcement action to motivate licensees to report radiological problems.

A leak of radioactivity occurred in early 1967 at the HDI at Fort Armstrong on Oahu. The cobalt-60 pencils were improperly shipped from the mainland to Oahu causing enough corrosion of the stainless steel encapsulation on some of the pencils to permit a small release of cobalt-60 into the shipping cask. During the source transfer operation at the HDI, about 9 curies of cobalt-60 escaped from the shipping casks into the storage pool water and was detected. When the contaminated cask and its load of pencils were lifted back out of the pool and through the roof of the building, a small amount · ˉcobalt dribbled onto the roof. Rain later washed it off the roof and onto a section of lawn. The contaminated soil was immediately placed into 55-gallon drums and shipped to the mainland for disposal (Clark, 1986). Thirteen years later, the irradiator was decommissioned and a small amount of residual radioactivity posing no significant radiation hazard was found.

In October 1980, an event occurred in Nebraska in which medical product passing by a radiation source for sterilization became jammed against the source plaque in such a way that the source plaque could not be returned to its storage position. In direct contact with the source pencils for a prolonged period of time, the product finally combusted. Although the damage threat was present, no actual loss of source integrity or personnel exposure occurred. Since the incident, licensing guidelines have specified preventative measures such as source plaque guards or conveyor/carrier covers which will not allow the product to come into contact with the source.

The NRC requires that the irradiator licensee strictly comply with government regulations and the facility license. Enforcement actions are taken for any deviation from approved procedure. One facility in Rockaway, New Jersey, had its license suspended twice in 1986 for deliberately and repeatedly bypassing certain safety interlock systems (NRC

G-3)

1986; CRA 1986a and 1986b). The need for such suspensions has been rare for the industry as a whole.

The preceding material has described some of the improvements in regulatory control and safeguard technology for irradiators during the last decade. The mandatory implementation of these controls and technology reflect prudent reaction by the regulatory agencies to past operational failures.

4.3 Source Transportation Hazards

The safety of transporting radioactive materials is evaluated in the NRC report entitled Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes (NUREG-0170). The report concludes that the total risk from all transportation of such materials is acceptably low. NRC has determined, after review of the subject, that the regulations are adequate to protect the public against unreasonable risks from the transport of radioactive materials (46 FR 21619, April 13, 1981). NRC believes such shipments can be made safely because licensees shipping radioactive material for use in irradiation facilities are required to comply with a NRC regulatory program.

Isotopic source materials are permanently packaged in the form of welded, sealed sources. These are transported in accident-resistant packaging (casks). There has never been a release of radioactive materials from one of these packages in the United States as a result of a transportation accident, even when transporting powders, liquids, or gases. The transportation of sealed sources would make a release even more unlikely (FDA in CH2M Hill 1986).

U.S. transportation regulations are based on three principles:

1. Release prevention should depend entirely upon the package and not in any way on special handling or routing or upon the training or performance of transportation personnel.

2. The protection should be appropriate for the amount and form of radioactivity involved.

3. The package design and construction should be proven effective through engineering analysis, testing, or a combination of both.

Type B containers would be used to transport (probably by ship) the isotope to the irradiator in Hawaii. These transportation casks meet extremely stringent standards. They must survive (using analysis, actual testing, or both) the following tests without a significant loss of shielding or loss of contents:

In addition to packaging regulations, regulations are established by the NRC and by the U.S. Department of Transportation (U.S. DOT) in the areas of physical transport of isotope, driver training, component certification, and quality assurance of packaging to ensure that other related activities important to safety are properly conducted.

Table 4-3 identifies possible source transportation accidents, mitigation methods and worst-case consequences.

Table 4-3

POTENTIAL ACCIDENT SCENARIOS

Accident	Mitigation/Worst-Case Consequence
Source Capsule Transportation	
1. Highway accident	Licensed transportation cask/None[a]
2. Fire on transportation vehicle	Licensed cask/None[a]
3. Accident at sea	Licensed cask/None[a]

[a]Based on the testing and licensing regiments of the NRC to ensure public safety in the transportation and use of these isotopes, and as best can be determined from reasonable assumptions about credible scenarios, the risk approaches zero.

Source: CH2M Hill 1987

The position of the American Nuclear Society (ANS) is that:

1. The existing radioactive material transportation regulations are adequate to ensure a very high degree of public safety.

2. The technology is available and in use to design, manufacture, and evaluate equipment used in safely transporting radioactive materials.

3. The risks involved in transporting radioactive materials are very small when compared to other risks in our society and when weighed against the societal benefits of those materials (CH2M Hill 1987).

The responsibility for responding to and dealing with a transportation accident has been determined and assigned throughout the country by the Federal Emergency Management Agency (FEMA), which has the lead in coordinating emergency planning and response. Federal agencies have been assigned the responsibility by FEMA for assisting state and local governments in their radiological emergency planning and preparedness activities. FEMA has also provided guidance for developing response plans and preparedness if there should be transportation accidents involving radioactive materials.

Transportation of radioactive isotopes is highly regulated on both the federal and state levels. As mentioned previously, both U.S. DOT and NRC have regulatory requirements (49 CFR Parts 100-177 and 10 CFR Part 71, respectively) that govern all aspects of transportation in detail, from quality assurance in accident-proof packaging to requirements for posting information that is clearly visible on casks and trucks. The approach used by the NRC, U.S. DOT, and the states has been effective in ensuring safety (FDA 1986; Jefferson 1985).

4.4 External Hazards Assessment

This subsection summarizes the results of an examination of the potential risks associated with operation of a food irradiation facility at three proposed sites in Hilo, Hawaii. Because the facility has not yet been designed, detailed assessment of risks is not possible. Consequently, our approach has been to identify incidents that could have significant consequences, and then do bounding calculations on the risks associated with those incidents. This subsection addresses the risks of public exposure and environmental contamination associated with external events.

4.4.1 The Concept of Risk

Quantitative risk assessments are used to support decision-making in many areas. A risk assessment identifies those events that have significant consequences and are sufficiently likely to occur that some type of corrective action is warranted. Risk is usually defined as the product of the frequency (or probability) of an event and the consequence associated with the event. Risks are controlled by designing, locating, and operating facilities to minimize, where practical, the probability of events that cause damage, the consequences of damage, or both. Consequences may include economic loss, health effects, contamination of land or water resources, etc. For this assessment, the consequence of concern is exposure of workers and the general public to the radiation from the cobalt-60 source.

4.4.2 Scope of External Events Risk Assessment

A complete assessment of the potential hazards posed by the effects of external events on nuclear facilities covers a wide range of events including fire, flood, earthquake, etc. (NRC 1983). In this assessment we have used available information about the characteristics of the source and structure to eliminate from consideration those types of events that have little or no potential for causing release of radioactive material from the facility or exposure of personnel to radiation from the source. In this section we develop the rationale used in determining which external events require assessment at this stage.

As long as the inner and outer source capsules remain intact and adequate shielding is maintained between the source and people in or near the facility, the source does not represent a radiation hazard. In this assessment, we have examined the ways that the integrity of the capsules or the shielding could be compromised. It is possible that the integrity of both the inner and outer source capsules could be lost as a result of corrosion, crushing, or melting. Corrosion could be caused by an improper weld, crushing or melting by catastrophic external events. Adequate shielding might be lost if the shield pool were drained (creating a potential for worker exposure only) or if the building were breached when the source is in the raised position (creating a potential for worker and public exposure).

Corrosion of the source pencils is highly unlikely due to the stringent quality controls applied in their manufacture and the materials used. If it should occur, the pool water could become contaminated; however, the amount of material released to the pool would be

small. Cobalt is a hard, brittle metal. It would not dissolve or react rapidly if it came into contact with the water. If corrosion products were released to the pool, radiation monitors in the pool water recirculation system would indicate the presence of contamination, and the facility would have to be decontaminated. Corrosion of the source pencils is a hazard only if it occurs simultaneously with another safety system failure such as a breach of the pool by an external event.

There is no internal energy source that can cause loss of integrity of the capsules or the building structure. Thus, if an external event is to cause a release, all the energy required to disperse the radioactive material must come from the external event. Crushing the source pencils would require the direct application of intense pressure. Melting and dispersing the source pencils would require application of intense heat. Therefore, only external events that can damage the structure or produce severe pressure or temperature environments were considered in the assessment.

Based on the foregoing considerations of source and structure characteristics, the external events assessment has included the following types of events:

- Aircraft Crashes
- Flooding and Tsunami
- Industrial/Military Accidents
- Transportation Accidents
- Seismic Activity
- Volcanic Hazards

4.4.3 Aircraft Crash

4.4.3.1 Introduction

The purpose of this analysis is to estimate the probability of an aircraft crash into three proposed food irradiator sites near General Lyman Field, Hilo, Hawaii, and the potential damage that such crashes might cause. Three classes of aircraft were studied -- (1) commercial airliners, (2) large-winged military aircraft, and (3) small-winged military aircraft. Small, general aviation aircraft and helicopters were not considered in this analysis because they do not have sufficient energy to cause damage to the irradiator facility structure.

4.4.3.2 Probability of Aircraft Crash Into Facility

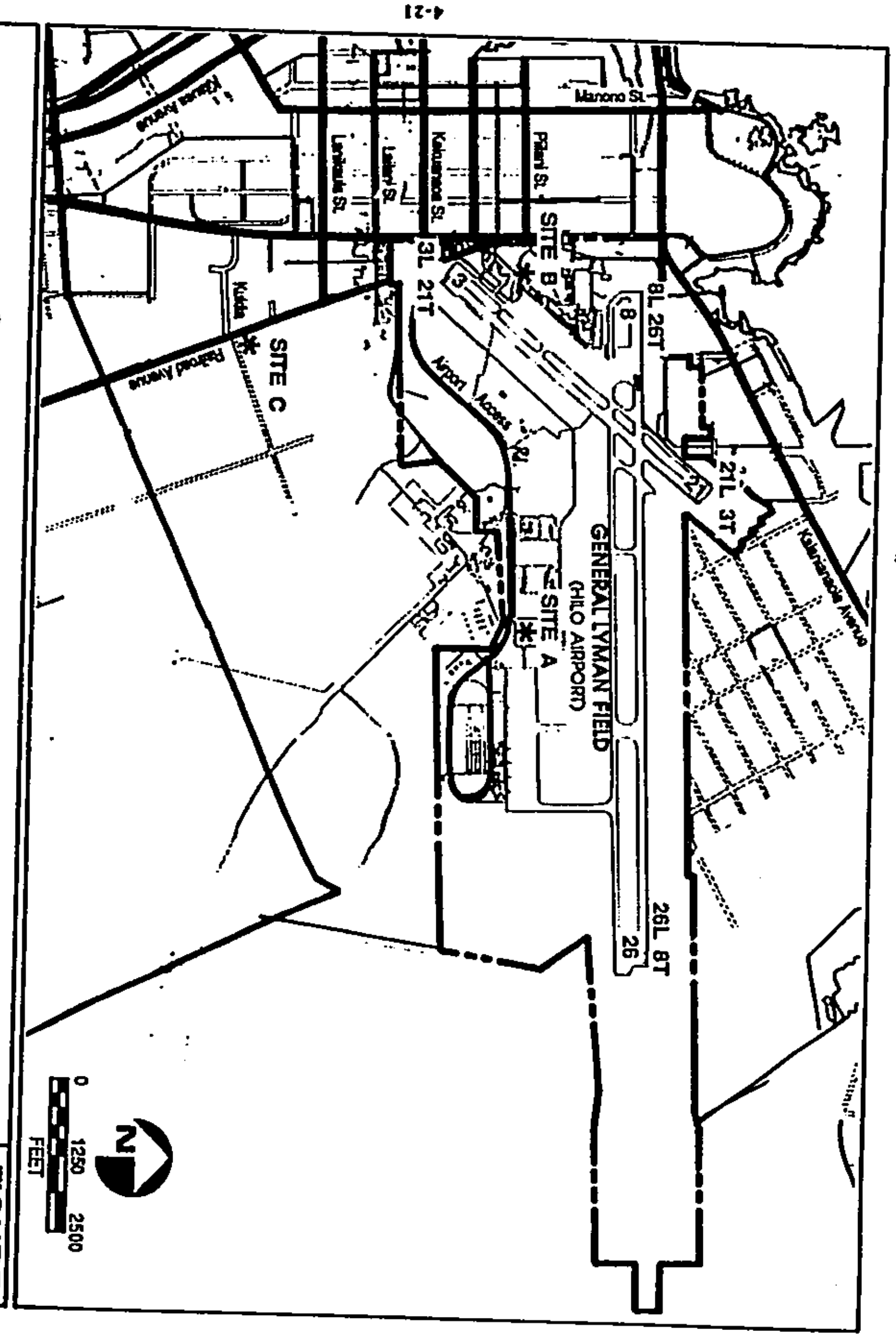
The methodology used to estimate aircraft crash probabilities was developed by Sandia National Laboratories (Smith 1983). A general aircraft crash equation is expressed as follows:

$$P = N \times P_N \times c(a) \times e^{\frac{-|x|}{\theta(x,a)}} \times e^{\frac{-|y|}{\theta(y,a)}} \times A$$

where:

- P = annual probability of an aircraft crash at a site;
- N = number of operations (take-offs or landings) from a runway (per year);
- P_N = probability of an aircraft crash during take-off or landing;
- c(a) = crash density constant as a function of type of operation (take-off or landing);
- x = perpendicular distance (in miles) from the centerline of the runway (or its projection) to the site;
- y = perpendicular distance (in miles) from the threshold end of the runway (or its projection) to the site;
- $\theta(x,a)$ = crash density constant as a function of x and type of operation (take-off or landing);
- $\theta(y,a)$ = crash density constant as a function of y and type of operation (take-off or landing); and
- A = effective crash area (in square miles) as a function of building and aircraft size.

A site plan of General Lyman Field and the three proposed sites for the irradiator facility is shown in Figure 4-1. Table 4-4 gives coordinate distances (x and y) from each site to the end of each runway that contributes to the probability of crash at the site. The ends of each runway are labeled to designate take-off and landing directions. For example, the end of the runway nearest to Site B handles landings on Runway 3 (3L) and takeoffs on Runway 21 (21T). Only operations at the end of the runway nearest a site are considered as contributors to the probability of crash into the site.



General Lyman Airfield and Proposed Irradiator Sites (4)

FIGURE 4-1

WESTEC Services, Inc.

Table 4-4

DISTANCE FROM EACH SITE TO EACH RUNWAY (MILES)

	Site A X	Site A Y	Site B X	Site B Y	Site C X	Site C Y
Runway 8	----	----	0.343	0.0746	1.209	-0.179
Runway 26	0.373	-1.015	----	----	----	----
Runway 3	----	----	0.179	-0.194	0.567	0.298
Runway 21	0.716	-0.134	----	----	----	----

Table 4-5 lists the number of take-off and landing operations (N) for each runway for each class of aircraft that was considered in this study (Belt Collins & Associates 1987).

Figure 4-2 shows the aircraft take-off and landing crash impact zones defined in the methodology used in this study. All of the sites proposed for the irradiator facility are in zones I or II for each runway at General Lyman Field. Table 4-6 presents the probability of crash per operation (P_N) and crash density constants (c(a), Θ(x,a), Θ(y,a)) for military and commercial aircraft during take-off and landing.

The effective crash area (A) is a function of the size of the building, the skid distance of the aircraft, and the shadow angle of the building. The effective crash area is given by the following equation:

$$A = (L + Aw) \times (W + Sk + H \times \cot o)$$

where:

- L = length of building (miles)
- Aw = aircraft wing span (miles)
- W = width of building (miles)
- Sk = skid distance of aircraft (miles)
- H = height of building (miles)
- o = aircraft crash attitude angle (assumed to be 15o)

Table 4-5

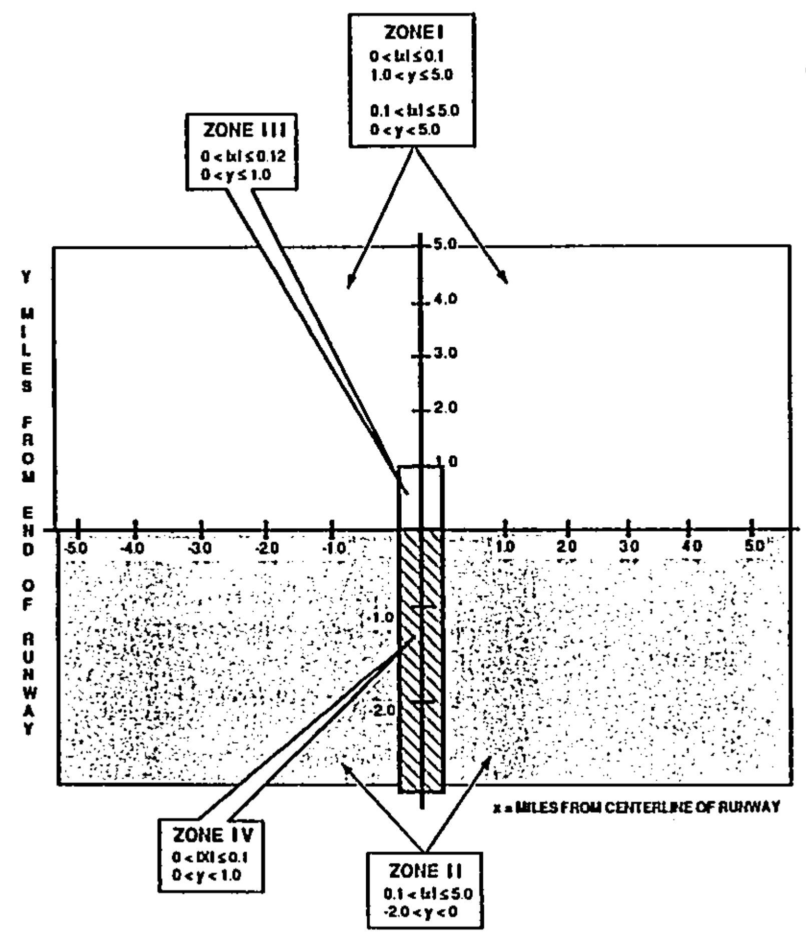
FLIGHT OPERATIONS AT EACH RUNWAY (PER YEAR)

	Commercial Arrival Operations	Commercial Departure Operations	Military Large Arrival Operations	Military Large Departure Operations	Military Small Arrival Operations	Military Small Departure Operations
Runway 8	5041	7347	2274	2986	1088	1537
Runway 26	5504	3548	3376	2245	1042	599
Runway 3	0	0	106	526	29	1310
Runway 21	376	0	106	106	1106	201

Table 4-6

AIRCRAFT CRASH PROBABILITY PARAMETERS

	Probability per Operation	Zone 1 C(A)	Zone 1 Θ(X,A)	Zone 1 Θ(Y,A)	Zone 2 C(A)	Zone 2 Θ(X,A)	Zone 2 Θ(Y,A)
Commercial Arrival	2.3×10^{-6}	0.28	0.7	1.4	0.014	0.7	1.4
Commercial Take-off	6.0×10^{-7}	0.28	0.7	1.4	0	---	---
Military Arrival (Large or small wing)	3.1×10^{-6}	0.11	1	3	0.006	1	3
Military Take-off (Large or small wing)	1.6×10^{-6}	0.043	3	3	0	---	---



Aircraft Take-off and Landing Crash Impact Zones (3)

FIGURE 4-2

Table 4-7 contains the data used to calculate effective crash area for commercial, large-, and small-winged military aircraft. Table 4-8 presents the effective crash areas for each type of aircraft.

Tables 4-9 through 4-11 present the annual probabilities of each class of aircraft crashing into each proposed irradiator site during take-off and landing. Cumulative figures indicating the total annual aircraft crash probability at each site are also provided.

4.4.3.3 Effects of Aircraft Crash on Facility

Two types of effects are considered in this section: the damage caused directly by impact of aircraft and the damage caused by explosion of bombs carried by military aircraft impacting on the facility. Conservative assessments are provided for these effects.

Aircraft Impact

In order to determine whether or not an aircraft crash could potentially breach the structure, a missile penetration model was used. (Bennett and Finley 1981). The aircraft were idealized as hard missiles. A forward diameter of the plane was selected as representative, and the mass of the plane was then packed into a bullet-shaped missile with the representative diameter to see whether it would penetrate the structure.

This is a very conservative approach since an aircraft is relatively fragile and of low density. Upon impact, much of an airplane's kinetic energy is absorbed by the internal structure of the aircraft as it is destroyed. Additionally, this model is designed for small projectile penetration of concrete structures. While the added strength due to reinforcing in the concrete is considered in the general sense, the model is designed for a projectile which is small compared to the gaps between reinforcing materials. In the case of aircraft impact with the structure the "rebar" mesh would actually behave more like an elastic net with the ability to absorb a great deal of energy before total structural failure occurred.

Table 4-7

EFFECTIVE CRASH AREA DATA (IN MILES)

Facility Length (L)	0.015589
Facility Width (W)	0.007794
Facility Height (H)	0.003231
Sk Commercial (Skid Distance for Commercial Aircraft)	0.171102
Sk Millitary (Skid Distance for Military Aircraft)	0.190114
Aw Commercial (Wing Span for Commercial Aircraft)	0.026615
Aw Military (Wing Span for Large Wing Military Aircraft)	0.028517
Aw Military (Wing Span for Small Wing Military Aircraft)	0.007604

Table 4-8

EFFECTIVE CRASH AREA FOR EACH CLASS OF AIRCRAFT (SQUARE MILES)

Effective Area (Commercial)	0.0081
Effective Area (Millitary Large Winged)	0.0093
Effective Area (Military Small Winged)	0.0049

Table 4-9

ANNUAL PROBABILITY AT SITE A OF AN AIRCRAFT CRASH

Runway	Operation Type	Commercial Aircraft	Large-winged Military Aircraft	Small-winged Military Aircraft
26	Landing	4.1×10^{-7}	2.9×10^{-7}	6.3×10^{-8}
8	Take-off	0	0	0
21	Landing	3.2×10^{-8}	8.5×10^{-9}	4.7×10^{-8}
3	Take-off	0	0	0

Total Annual Probability of an Aircraft Crash into Site A = 8.5×10^{-7}

Table 4-10

ANNUAL PROBABILITY .T SITE B OF AN AIRCRAFT CRASH

Runway	Operation Type	Commercial Aircraft	Large-winged Military Aircraft	Small-winged Military Aircraft
3	Landing	0	1.4×10^{-8}	2.1×10^{-9}
21	Take-off	0	0	0
8	Landing	1.5×10^{-5}	5.0×10^{-6}	1.3×10^{-6}
26	Take-off	2.8×10^{-6}	1.2×10^{-6}	1.8×10^{-7}

Total Annual Probability of an Aircraft Crash into Site B = 2.5×10^{-5}

Table 4-11

ANNUAL PROBABILITY AT SITE C OF AN AIRCRAFT CRASH

Runway	Operation Type	Commercial Aircraft	Large-winged Military Aircraft	Small-winged Military Aircraft
3	Landing	0	1.7×10^{-7}	2.5×10^{-8}
21	Take-off	0	5.1×10^{-8}	5.1×10^{-8}
8	Landing	2.1×10^{-7}	1.1×10^{-7}	2.8×10^{-8}
26	Take-off	0	0	0

Total Annual Probability of an Aircraft Crash into Site C = 6.5×10^{-7}

Four different aircraft were selected as being representative of those using General Lyman Field:

B737-200	Most frequent commercial plane
P-3	Most frequent military plant
C-5	Largest military plane
F/A-18	High performance military plane

The weight used was the maximum takeoff weight of the aircraft. The velocity considered was the minimum takeoff or stall velocity. The data used in the calculations are shown below:

Aircraft	Weight(kg)	Velocity(km/hr)	Diameter(m)
B737	52,390	189	4
P-3	61,235	208	3.4
C-5	379,657	193	8.2
F/A-18	22,328	248	1.6

The results of the analysis reveal either perforation (the creation of a hole) or spalling of the concrete. In no case did the missile penetrate the concrete.

The levels of damage that would be expected are as shown below:

Aircraft	Penetrate	Perforate	Spall
B737	No	Yes	Yes
P-3	No	Yes	Yes
C-5	No	No	Yes
F/A-18	No	Yes	Yes

The aircraft that represents the greatest challenge to the structure is the P-3. The P-3's smaller effective diameter, higher velocity and relatively large mass all contribute to its ability to penetrate. The C-5 with its mass spread over a larger cross sectional area is the least challenging to the facility.

Under these very conservative conditions, in no case did the "aircraft" actually penetrate the facility. Consequently, no kinetic energy was available to cause direct damage to the cobalt sources due to the aircraft crash.

In three cases, a hole (perforation) was made in the concrete outer surface. We believe that more realistic calculations would show that the level of actual damage is less than predicted in this conservative assessment. Likewise, careful design of the facility structure with adequate reinforcing will reduce the amount of spalling that would occur to the inside wall of the facility on impact. The spalling could potentially damage the cobalt source or foul the mechanism that allows the source to be returned to the pool.

Bomb Impact

[Note to reader: Subsequent to preparation of this analysis, data was provided by the State of Hawaii Department of Defense that states that munitions, including bombs, are no longer transported through General Lyman Field (State of Hawaii Department of Defense - Lum consultation). Thus this potential risk is no longer applicable. This analysis is left in the report to provide information if military operations change.] Military aircraft operating in the vicinity of the irradiator sites may be carrying conventional high explosive (HE) bombs. If an aircraft carrying a bomb crashes into the facility, it is possible that the bomb would detonate on impact. We were unable to obtain information on the specific types of munitions carried by aircraft taking off or landing at General Lyman Field or the frequency of munitions-bearing flights. Consequently, we can only bound the probability of impact into the facility by an aircraft carrying a bomb by assuming that all military aircraft crashes involve bombs. Thus the probability of a large bomb impacting the sites is taken from Tables 4-9 through 4-11 to be the sum of large- and small-winged military aircraft crash probabilities. The results are summarized in Table 4-12.

Table 4-12

UPPER BOUND BOMB IMPACT PROBABILITY

Site	Bomb Impact Probability
A	4x10-7 per year
B	8x10-6 per year
C	4x10-7 per year

We assume that aircraft that crash into the site would not be carrying armed munitions. However, the impact would be sufficient to cause HE detonation in at least some cases. To be conservative, we assume that the conditional probability of detonation given impact is 1.0. Thus, the upper bound probability of detonation of a bomb on each site is given in

Table 4-12. Additional effort would be required in order to develop more realistic estimates of detonation probability.

In order to bound the possible effects of bomb impact, we estimated the damage that might be done to the facility by detonation of the types of general purpose (GP) bombs commonly carried by military aircraft. The wall thickness that an explosive charge will penetrate is defined as its breaching radius. (Department of Army 1967). The bombs assumed to be representative of those likely to be carried on the aircraft that operate in the area, their physical characteristics, and their breaching radii are listed in the following table:

Weapon	Weight (kg)	HE Weight (kg)	Breaching Radius (ft)
Mk82	241	87	5.2
Mk83	447	202	7.5

The Mk82 (500-pound) bomb would likely cause significant damage to the wall or roof of the irradiator structure, but it would not be expected to penetrate either surface. There would be considerable spalling from the inner surface that could potentially damage the source if it were in the raised position. The detonation of a Mk83 (1000-pound) bomb on the surface of the irradiator structure would be expected to breach the wall and release significant energy inside the structure.

4.4.3.4 Maximum Expected Dose Due to Aircraft Crash

An aircraft crash could cause exposure of facility workers and the public in two ways: dispersal of radioactive material and reduction of the shielding surrounding the source. The following sections discuss the potential hazards associated with these exposure mechanisms.

4.4.3.4.1 Dispersal of Radioactive Material from the Facility

Two bounding scenarios have been identified for dispersal of radioactive material from the irradiator facility as a result of aircraft crash. Both scenarios involve the crash of a military aircraft into the facility and detonation of a large high explosive bomb on the structure. In the first case we consider the dispersal of cobalt-60 as a result of the bomb explosion. In the second case we assume that the aircraft fuel is released inside the irradiator building and subsequently burns, thereby dispersing the radioactive material.

Explosive Dispersal

Resources were not available to perform detailed assessments of the amount of energy coupled into the facility in the event of detonation of a bomb at the surface or to estimate the resulting damage to the source pencils. We have used data on the potential dose produced by explosive dispersal of cobalt-60 metal to estimate the radiation dose that might result from bomb detonation. (Altman and Hockert 1988) The referenced work indicates that a large quantity of explosives detonated in contact with 1,500,000 curies of cobalt-60 metal could result in a 50-year effective dose commitment of 25 rem for the maximally exposed individual at a distance of 1 km. This level of dose commitment is generally presumed to have no adverse health effects.

The dose should scale with source strength. Since the irradiator source is an order of magnitude smaller than the one considered in (Altman and Hockert 1988), an individual 1 km away from one of the irradiator sites could receive approximately a 2.5 rem exposure over 50 years if the bomb exploded adjacent to the source material. Dose does not scale directly with distance, so individuals closer to the source would receive relatively higher doses. However, the amount of material released would be significantly less than modeled in (Altman and Hockert 1988) because the explosive is not in direct contact with the cobalt-60. We cannot estimate the expected dose commitment at points near the boundaries of the proposed sites without additional analysis, but our judgement is that the dose resulting from material dispersal by detonation of a large bomb on the facility would be no more than a few rem at the site boundary (approximately 100 feet from the irradiator). We will use 10 rem as an estimated upper bound on the 50-year dose commitment of an individual at the site boundary due to material dispersed by bomb detonation. This dose level would present no appreciable health hazard to exposed individuals.

The direct effects of the detonation of a 1000-pound bomb w[illegible]ld be more significant than the potential health effects associated with release of material from the irradiator. Overpressures of 55 to 65 psi are lethal. (White and Richmond 1959). A 1000-pound bomb would produce 55 psi out to a distance of about 40 feet from the explosion and would produce pressures capable of destroying structures at considerably greater distances (Department of the Army, 1984) Flying debris created [illegible] the explosion would also be potentially lethal to individuals in the vicinity of the site. Anyone close enough to the facility to receive even a small dose of radiation from the dispersed material would be likely to be killed by the effects of the blast. (Finley 1980).

Fire Dispersal

The second case considered for dispersal of radioactive material from the irradiator facility requires a crash of a military aircraft into the facility, detonation of a large bomb upon impact, release of the aircraft fuel into the irradiator structure, and ignition of the fuel. In this case, the heat from the burning fuel provides a driving force for dispersing radioactive material.

In order to release radioactive material in this accident, the blast will have to cause substantial damage to the source pencils. Petrochemical fuels burn at temperatures of approximately 1250 degrees C. The melting point of stainless steel is around 1450 degrees C and the melting point of cobalt is 1495 degrees C. The only possibility for releasing radioactive material in the fire is if the pencils are crushed, the cobalt is reduced to fine powder, and the powder is entrained in the plume from the fire. As discussed above, we cannot estimate the degree of damage to the source pencils without additional analysis, but is highly unlikely that the pressures inside the structure will be high enough to crush the stainless steel and zircalloy capsules and the cobalt slugs.

An experimental study of accidents involving sealed sources determined that the release fraction for finely divided cobalt-60 powder placed in an intense fire is on the order of 10^{-4} (NRC 1985). If all 150,000 curies of the source were pulverized by the detonation and burned in the fire, the quantity released would be about 15 curies. The estimated dose to the public in the Reference 11 study, scaled to the irradiator size source, would be between .03 and 3 rem. The total dose depends on the population density in the vicinity of the site, meteorological conditions, and other factors which we are not able to model in this assessment; however, it is clear that dose commitments due to dispersed material would be insignificant for the actual conditions of an aircraft crash, bomb detonation, and fire at the irradiator facility. As a comparison with the explosive dispersal case, we estimate that an individual exposed for 8 hours at a point 1 km from the irradiator would receive a dose commitment of about 0.1 rem. Our judgment is that an individual at the site boundary would receive a 50-year dose commitment of no more than 10 rem due to material dispersed by fire. These exposure levels represent no significant health hazard.

4.4.3.4.2 Reduced or Breached Shielding

Both the impact of an aircraft on the facility and the detonation of a bomb at the facility surface could damage the structure, thereby reducing its shielding effectiveness in the region adjacent to the impact location. The possible exposure of workers and the public as a result of reduced shielding is discussed below.

Aircraft Impact

Aircraft impact is not expected to breach the facility structure; however, such an impact could crater the exterior surface and cause spalling from the interior surface. If the source was in the pool at the time of the crash or if it could be immediately lowered into the pool, there should be no exposure resulting from the incident. If the source was in the raised position and could not be lowered, emergency response personnel, facility workers, and the public who come within line-of-site of the damaged area might be exposed to unacceptable levels of radiation. We are not able to estimate the magnitude of possible exposures at this level of project development.

Bomb Impact

The damage to the exterior surface caused by a 500-pound bomb could significantly reduce shielding in the area adjacent to the impact location but should not penetrate the structure. If the source was in the pool at the time of the impact or if it could be lowered immediately following the impact and the pool water level could be maintained, there should be no radiation exposure resulting from detonation of a Mk82 GP bomb on the facility surface. If the source was in the raised position, the dose levels would probably be high enough to complicate emergency response operations and create off-site public exposure. The actual dose levels and possible health effects resulting from partial penetration of the structure cannot be estimated without additional analysis.

Detonation of a 1000-pound bomb would likely penetrate the structure. If the source was in the pool and the pool water level could be maintained, there should be no radiation exposure even from this severe incident. If the source was in the raised position or if the pool water was lost, then there could be exposure of personnel in the vicinity of the facility. As a limiting case, we assume that the source remains intact and in the raised position.

Under these conditions, an individual 1 km from the site would receive a dose of about .04 rem in 8 hours, with negligible health effects. An individual at the site boundary is estimated to receive a maximum dose of about 175 rem per hour if in direct line of sight with the source. The health effects of exposures of this magnitude would be severe. If some of the source pencils are dislodged so that the entire source is not in line with the hole, or if debris obscures the hole, dose levels would be lower. More precise estimates of dose levels and public health effects would require additional project development and analysis.

4.4.3.5 Bounding Estimate of Risk Due to Aircraft Crash

We used bounding estimates of the probability of events that could cause release from the facility, and dose estimates from previous studies extrapolated to the irradiator facility problem on the basis of engineering judgement, to bound the expected risk to an individual exposed to the material released from the site. The results for dispersal of material are summarized in Table 4-12 and the results for reduced or breached shielding are summarized in Table 4-14.

The upper bound release or exposure probabilities are taken from Table 4-12. The dose estimates are based on the discussion in Section 4.4.2.4. We have estimated the 50-year dose commitment at the site boundary (100 feet or so from the irradiator) due to dispersed material to be no more than about 10 rem for explosive dispersal or fire dispersal. The resulting health effects are expected to be negligible.

We estimate that if the shielding were breached, exposures at the site boundary in-line with the breach could be as high as 175 rem per hour. This level of exposure would be hazardous to personnel in the vicinity of the breach. Dose levels for cases in which the shielding is reduced, but not breached, can not be estimated without additional analysis. However, it follows that the dose levels cannot be greater than the levels estimated for the case in which the structure is breached.

Table 4-13

ESTIMATED DOSE COMMITMENTS FOR BOUNDING AIRCRAFT CRASH SCENARIOS (DISPERSED MATERIAL)

	Annual Probability		Estimated 50-year Dose Commitment of an Individual: 1 km	Site Boundary	Resulting Health Effects
Explosive Dispersal	Site A Site B Site C	4×10^{-7} 8×10^{-6} 4×10^{-7}	2.5 rem	10 rem	Negligible
Fire Dispersal	Site A Site B Site C	4×10^{-7} 8×10^{-6} 4×10^{-7}	0.1 rem	1 rem	Negligible

Table 4-14

ESTIMATED DOSE FOR BOUNDING AIRCRAFT CRASH SCENARIOS (REDUCED OR BREACHED SHIELDING)

	Annual Probability		Estimated Dose to an Individual: 1 km	Site Boundary	Resulting Site Boundary Health Effects
Reduced Shielding	Site A Site B Site C	8×10^{-7} 2×10^{-5} 6×10^{-7}	<5 mrem/hr	<175 rem/hr	Negligible to Severe*
Breached Shielding	Site A Site B Site C	4×10^{-7} 8×10^{-6} 4×10^{-7}	5 mrem/hr	175 rem/hr	Severe

*Depending upon the amount of shielding that remains.

It is also possible that the blast would dislodge pencils from the source plaque. If any of the pencils were thrown intact outside the structure, they would represent a significant radiation hazard to people in the area. We have not estimated possible dose levels for this situation, but they would be less than those estimated for the entire source at the same distances. However, the area over which the dose could be received could be much greater than for the case in which the radiation is streaming through a hole in the shielding structure. Additional analysis would be required to assess whether depositing intact pencils outside the facility is a credible event and to estimate dose levels.

While we have not done the detailed consequence calculations necessary to estimate public health effects, we can compare the situation modeled as a bounding case in this assessment with one for which detailed calculations were done. Finley et al. (1980) addresses the release of cobalt-60 from a shipping container in New York City as a result of an explosive sabotage attack. In one situation modeled in Finley et al. (1980), 160 curies released from the container was estimated to cause no early fatalities (within one year of exposure), less than one illness appearing within weeks of exposure, and from 2 to 34 latent cancer fatalities (occurring any time subsequent to exposure). These estimates are based on an exposed population density characteristic of New York City (tens of thousands of people per km^2). The much smaller population density near the irradiator sites and the smaller amount of cobalt-60 expected to be released mean that the consequences due to dispersed material for the bounding irradiator accidents would be much less than those estimated in Finley et al. (1980). This provides additional support for our judgement that the health effects caused by dispersal of radioactive material would be negligible for our bounding cases.

Finley et al. (1980) also address the health effects caused by direct exposure of people near the site of a transportation accident to the radiation produced by an undispersed source. In the incident modeled, the entire contents of a shipping container (200,000 curies of cobalt-60) were assumed to be placed in the middle of the street so that pedestrians and motorists were exposed for 15 minutes. In this case, several early fatalities and several hundred early illnesses were predicted. This case is somewhat analogous to the situation in which an aircraft crash into the facility damages the structure, thereby reducing the shielding in the area of the impact. If the source is in the raised position, people in line with the damaged area could receive significant exposures. Again, the number of people exposed and the exposure levels would be much smaller for the case we are addressing;

thus, the actual health effects would be much less. Additional analysis is required to estimate health effects of reduced or breached irradiator shielding.

4.4.4 Flooding and Tsunami Hazard

Siting of any facility in a flood-prone area increases risk. These risks are generally managed by siting the facility outside the zones affected by flooding, or by physically flood proofing the structure. The three sites under consideration for the food irradiator have been identified by the Federal Emergency Management Agency (FEMA) as being in Zone C, "Areas of Minimal Flooding." The minimal flooding characteristics of the potential site locations along with the limited effects of flooding on potential shielding loss or dislocation of the source combine to eliminate this hazard from further consideration.

Hilo, however, has been affected greatly in the past by tsunami-induced flooding. The risk to tsunami damage has been raised as a potential concern affecting the siting of the irradiator facility at Hilo Airport. CH2M Hill researched official flood maps prepared and maintained by the Corps of Engineers for the FEMA. CH2M Hill determined that all potential airport cargo facility sites closest to areas that could be affected by any tsunami are out of the tsunami inundation line. Based on this information, the risk of the facility to tsunami damage is nonexistent.

4.4.5 Industrial/Military Accidents

4.4.5.1 Introduction

Industrial and military facilities near the proposed irradiator sites present potential hazards that must be considered in an assessment of the risks of radiation exposure. Only events that damage the irradiator facility structure have the potential for causing increased exposure levels or release of radioactive material. Therefore, we are interested in facilities in the vicinity of the proposed sites that may use or store materials that are capable of producing extreme pressure or thermal environments at the irradiator structure. This section discusses the hazards considered and the effects of those hazards on the irradiator facility.

In a thorough assessment of nearby hazards, a survey is made of the vicinity of the site to identify the locations and distances of industrial and military facilities, the nature and extent of activities conducted at those facilities, and the quantities of hazardous products and materials stored, used, or transported at each facility. For this assessment, we did not have a complete set of information on the nearby facilities. Instead, we obtained information available from employees of facilities known to be near the sites and from people familiar with the industrial activities in the area. From these sources we identified the installations that have the potential for producing hazards at the irradiator sites. In those cases for which we do not have precise information about the quantities of potentially hazardous materials stored near the sites, we performed bounding calculations to assess the damage potential for the types of hazards considered credible. None of the nearby facilities appear to present any risk of increased exposure or release of radioactive material from the irradiator sites.

Hazards normally considered in the evaluation of risks for nuclear facilities include toxic, flammable, and explosive materials. Toxic materials were eliminated from consideration in this assessment because we assume that no radiation exposure or release would occur even if the operators of the facility were incapacitated by exposure to toxic materials from a nearby accident. Consideration should be given in the design of the facility to ensure that this assumption is valid. Flammable materials were eliminated from consideration because previous studies have demonstrated that fires from off-site sources do not pose credible threats to heavy, reinforced concrete structures. (Bennett 1983). Thus, the only off-site hazards considered in this assessment are explosive materials.

4.4.5.2 Industrial Facilities

The industrial facilities in the Hilo vicinity that might have significant quantities of explosive materials are a propane bulk storage facility located about 1-1/2 miles northeast of the airfield and 1 mile north of Site A, the piers in Hilo Bay where propane barges dock about 1 mile from Site B, the HELCO power plant directly across Railroad Ave. from Site C where small quantities of propane are stored, and a quarry adjacent to Site C where explosives are stored and used. The quantities of propane present at each of the first three of these facilities is given in Table 4-15. The amount and type of explosive stored at the quarry is not known.

Table 4-15

AMOUNTS OF PROPANE STORED NEAR IRRADIATOR SITES

Facility	Amount Stored	Distance to Closest Site
Bulk Storage	15 30,000 gal. tanks 1 10,000 bbl. low press sphere. (2-phase mixture)	1 mile to Site A
Piers	9,000 bbl. barges	1 mile to Site B
HELCO Power Plant	Less than 2,000 gal.	1/4 mile to Site C

4.4.5.3 Military Facilities

The Keaukaha Military Reservation is located adjacent to the airfield. There are National Guard warehouses on the airport grounds and military training exercises in the vicinity of the airfield. We were unable to obtain information on the types and amounts of explosives stored and handled at the military facilities.

4.4.5.4 Maximum Propane Accident Environments

The propane explosion phenomenon at a propane storage facility 1 to 1-1/2 miles from the irradiator site was examined for two different conditions: release from a 30,000-gallon tank, and release from a 10,000-barrel low-pressure storage tank at the storage facility. The explosion of a 9000-barrel barge was also considered, but since the quantity was smaller than the low-pressure storage tank and the distance to the sites approximately the same, it was not developed further.

The phenomenology of the detonations of gaseous clouds is not well understood. The production of a potentially damaging shock front requires the release of a significant amount of combustible vapor, and a sufficiently strong initiation event such that a detonation occurs, instead of a slower process such as burning or deflagration. Work done by Sandia National Laboratories (Bennett and Finley 1981) estimates that an actual detonation will occur in only one of twenty vapor combustion events.

Similarly, the entire mass of flammable material contained within a given volume will not all be in a vapor cloud in the proper geometry awaiting the initiating event. Some will be in a liquid form and some in droplets suspended in the vapor. Depending on wind and temperature, some may be rapidly dispersed. The best-documented propane detonation referenced in the literature involved only about 7.5% of the total propane available. It is emphasized that "detonation in unconfined vapor clouds is an extremely unlikely event" (Bennett and Finley 1981).

The potential overpressures created by a propane explosion were estimated at a variety of ranges using standard techniques associated with the detonation of high explosive. This was done to see if there was sufficiently high overpressure at ranges of interest to warrant a more detailed analysis. The following assumptions were made:

1. The explosive equivalent weight of propane in a vapor form is 2.4 times its actual weight.
2. The density of propane liquid is 0.5 times the density of water.
3. The tanks at the storage area were filled to 85% of capacity.
4. The simultaneous detonation of multiple tanks at the storage area was considered an incredible event.

The overpressures associated with the detonation of the propane, subject to the above assumptions, were calculated using the techniques and charts outlined in Department of the Army 1984.

4.4.5.5 Results

The results of this preliminary screening for the sources at the storage site are summarized below. For each source, the quantity of propane, the HE-equivalent weight and the overpressure (peak positive normal reflected pressure) at selected ranges are shown in Table 4-16.

Table 4-16

OVERPRESSURE PRODUCED BY PROPANE-AIR EXPLOSION

	Overpressure (PSI)	
Range from Source	10,000-barrel tank (3.57 x 106 lbs HE-equivalent)	30,000-gallon tank (255,000 lbs HE-equivalent)
2 miles	1.2	0.15
1.5 miles	1.4	0.25
1.0 miles	2.5	1.2
0.5 miles	3.2	2.2

4.4.5.6 Conclusions

Despite the magnitude of the detonations involved (the 10,000- barrel tank with ideal detonation conditions would produce a blast equivalent of about a 2000-ton HE detonation), the impact on potential irradiator sites is minimal since the overpressure drops rapidly as a function of range from the detonation. While the detonation of one of the propane tanks could be devastating to nearby or less sturdy structures, the overpressures calculated above will not endanger the irradiator facility or cobalt-60 source. It is also important to restate that the amount of propane involved in the detonation is likely to be far less than the 85% of full volume as assumed above.

Without information on the type and quantity of munitions stored at the military facility, we are unable to directly address the impact of explosive accidents on military sites. However, it is unlikely that the stored munitions, if detonated, could cause overpressures at the irradiator sites greater than those produced by the propane transportation accidents described in the following section. Similarly, we can't assess the potential hazards associated with explosives storage at the quarry near Site C. T e explosives in the quarry are located well below the ground level of of the Site C facility. A major detonation of explosives at the quarry site is not expected to produce an overpressure at the irradiator site comparable to a propane tanker explosion. As discussed in Section 4.4.5, we have demonstrated that the detonation of a major fraction of a pr ane tanker as close as 10 feet from the facility would not cause structural damage. We con ude that explosives stored on the military site and in the quarry are not significant contributors to risks of radiation exposure or release from the irradiator sites.

4.4.6 Transportation Accidents

4.4.6.1 Introduction

Hazardous materials transported in the vicinity of the irradiator pose a potential threat to its safe operation in the same way that nearby facilities do. Using the same rationale as presented in Section 4.4.4 of this report, we eliminated from consideration all transportation accidents except those involving explosive materials. The only types of explosive materials thought to be transported near the irradiator sites are propane in tank trucks and munitions in military transports.

In a thorough treatment of hazards due to transportation accidents, a survey would be made of the traffic on roadways adjacent to the sites to determine the types and quantities of hazardous materials transported and the shipment frequencies. We were unable to conduct such a survey for this assessment. Instead, we determined the largest quantity of propane transported near the sites and performed a bounding calculation of the possible effects of an accident in which the propane detonated. We were unable to obtain information on the quantities of military munitions transported near the sites, and thus were unable to assess the potential risks associated with shipment of these materials.

4.4.6.2 Maximum Accident Environments

Of the potential transportation accidents, the propane tanker truck used to provide fuel to the propane ignitors at the power plant near Site C dominates the potential consequences. The propane, more energetic per unit mass than high-explosive, could potentially be released and ignited as the result of a tank truck accident in the vicinity of the site. Although the probability of the detonation of 50% of the total volume of a tank truck is extremely low, the explosive power could approach 15,000 pounds of high explosive which is clearly more explosive power than other flammable liquids and is approximately the same as the simultaneous detonation of more than 30 1000-lb bombs. A 1000-lb bomb contains about 450 lbs of HE. The latter is not viewed as a credible ammunition transportation accident. Thus, the propane tank explosion is considered a limiting case.

When the same approach as was used for the fixed site in the preceding section was taken for the 2000-gallon propane tank truck, it was obvious that the overpressures and loading

on the irradiator structure could be severe due to the potential proximity of the truck to the irradiator facility. These data are summarized below:

	2000-gallon Tank Truck Fraction of Contents Detonated	
Range from Source	50%	10%
500 feet	5 psi	2.5 psi
100 feet	40 psi	15 psi

Since these overpressure levels are sufficient to cause concern, a more detailed examination was conducted using the techniques in Kennedy et al. (1983). This report examined reinforced concrete structures at nuclear power plants and determined necessary standoff distances from potential high explosive incidents. Some of the results apply directly to the structure surrounding the irradiator facility and are summarized below:

1. Concrete structures designed for seismic loads are inherently hardened to withstand static overpressures.

2. Wall panels are more critical than roof slabs exposed to blast loading from surface detonations.

3. The ability of the wall to absorb energy must be considered using the ductility factor. While the American Society of Civil Engineers recommends that a ductility factor up to 30 may be used, the requirements on nuclear safety-related structures limit the ductility factor to 3. This corresponds to extensive cracking of the concrete, but no severe structural damage.

The report considered in detail the results of blast on 18-inch and 24-inch thick walls. The detailed techniques developed in Kennedy et al. (1983) allow an extension of the methodology to include other wall thickness and designs. After discussions with CH2M Hill, the following parameters were selected for the walls of the structure.

Wall Thickness - 6 feet
Percentage of tensile reinforcing steel - 1%
Concrete strength - 4000 psi
Reinforcing steel strength - 60,000 psi

These parameters allow the calculation of the ultimate static moment capacity (Mu) for the reinforced concrete wall. Given this static moment capacity, the ductility factor (3), the length of the wall (70 feet), and the magnitude of the explosion, we can compute a safe separation distance; that is, the minimum separation between the explosive and the wall that will prevent damage to the wall. Although the longest span wall is best characterized as an "ideal" fixed span, calculations were done for an "ideal" simple span, further increasing the conservatism.

4.4.6.3 Results

The results of those calculations are shown below for 10% and 50% of the tank truck volume.

Tank Truck (2,000-gallon)

Fraction Of Tank Volume Detonated

	50%	10%
High Explosive Equivalent	10,000 lbs	2,000 lbs
Simple Span Safe Separation Distance	5.9 ft.	3.3 ft.

Thus any reasonable standoff distance between the propane tank truck and the irradiator facility would preclude potential damage to the irradiator facility.

4.4.6.4 Conclusions

The nuclear safety-related construction quality of the walls and roof of the facility (6-foot thick walls and roof, heavily reinforced concrete) preclude damage to the facility if a stand-off distance from the facility to the detonation site of about 10 feet is maintained. A detonation occurring off site will cause no damage to the facility or the contained cobalt sources although the metal-framed warehouse could be severely damaged and the operators could be injured by such a lesser event.

4.4.7 Seismic Activity

4.4.7.1 Introduction

Seismic hazards are considered in the assessment of the risks associated with the irradiator facility because a sufficiently violent earthquake could cause structural damage to the facility, thereby reducing the shielding provided by the walls and roof. If the source were in the raised position at the time of the earthquake, the structural damage might make it impossible to lower the source, thereby creating the potential for exposure of workers and the public. A less serious concern is that a seismic event capable of breaching the shielding pool might occur at a time when one or more leaking cobalt-60 pencils have contaminated the pool water. In this case, the radioactive water could escape into the subsoil and perhaps, eventually into the groundwater.

A seismic hazards assessment cannot be performed without complete design details for the facility and extensive information on seismic intensity versus return period for the site. Neither of those types of data were available for this study. In order to provide some estimate of the potential risk contribution of seismic events, we made some very crude assessments of earthquake frequency and irradiator structural response. The results of this analysis should be considered only as indicative of the seismic vulnerability of the facility; however, with the limited information available, we believe the results are conservative.

We used a methodology developed by Sandia National Laboratories to analyze the potential seismic risks of the irradiator facility (Sanders et al. 1987). This methodology was originally used to estimate the seismic risks at a nuclear power station.

4.4.7.2 Seismic Activity and Return Periods

The island of Hawaii has experienced several relatively large earthquakes in the past 25 years. Most recently, earthquakes of magnitude 7.1 and 6.6 occurred in 1975 and 1983, respectively. The County of Hawaii bases its structural design standards on Uniform Building Code (UBC) Zone 3 (where Zone 0 is least susceptible to earthquake hazards and Zone 4 is most susceptible).

To estimate the annual probability versus intensity of earthquakes on the island of Hawaii, we used the approach described in Sanders et al. (1987). According to data collected on history of earthquakes, the largest earthquake recorded in Hawaii in modern times was an earthquake of Modified Mercalli (MM) intensity IX. (Buchanan-Banks). We can use the following relation to determine the ground acceleration caused by this maximum earthquake:

$$\log Ah = -0.014 + 0.3 * Imm$$

where: Ah = peak horizontal ground acceleration (cm/sec2)

Imm = largest MM intensity in the last 200 years

Using a MM intensity of IX yields a peak horizontal ground acceleration of 485 cm/sec2 (.49 g). According to Sanders et al. (1987) this value represents the expected peak horizontal ground acceleration occurring with a frequency of 2.5×10^{-4} per year.

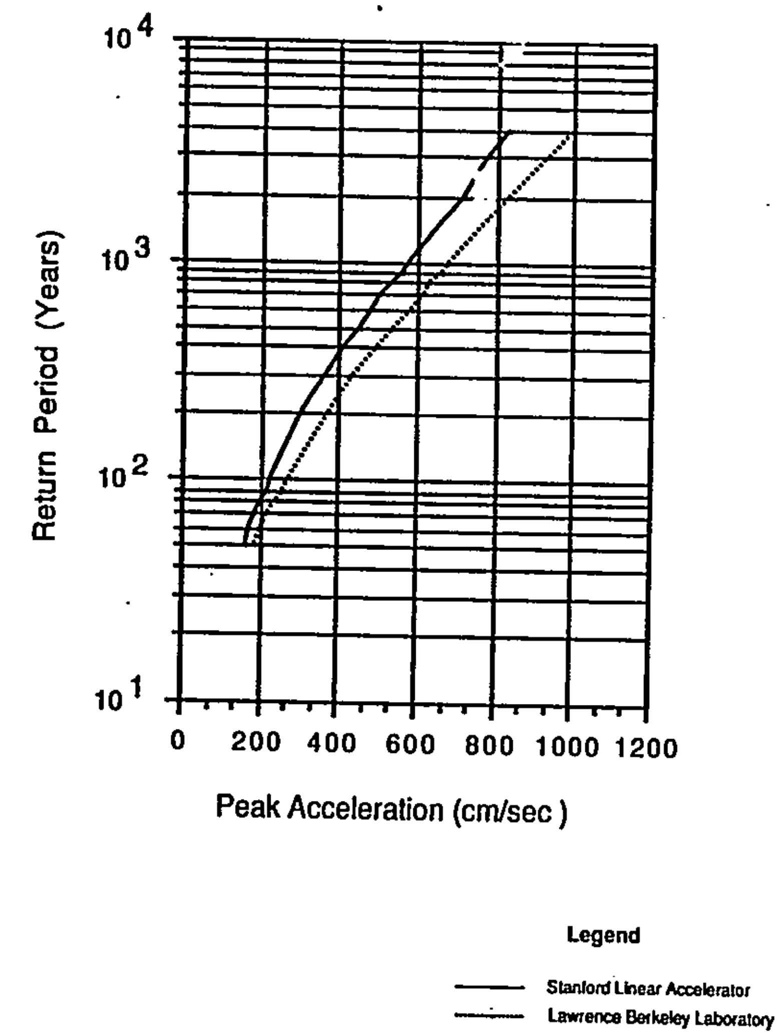
We make the conservative assumption that the earthquake magnitude versus frequency curve for the Hawaii site has approximately the same slope as those of other sites in high-frequency earthquake zones (see Figure 4-3 [Coats and Murray 1984]). This assumption yields a rough magnitude versus frequency curve for the Island of Hawaii (see Figure 4-4). Table 4-17 presents values from this curve at different probability levels.

Table 4-17

PROBABILITY VERSUS MAGNITUDE ESTIMATES OF EARTHQUAKE ACTIVITY IN THE HILO, HAWAII, AREA

Annual Probability (Per Year)	Earthquake Magnitude
2.5×10^{-3}	0.11g
1.0×10^{-3}	0.23g
2.5×10^{-4}	0.49g
1.0×10^{-4}	0.68g

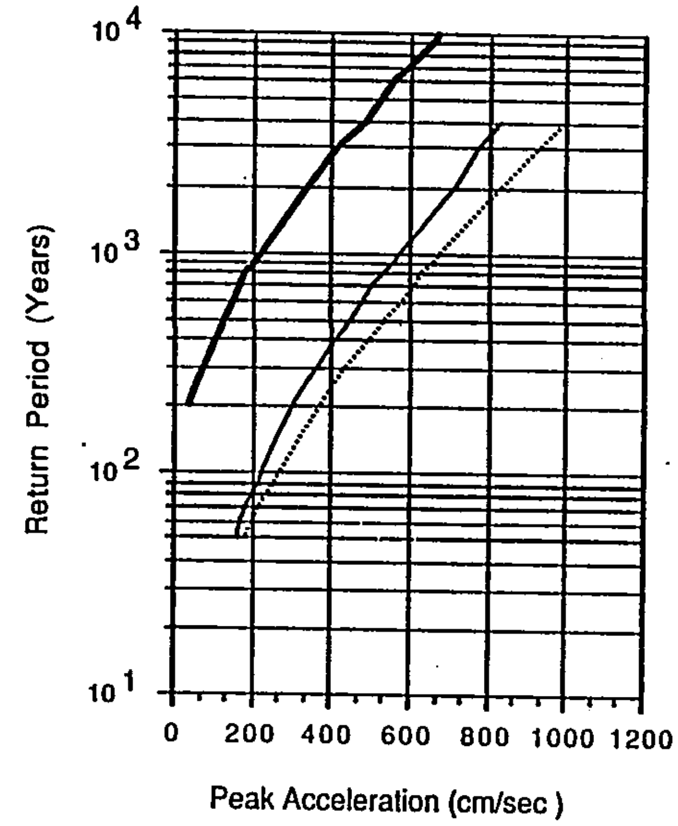
Without a detailed analysis of the irradiator facility structure, it is difficult to estimate the effects on the structure at various earthquake levels or to estimate the maximum earthquake acceleration level that will breach or collapse the structure. We therefore make a very



Earthquake Hazard Curve for High Earthquake Prone Areas

FIGURE 4-3

WESTEC Services, Inc.



Earthquake Hazard Curve for Hilo, Hawaii

FIGURE 4-4

WESTEC Services, Inc.

coarse estimate of the earthquake magnitude necessary to initiate structural damage to the facility. This earthquake magnitude is compared to the earthquake magnitude versus probability estimates given in Table 4-17 to get a relative measure of the strength of the structure against the predicted level of earthquake activity at the site.

If we assume that the irradiator facility structure can be modeled as a 6-foot thick free standing wall of steel reinforced concrete, we can determine the ground acceleration necessary to cause onset of damage to the structure (assumed to be the value that causes the structure's ultimate static moment [Mu] to be exceeded). The acceleration necessary to exceed the ultimate static moment of the irradiator facility structure is estimated to be on the order of 1.2g. This figure is approximately twice as large as any recorded earthquake in the U.S.

4.4.7.3 Results

Table 4-18 presents the findings of this analysis in which the estimated earthquake levels occurring at various frequencies are compared with the est:·nated earthquake level at which the irradiator structure would be damaged. These results s..ggest that the irradiator facility can withstand the effects of earthquakes occurring as infrequently as once every 10,000 years and beyond.

Table 4-18

FINDINGS OF THE STRUCTURAL RESPONSE OF THE IRRADIATOR FACILITY TO VARIOUS EARTHQUAKE MAGNITUDES

Annual Probability (per year)	Earthquake Magnitude	Earthquake Magnitude Necessary for Structural Damage	Comment
2.5×10^{-3}	11g	1.2g	No Damage
1.0×10^{-3}	23g	1.2g	No Damage
2.5×10^{-4}	49g	1.2g	No Damage
1.0×10^{-4}	68g	1.2g	No Damage

4.4.7.4 Conclusions

This analysis has investigated the potential effects of earthquake activity on the proposed irradiator facility. We used a simplified, conservative methodology and the available data to estimate the likelihood and consequence of earthquakes on the irradiator facility

G-48

to estimate the likelihood and consequence of earthquakes on the irradiator facility structure. Our findings suggest that the facility, as currently envisioned, will provide adequate protection against earthquakes occurring with probabilities greater than 1 x 10-4 per year. Our approximate calculations indicate that the structure can withstand an earthquake twice as large as the maximum earthquake ever recorded in the most earthquake-prone areas of California (where most areas are considerd UBC Zone 4).

We have not investigated the likelihood or consequences of earthquake-induced damage inside the facility. For instance, we did not examine whether the effects of the earthquake could cause the source or its elevation control mechanism to be shaken violently; possibly causing the source to be jammed in the raised position. This type of event should be considered in the design process to minimize the risks of excess exposure. There is insufficient design information available at the present time to estimate the radiation dose that might result from earthquake induced structural damage.

Although a more detailed analysis will be required to provide confidence in the quantitative estimates, the probability of pool failure is expected to be lower than that for the structure in general. The pool wall thickness will be less than the thickness of the facility walls (about 2 feet vs 6 feet). However, the pool is embedded in the soil and thus will not experience the differential stresses that the above-ground structure does. Furthermore, the pool is lined with stainless steel. The steel liner will retain its integrity beyond the point at which the concrete pool wall begins to crack. We conclude that the probability of leakage from the pool is well below 10-4 per year. Furthermore, pool leakage is important only if radiation has contaminated the pool. The likelihood of a seismic event occurring at a time when a leaking pencil has contaminated the pool is extremely small. Further, the level of contamination possible from a leaking pencil and seismically-induced loss of integrity, if it were to occur, would be minimal. In the only instance of leaking pencils for which we have data, a total of about 9 curies of radioactive material escaped (CH2M Hill 1987). Such a small amount of cobalt-60 released into the subsoil would not produce any detectable health effects.

4.4.8 Volcanic Hazards

The Big Island is an area of active volcanism. Hilo itself has been threatened or affected in historic times from flows originating from the Northwest rift of Mauna Loa. Earlier lava flows from this rift zone have built a broad ridge that also trends toward Hilo. Recent

work by the U.S. Army Corps of Engineers (1980) looked at the risk of volcanism affecting the City of Hilo.

Since 1843, there have been seven major eruptions in Mauna Loa's Northeast rift zone, each producing a lava flow containing at least 100 million cubic yards of lava. Of these seven flows, four advanced within 7 miles of the city. Lava from the 1880 eruption came within 1-1/2 miles of the harbor, and portions of Hilo are on the area covered by this flow.

The risk of active volcanism affecting Hilo, while not quantifiable, is considered miniscule and should not deter considering the merits of constructing an irradiation facility in Hilo.

Preliminary discussions by CH2M Hill with the USGS in Hawaii and with Sandia National Laboratories in New Mexico, indicate the very low probability that lava flows could cause a release of radioactivity from the sealed sources to the environment. Specifically,

- Lava flows are too viscous to enter the irradiation chamber through a labyrinth.
- Good design would prevent any movement of the facility due to the weight of a flow against the facility.
- The concrete shielding walls would not melt or crack due to either chemical or heat transfer attacks of the lava flows.
- The temperature rise inside the irradiation chamber, due to heat transfer through the concrete walls, would be insignificant due to the large thickness of the walls.

However, if in a given situation lava flows were perceive as a threat to facility safety, the source could be removed from the facility and transferred to a different location. If the facility was located in the Hilo area, it would take days, probably weeks, for the flow to arrive since Hilo is not directly next to or downstream from a rift. There should be ample time to transport casks to the site and make the source transfer operation.

4.4.9 Summary and Conclusions

4.4.9.1 Limitations of the Assessment

This assessment provides perspective on the risks associated with external events that might affect the proposed food irradiator facility. Risks due to safety system failures, operator errors, material handling accidents, etc. are not addressed. Conservative estimates are provided for the probabilities and consequences of external event incidents that could lead to exposure of personnel. The study does not, however, provide a complete assessment of risk for the types of events considered. Resources were not available to support the data collection and analytical effort required to perform such an assessment. The bounding approach used here does allow us to eliminate from consideration events known to have lower potential effects on the facility than the cases modeled. Once additional facility design information is available, it will be possible to compare, in a general sense, the risks due to external events with the risks due to normal operating and accident conditions. The major limitations of the study are summarized below.

1. Structural characteristics of the facility are not completely defined. We have assumed that the structure will be similar to other irradiator facilities currently in operation.

2. A detailed assessment of potential industrial hazards in the area of the proposed sites has not been performed. It is possible that other nearby facilities could represent hazards to the irradiator facility. It is unlikely that any facilities could represent hazards greater than those addressed in the bounding analyses performed in this assessment, but a thorough risk assessment would require a more detailed review of industrial activity in the area.

3. A detailed assessment of hazardous materials transported in the vicinity of the irradiator sites has not been performed. We believe that the transportation accident considered in this study provides an upper bound on the risks associated with hazardous materials shipment, but a thorough risk assessment would provide a more detailed review of materials transported in the area, shipped quantities, and shipment frequencies.

4. Detailed information on the potential hazards represented by operations at Keaukaha Military Reservation was not available for the study. Quantities of stored munitions; munitions shipment routes, quantities and frequencies; and aircraft armament data are needed to do a thorough assessment of hazards from these sources. In our assessment, we considered the effects of two types of bombs typical of those carried by military aircraft and conservatively assumed that any military flight could be carrying such munitions. We further assumed that one bomb detonated on impact in any military aircraft crash.

5. In estimating the dose due to dispersal of source material resulting from bomb explosions, we extrapolated results from a study which predicted the effects of dispersal by high explosives placed in close proximity to a cobalt source away from buildings or other structures. A realistic assessment of the amount of energy coupled into the facility would probably indicate less damage to the source pencils than assumed in our assessment.

6. In estimating doses due to dispersed material at points close to the site boundary we have used technical judgement to extrapolate results from related studies. No direct analysis of the expected dose has been attempted.

7. Estimates of the damage done to the reinforced concrete structure due to propane explosion, aircraft impact, and bombs were based on three different methodologies. Only the methodology for the propane tank explosion provided a means to adjust for the strength of nuclear-safety-grade concrete. A more detailed analysis would account for the actual design characteristics of the structure.

8. No calculation of public dose or health effects has been performed. Statements regarding health effects are technical judgements based on results of other studies. A complete risk assessment would model the release and exposure scenarios in greater detail. Complete risk assessment based on incomplete project inputs, however, would not provide worthwhile information.

9. A very simplistic method was used to perform the seismic hazards assessment. In addition, we had little data on seismic intensity vs. frequency

at the sites, and only limited information on the design characteristics of the facility. The assessment of structural failure is believed to be a conservative approximation, but additional detail is required before a definitive analysis could be performed. Pool wall failure was not assessed quantitatively. Our assessment that its failure characteristics would be comparable to those of the above-ground structure is a technical judgement.

10. Estimates of individual doses due to reduced or breached shielding are based on complete structural failure of the reinforced concrete wall. This is extremely unlikely and a more detailed structural analysis might reduce or eliminate this type of event as a potential source of exposure.

11. Our assessment did not address the effects of external events that do not damage the facility structure. Damage caused to internal equipment (source elevation control mechanism, safety equipment, ventilation, etc.) that could contribute to worker exposure risk is not considered. These issues should be addressed as design definition is completed.

4.4.9.2 Summary of Potential Risks Due to External Events

The results for each class of external events considered in this assessment are summarized in Table 4-19 and discussed below.

Aircraft Crash

All the sites considered for the food irradiator are within 1.2 miles of General Lyman Airfield. Air traffic using the airfield includes commercial, military, and general aviation aircraft. The general aviation aircraft represent no threat to the integrity of the irradiator structure, and they were excluded from consideration.

The probability of an aircraft crashing into Site A or Site C is approximately 10^{-6} per year. For Site B, the probability is approximately 10^{-5} per year.

Table 4-19

SUMMARY OF EXTERNAL EVENT RISK AT PROPOSED FOOD IRRADIATION FACILITY SITES

Type of External Event	Estimated Probability	Damage to Shield Structure	Potential Public Radiation Exposure	Comments
Aircraft Crash	Site A: 8×10^{-7}/year Site B: 2×10^{-5}/year Site C: 6×10^{-7}/year	Minor	Minor to Severe	Facility would sustain damage but would not be breached. If source submerged, no radiation consequences expected. If source raised, radiation exposure ranging from minor to severe is possible in area immediately surrounding facility.
Aircraft Crash (with bomb)	Site A: 4×10^{-7}/year Site B: 8×10^{-6}/year Site C: 4×10^{-7}/year	Major	Severe	Facility would sustain major damage and shielding could be breached. If source submerged, no radiation consequences expected. If source raised, severe levels of radiation exposure possible.
Bulk Propane Explosion (10,000 barrels)	Extremely unlikely	None	None	Shield structure would be undamaged by most pessimistic scenario. Surrounding structures would be devastated by such a blast.
Propane Truck Explosion (2,000 gallons)	Extremely unlikely	None	None	If a distance of at least 10 feet is maintained between the truck and the containment facility, no damage is expected. Metal framed warehouse could be severely damaged.
Earthquake	1×10^{-3} (0.23 g) 1×10^{-4} (0.68 g)	None	None	The facility is designed to maintain integrity under severe earthquake conditions. Pool failure judged to be equally unlikely. Can withstand the 10,000+ year earthquake.

On the basis of our bounding estimates, we conclude that none of the military or civilian aircraft expected to use General Lyman Airfield would penetrate the irradiator structure if they crashed into it. Significant local damage would be caused to the exterior of the building and some spalling of concrete from the interior surface would be expected for direct hits by some of the aircraft. This could reduce the shielding effectiveness for the region outside the building in-line with the damaged wall if the source is in the raised position. It is conceivable that spalling from the inside surface of the building might damage the mechanism for lowering the source into the pool, but we have not attempted to estimate the likelihood of such an event. An inability to lower the source could complicate recovery actions following the crash, but simple emergency measures could be implemented to prevent exposure of the public.

We also assessed the case in which a military aircraft carrying a conventional high explosive bomb crashes into the facility and the bomb detonates as a result of the impact. We were not able to obtain specific information on the munitions carried by military aircraft flying in the vicinity of the sites for this study. Therefore, we assessed the vulnerability of the structure to the types of general purpose (GP) bombs commonly carried by the types of aircraft similar to those using the field. Information in the literature indicates that a 500-pound GP bomb will penetrate approximately 5.2 feet of reinforced concrete and a 1000-pound GP bomb will penetrate approximately 7.5 feet. Thus, a direct hit by an aircraft carrying a 1000-pound GP bomb could breach the facility and probably cause significant damage to the interior of the facility if the bomb detonated. A direct hit by an aircraft carrying a 500-pound GP bomb could at most cause significant cratering of the exterior wall and spalling from the inside surface even if the bomb detonated. Without information on the munitions actually carried by the military aircraft in the area, we are unable to estimate the probabilities of these events, but we know they are no larger than the probability of impact by a military aircraft (4×10^{-7} per year for Sites A and C, 8×10^{-6} per year for Site B).

If the source were in the raised position when a large bomb detonated, significant exposure of workers or the public might occur as a result of the reduced shielding. The maximum dose to an individual at the boundary could be as high as 175 rem per hour in line of site with the damaged wall. The health effects of an exposure of this magnitude could be very serious.

Source pencils might be dislodged from the source plaque by bomb detonation. It is unlikely that the pencils would be crushed to a dispersable powder by the impact, but additional analysis will be required to determine the amount of damage expected. We estimate, on the basis of previous studies and engineering judgement, that an individual at the facility boundary would receive a 50-year dose commitment of no more than 10 rem as a result of material dispersed from the facility by a bomb exploding on the structure. No health effects would be expected from such small exposures. If dislodged pencils were scattered outside the shield structure, significant exposures coul. .esult. Assessment of the likelihood of a bomb explosion scattering intact pencils outside .: facility and the resulting doses would require additional analysis.

If an aircraft carrying a large bomb should crash into the facility, we cannot rule out the possibility that a significant amount of aircraft fuel would t released into the facility and burned. Even in such an event, we do not expect significant release of cobalt-60 from the site for two reasons. First, the temperature attained in a petroleum fire is relatively low. It is doubtful that there would be sufficient heat to breach the source capsules. Second, the amount of cobalt-60 that can be released as the result of even an intense fire is quite small. Even if the impact crushed some of the source capsules, exposing the cobalt-60, the fraction of material released in respirable form is expected to be no more than about 10^{-4}. We estimate, on the basis of previous studies and engineering judgement, that an individual at the facility boundary would receive a 50-year dose commitment of no more than 10 rem as a result of material dispersed from the facility following an aircraft crash, bomb detonation, and fire. This level of exposure would not cause any discernible health effects.

Hazards Due to Nearby Facilities

Facilities near the potential irradiator sites were reviewed to identify those which pose a potential hazard to the irradiator facility and the cobalt source. Potential candidates included the propane storage site located 1 to 1-1/2 miles from the irradiator site and ammunition storage associated with local military operations.

As a bounding estimate, an accident involving the 10,000-barrel low pressure propane storage sphere was selected. If the contents of the sphere could be detonated, there is the potential (although it is extremely improbable) for an explosion with a high-explosive equivalent yield on the order of 2 kilotons. Although this would devastate nearby structures, the overpressures reaching the potential irradiator facility sites would be less than 4 psi which would pose no threat to the irradiator facility structure or the contained cobalt sources.

Hazardous Material Transportation Accident

We considered a variety of hazardous materials that could potentially be involved in an accident where the material or its effects could propagate to the site and cause damage. Since the effects must be sufficiently energetic to cause damage to the cobalt pencils, all events capable of only endangering the workers on site (e.g., release of a toxic gas) were eliminated. This leaves those events where large quantities of energetic material (e.g., aviation fuel, propane, weapons) would be transported near the site.

Of the transportation accidents identified, explosion of a propane tank truck near any of the sites dominates the potential consequences. The propane, more energetic per unit mass than high-explosive, could potentially be released and ignited as the result of a tank truck accident in the vicinity of the site. Although the probability of the detonation of 50% of the total volume of a tank truck is extremely low, the explosive power could approach 15,000 pounds of high explosive which is clearly more explosive power than other flammable liquids and is approximately the same as the simultaneous detonation of more than 30 MK83 bombs. The latter is not viewed as a credible ammunition transportation accident.

The nuclear safety-related construction quality of the walls and roof of the facility (6-foot-thick walls and roof, heavily reinforced concrete) preclude damage to the facility if a stand-off distance from the facility to the detonation site of about 10 feet is maintained. A detonation occurring off site will cause no damage to the facility or the contained cobalt sources although the metal-framed warehouse could be severely damaged and the operators could be injured by such a lesser event.

Seismic Hazards

A simplified, conservative analysis of the likelihood and consequence of earthquakes on the irradiator facility structure suggests that the facility, as currently envisioned, will provide adequate protection against earthquakes occurring with probabilities greater than 10^{-4} per year. Our approximate calculations indicate that the structure can withstand an earthquake

twice as large as the maximum earthquake ever recorded in the most earthquake-prone areas of California.

Worker and public exposure to radiation could occur if a large earthquake caused major structural damage to the facility and simultaneously made it impossible to lower the source into the shielding pool. The likelihood of an earthquake capable of causing such damage is believed to be much less than 10^{-4} per year. Additional analysis will be required once more complete design detail is available to predict structural and system response and to estimate radiation doses.

The probability of pool failure is expected to be lower than that for the structure in general because the pool is embedded in the soil. In addition, the pool has a steel liner that will retain its integrity beyond the point at which the concrete pool wall begins to crack. We conclude that the probability of leakage from the pool is well below 10^{-4} per year. The likelihood of a seismic event occuring at a time when a leaking pencil has contaminated the pool is even more remote. The small amount of cobalt-60 that might be released into the subsoil as a result of such a sequence of events would not produce any detectable health effects.

4.4.9.3 Conclusions

Based on the assessments performed in this study, subject to the limitations listed in Section 4.4.8.1 we conclude the following:

1. The risks of radiation exposure to workers or the public due to external events affecting the food irradiation facility are extremely low.

2. The massive structure of the facility is the key factor in reducing hazards associated with external events.

3. The only external events that threaten significant public exposure are aircraft crashes into the site. The probability of aircraft crash is in the range of 10^{-5} to 10^{-7} per year depending on class of aircraft and site considered.

4. Direct exposure due to reduced or breached shielding is likely to be a more important contributor to public dose committments than is the dispersal of radioactive material from the site.

5. Emergency preparedness will be a critical element in controlling risk associated with loss of facility shielding integrity. Emergency plans must be in place and emergency response personnel thoroughly trained to deal with accidents that damage the facility structure or incapacitate the operators.

6. Given the very low probabilities associated with the external events of concern, it is likely that risk associated with operation of the facility will be dominated by safety equipment failures, violations of procedures, source material handling accidents, and human errors. Detailed assessments of these events should be undertaken as the facility design is completed.

SECTION 5
HEALTH EFFECTS OF GAMMA RADIATION

5.1 RADIATION

Radiation is emitted as a result of radioactive nuclides undergoing spontaneous decay. During the decay process, these nuclides emit characteristic electromagnetic radiation and are thereby transformed into more stable forms of the same nuclei. From a radiological health viewpoint, three of the most important types of radiation are charged particles, neutrons, and electromagnetic radiation. Electromagnetic radiation, in the form of gamma rays, is the only form of radiation emitted from a cobalt-60 source.

5.1.1 Gamma Radiation

Gamma radiation consists of photons released from the nucleus of a radionuclide during its decay into a more stable element. The rate at which atoms decay in a gamma source is called the activity. Activity is measured in units of curies, where one curie, denoted as Ci, is defined as 37 billion disintegrations per second. Since the probability of decay is a constant, the activity of a radionuclide will decrease exponentially with time. A half life is the time required for 50 percent of a radioactive source to be depleted. For cobalt-60, the half life is 5.2 years.

The emitted photons exhibit both particle and wavelike behavior; they have zero rest mass and zero charge, and travel in a vacuum at the speed of light. Photons radiate in all directions and in straight lines from the source. They do not bend like magnetic flux. They are not convective in nature like thermal radiation, nor do they radiate in concentric circles like sound. They contain a fixed amount of energy, which averages 1.25 MeV for each of the two photons released per disintegration from cobalt-60.

Cobalt-60 does not fission, emit neutrons, exhibit rapid powe. excursions, or activate (make radioactive) other materials. This isotope simply decays or disintegrates at a constant rate.

G-54

5.2 DOSE

Radiation exposure may be measured in terms of its ionizing effect or in terms of the energy absorbed per unit mass of exposed material. Historically, radiation exposure for x- and gamma radiation was measured in units of roentgens (the amount of radiation required to produce one electrostatic unit (esu) of charge from either part of an ion pair in 1 $cm.^3$ of dry air). It can be shown that 1 roentgen is equivalent to energy deposition of 88 ergs in 1 gram of dry air (Braestrup 1958). A modern and more useful method for quantifying radiation interaction is in terms of the energy absorbed per unit mass. One radiation absorbed dose (rad) unit equals 100 ergs per gram of absorbing material. This unit has been superseded by the Gray (Gy), which is equal to 100 rads.

Since biological effects of radiation have been found to depend on both the energy deposited and the spatial distribution of the deposition, it was found convenient to define the relative biological effectiveness (RBE) as

$$RBE = \frac{\text{Dose of 220-250 keV x-rays for a given effect}}{\text{Dose of the radiation in question for the same effect}}$$

where a particular biological effect is considered (Fabrikant 1972). In an attempt to devise a unit that would provide a better criterion of biological injury when applied to different radiations, a biological dose unit, the Roentgen Equivalent Man (rem), is defined by

$$\text{Dose equivalent in rem} = \text{RBE} \times \text{absorbed dose in rad}$$

In a similar manner to the rad, the rem unit has been superseded by the Sievert (Sv), which is the dose equivalent for an absorbed dose of 1 Gray or 100 rads. Therefore, 1 Sievert equals 100 rem.

Since RBE will depend on effect studied, dose, dose rate, physiological condition, and other factors, the quality factor (QF) is defined to be the upper limit for the most important effect due to the radiation in question. The biological effect of 1 sievert of radiation will be equivalent for all types and energies of radiations; radiation doses in sievert are thus additive, independent of radiation nature. Table 5-1 lists QFs for various types of radiation.

Table 5-1

QUALITY FACTORS FOR VARIOUS TYPES OF RADIATION

Radiation	Range of Quality Factor	Typical Value
x-ray, gamma-ray	1.0	1
Beta particles, electrons	1.0 - 1.7	1
Fast neutrons	5.0 - 11.0	10
Slow (thermal) neutrons	2.0 - 5.0	3
Alpha particles	1.0 - 20.0	10
Protons	1.0 - 10.0	10
Heavy ions, fission fragments	20.0	20

Source: Foster and Wright 1969, NCRP 1971, and US Department of Health 1970.

Radiation from sources external to the body is usually only harmful to humans when in the form of neutrons, x-rays, or gamma rays, since alpha and beta particles are typically stopped by the skin. (Extremely energetic beta radiation can penetrate the outer layers of skin and damage the more sensitive inner layers.) However, any source of radiation incorporated into the body is potentially hazardous. The large QF assigned to alpha particles, for example, indicates that they may be especially hazardous internally, where they can deposit a large quantity of energy in a small amount of potentially more sensitive internal body tissue. A cobalt-60 irradiation source, however, will only emit gamma radiation, which has the lowest quality factor.

The radiosensitivities of different life forms differ considerably. In general, higher life forms are more sensitive to radiation than lower forms, although is some specific cases this is not true (Fabrikant 1972). Table 5-2 shows the dose response for a range of life forms. Throughout this assessment, the radiological impact to man will be the only one quantitatively evaluated. This perspective is taken because of the generally higher sensitivity of man to radiation and because the societal impacts of doses to human beings are generally considered to be more significant than the impact due to irradiation of lower life forms.

Table 5-2

APPROXIMATE RADIOSENSITIVITY OF VARIOUS LIFE FORMS TO EXTERNAL RADIATION

Life Form	Biological Effects	Necessary Dose (Gy)
Plant life	Growth Impairments	20 - 700
Arthropods	Death	10 - 1,000
Insect Pupae and Larvae	Death	2 - 20
Fish, Amphibia, Reptiles	Death	10 - 20
Mammals (general)	Death (LD 50/30)*	3 - 8
Hamsters	Death (LD 50/30)*	8
Mouse	Death (LD 50/30)*	6
Man	Death (LD 50/30)*	3-6

*Lethal dose to 50 percent of the exposed population within 30 days.
Source: Fabrikant 1972

5.3 Background Sources of Exposure

As described earlier, mankind is constantly exposed to radiation sources. Natural background radiation, originating primarily from cosmic rays and terrestrial gamma emitters, constitutes the most significant source of radiation exposure to the general population. The dose from background sources will vary with altitude, latitude, and differences in the radioactive material content of the soil, building materials, etc. Consequently, the individual dose from these sources will vary considerably with location. For example, a person in Louisiana or Texas will receive about one-half the annual dose received by a person in Colorado or Wyoming (Eisenbud 1973).

Both internal and external exposure to all persons results from the presence of naturally occurring radioactive material in the soil, air, water, vegetation, and even the human body. The doses received by various organs from these sources can differ widely depending on the type of soil, house construction material, diet, etc. An average annual individual

whole-body equivalent dose of 2 mSv is received from natural background exposure (cosmic rays and internal and external terrestrial sources).

Radiation exposure to the public also occurs in medical and dental applications of radiation sources (0.40 mSv), fallout from atmospheric weapon testing (0.02 mSv) and nuclear power operations (0.001 mSv). Additional exposure results from color television sets, commercial air travel, and various consumer products using radium or other radioactive materials.

5.4 Hazards from Radiation

The effects of radiation upon the body are a manifestation of the localized deposition of electromagnetic energy in the atoms along the path traveled by the radiation. The ionizations and excitations caused by this deposition can directly or indirectly alter both the chemical composition and the chemical equilibrium within the cells along the path (Fabrikant 1972). The effects of the radiation may be undetectable, or they may manifest themselves as acute physiological changes, carcinogenesis, or genetic effects, depending on the amount and type of incident radiation, the type of cells irradiated, and the time span over which irradiation occurs. Each of these effects will be discussed briefly below.

5.4.1 Acute Physiological Changes

Acute physiological changes are normally associated with relatively large absorbed doses received over a short period of time. Data on these effects in man are derived largely from Japanese atomic bomb casualties, some radiation therapy patients, and a few recipients of high acute doses from industrial accidents in the early days of the nuclear weapon development programs. Table 5-3 summarizes acute whole-body radiation effects in man.

If the acute irradiation is localized in a specific region of the body, the effects can vary widely because of variations in cell sensitivity to radiation. The reproductive organs are among the more sensitive. Radiation doses to males beginning above 0.10 Grays and extending to 6 Grays produce a decrease in, or absence of, sperm beginning 6 to 7 weeks after exposure and continuing for a few months to several years, after which time there is full recovery. The extent of sperm count decrease and the rate of recovery are related to the magnitude of the dose (NRC 1975). On the other hand, organs such as kidneys, lungs, stomach, bladder, and rectum may be able to withstand acute doses of several tens of Grays before substantial damage occurs (NCRP 1971).

Table 5-3

DOSE-EFFECT RELATIONSHIPS IN MAN FOR ACUTE WHOLE-BODY GAMMA IRRADIATION

Dose (Gy)	Nature of Effect
0.05 - 0.25	Minimum detectable dose by chromosome analysis or other specialized tests.
0.50 - 0.75	Minimum acute dose readily detectable in a specific individual.
0.75 - 1.25	Minimum acute dose likely to produce vomiting in about 10 percent of people so exposed.
1.50 - 2.00	Acute dose likely to produce transient disability and obvious blood changes in a majority of people exposed.
~ 3.40	Median lethal dose for single short exposure with no medical treatment (Ref. 3-13).
~ 5.10	Median lethal dose for single short exposure with supportive medical treatment (barrier nursing, antibiotics, transfusions) (Ref. 3-13)
~ 10.50	Median lethal dose for single short exposure with heroic medical treatment (bone marrow transplants, etc.) (Ref. 3-13).

Source: NCRP 1971 and NRC 1975

5.4.2 Carcinogenesis

Fatal cancers account for approximately 20 percent of all deaths in the U.S. (Cairns 1975). These cancers are divided into three broad groups: carcinomas, sarcomas, and leukemias or lymphomas. Within these groups, there are 100 or so distinct varieties of disease based on the original site of the malignancy.

There are many theories of carcinogenesis, but most researchers acknowledge that a statistical correlation can be established between certain environmental factors and cancer induction. Examples of these correlation include the correlation of smoking to lung cancer and that of radiation dose to leukemia among atomic bomb survivors. The correlation

between exposure to radiation and cancer induction has been qualitatively established for animal exposures and is widely accepted for human exposures (Maynford and Clark 1975), although the physiological mechanisms involved are not well understood.

5.4.3 Genetic Effects

The genetic material (DNA) is organized into linear sequences (chromosomes) of large numbers of protein groupings (genes). Changing the chemical nature or location of one or more of the protein molecules within a gene will change t .e genetic information carried by the chromosome and, hence, the genetic information used to "construct" cells in any offspring. Changes that result from such modifications of the genetic coding are called gene mutations. In extreme cases where there are gross changes in the number or overall composition of entire chromosomes, the mutations are called chromosomal aberrations (NRC 1975).

Whatever their origin, mutations are frequently detrimental, and every individual appears to carry a "load" of defective genes which collectively tends to reduce his overall fitness to some degree (NCRP 1971). During the evolutionary past, an equilibrium between mutation rates and natural selection against detrimental genes and in favor of favorable genes has been established for each species (NCRP 1971). Concern has arisen because of the laboratory work that has shown radiation to be mutagenic in lower life forms such as Drosophilia (fruit flies) and various species of mice. These data have been extrapolated to dose-effect relationships (Shapiro 1972; NCRP 1971; and BEIR 1972) lymphocytes. However, several detailed investigations of children of Japanese atomic bomb survivors have not shown significant increase in mutation incidence (ICRP Publication 18 1972).

5.5 COST-BENEFIT

There is a certain amount of statistical risk involved with any level of exposure to radiation. In line with other activities and needs of society, one must compare the benefits gained from the use of radioactive substances with the possible risks entailed. For example, people continue to use medical x-rays and radiopharmaceuticals that may help discover a developing tumor in spite of the potential for other cell damage produced by the radiation (Johnson 1972). Similarly, few people are likely to change their location to reduce background dose, although this background can differ between certain states by as much as 1.0 mSv per year. In short, benefits outweighing the prospective costs are usually expected from certain uses of radioactive substances, just as from many other hazardous materials. In Table 5-4, the risk of fatal cancer or life-span shortening from radiation is compared to estimates of other risks commonly accepted in our society.

Table 5-4

COST IN DAYS OF LIFE ASSOCIATED WITH VARIOUS ACTIVITIES

Activity	Cost in Days of Life
Living in city (rather than in country)	1800
Remaining unmarried	1800
Smoking 1 pack of cigarettes per day	3000
Being 4.5 kg overweight	500
Using automobiles	240
1.7 mSv / year of radiation dose	10
Transportation of radioactive material*	0.030

*Calculation based on an average of 0.005 mSv per year to an average exposed individual.

Source: Cohen 1974

APPENDIX G.3

TRANSPORT AND DISPOSAL OF COBALT-60

TRANSPORT AND DISPOSAL OF COBALT-60
INDUSTRIAL RADIATION SOURCES

Peter Runstadt
AECL, Radiochemical Company
Presented at IOGPI
Meeting April 18-22, 1988
Cadarche, France

TRANSPORT AND DISPOSAL OF COBALT-60 INDUSTRIAL RADIATION SOURCES

This paper will deal with safety aspects of the handling and transportation of Cobalt-60, the most widely used industrial radio-isotope. Cobalt-60 is a man-made radioisotope of Cobalt-59, a naturally occuring non radioactive element, that is made to order for radiation therapy and a wide range of industrial processing applications including sterilization of medical disposables, food irradiation, etc. The shipment of a Cobalt-60 source is the last step in a long and detailed manufacturing and quality control process, including many stages such as:

1. Cobalt specification and preparation
2. Encapsulation design and manufacture
3. Reactor target design and manufacture
4. Shipping container design and manufacture
5. Final source design and manufacture

Cobalt-60 Production and Encapsulation

A typical cobalt capsule is shown on Figure 1. 99.9% pure Cobalt-59 slugs are nickel plated and welded into a Zirconium alloy (Zircalloy) "Inner Capsule". Inner Capsules are assembled into Reactor Target Bundles and placed into reactors for activation (conversion of Co-59 to Co-60). After activation, target bundles, now containing approximately 90% Cobalt-59 and 10% Cobalt-60, are extracted from the reactor into a shielded flask and transferred into a 10 metre deep, water filled storage bay where they are transferred into an approved shipping container. Next, they are transported to the Cobalt Processing Facility, where the bundles are dismantled and the Zircalloy inner capsules are further sealed in stainless steel "Outer Capsules". The finished product is most often the C-188 Cobalt-60 source pencil (Figure 1). This capsule has become a world-wide industry standard.

Capsules are manufactured to a very strict quality assurance program that includes verification of incoming materials and chemical analysis of material samples. They are automatically welded in an argon atmosphere using non-consumable tungsten electrodes. In every production run, destructive testing is done on the first and last and one intermediate capsule or at least one in every twenty-five. To improve corrosion resistance, the outer capsules are made from ASTM 316 L stainless steel which, due to its low carbon content, permits welding with minimum carbide precipitation.

Shipment of Cobalt-60 Sources

Cobalt-60 has to be shipped:

1. From the Reactor to the Processing Facility
2. From the Processing Facility to the customer, and
3. From the customer to the Processing Facility after its useful life.

Shipping Container Design

All AECL shipping containers are designed to meet Type B(U) requirements of the IAEA Regulation for Safe Transport of Radioactive Materials, Safety Series 6 (1985). Packages are generally categorized as "Type A" for small, often hand carried packages containing small amounts of radioactive materials and "Type B" for more substantial quantities of radioactive materials under regular and severe shipping conditions. An example of a Type A package would be a small lead pot in a cardboard box, light enough to be carried by hand. Examples of Type B packages will be discussed in the following paragraphs. As with many other products, a designer of a shipping container must successfully blend together a variety of often conflicting requirements. Aspects that must be considered vary from current and anticipated regulatory requirements and operating characteristics to compatibility with existing facilities and costs.

Bulk Product Shipping Container

A typical bulk shipping container designed to transport Cobalt-60 from the Reactor Site to the Processing Facility is shown on Figure 2. This container, known as the F-231, conforms to IAEA Type B(U) specification and carries Canadian Atomic Energy Control Board Certification No. CDN/5060/XT. AECB is an independent government regulatory and enforcement agency. It is steel encased and shielded by approximately 29 cm of lead. It weighs approximately 7600 kg. It is licensed to transport up to 400,000 Ci of Cobalt-60. The cargo cavity measures 29.2 cm in diameter and is 44.5 cm high. Bulk Cobalt bundles are inserted into the F-231 shipping container on Cobalt Bundle Trays shown in Figure 3. Upon arrival at the Processing Facility, the bundles are removed from the trays and disassembled for further processing which includes rigorous quality control.

Finished Product Shipping Containers

A typical shipping container, the F-168, designed to transport finished, doubly-encapsulated Cobalt-60 sources, is shown in Figure 4. Similarly to the previously described container, the F-168 also conforms to International Atomic Energy Agency Type B(U) specification. It is certified by the Atomic Energy Control Board in Canada under CDN/3012/B(U)T. As the F231, it is a steel encased, lead filled container which weighs approximately 5000 kg and is licensed to carry 200,000 Ci of Cobalt-60. It is shielded by approximately 27 cm of lead. Its cargo cavity measures 16.2 cm in diameter and is 47.9 cm high. Cobalt-60 capsules are loaded into a Source Capsule Cage as shown in Figure 5 for insertion into the F-168 shipping container. This arrangement (capsule cage and container) is used for transporting sources from the Processing Facility to customers' sites as well as for returning depleted sources from the customers back to the Processing Facility.

A drop test facility with a capacity of 20,000 lbs. (9072 kg) was constructed during the summer of 1978 at Canada's Chalk River Nuclear Laboratories, a division of Atomic Energy of Canada Limited. It consists of a cement impact pad resting on bedrock and covered with a 4-inch (10 cm) thick high strength steel plate. Above the pad, a tower with an electrical hoist provides 42 feet (12.8 m) clearance between the hoist hook and the surface of the pad.

A special release mechanism was designed and fabricated at the AECL, Radiochemical Company. The mechanism is actuated by a remotely controlled pneumatic cylinder and has a capacity of 20,000 lbs. (9072 kg). The important feature of the device is its true vertical release action which ensures that the preselected drop orientation of the package is maintained during the free fall. Each package is monitored with decelerometers to provide, together with the examination of the high speed films, the basis for subsequent assessment of similar flask models. To facilitate the interpretation of the high speed film, a checkered (20 cm squares) pattern is installed as a background. Immediately prior to each test, the package attitude is confirmed and recorded.

Fire Tests

As with the drop tests, one must have a facil! / to carry out fire tests which will satisfy the regulatory requirements. The most convenient facility in the Ottawa area is at the Materials Fire Testing Branch of the National Research Council. The furnace located there is a propane fired unit with a chamber volume of 1620 ft^3 (45.9 m^3).

The furnace is designed to perform according › the ASTM Standards.

Additional Remarks on Quality and Safety

Somewhat less scientific tests in the USA and UK of type B containers which met the same standards as AECL's F-168 and F-231 have involved the face fall drop of the container from an aircraft at an altitude 600 m onto a concrete runway and the impact of a diesel locomotive traveling at 80 mph (130 km/hr). The locomotive was totally destroyed while the container was undamaged.

In addition to the previously mentioned standard engineering techniques and destructive tests, AECL's shipping containers are subject to a regular inspection and maintenance programme.

Design, Manufacturing, Quality Control and Quality Assurance procedures are approved by the Canadian Atomic Energy Control Board. AECB certification conforms to International Atomic Energy Agency's specifications and is accepted world-wide by competent authorities.

Since the beginning of Cobalt-60 shipping activities in 1955, there have only been a few incidents involving AECL-RCC's industrial Cobalt-60 shipments. Not one of these resulted in the release of any radioactive materials or pointed any radiation hazard to the public environment. The total amount of industrial Cobalt-60 shipped by AECL up to March 1, 1988 is approximately 190 million curies. This represents approximately 870 separate shipments. Furthermore, during the same period in North America there were in excess of 1 million shipments of radioactive materials in similar (Type B) containers - not one of these caused any radiation exposure to the public or the environment. The record of the industry in this regard is without parallel compared to shipments of other hazardous materials such as toxic chemicals, gasoline and heating fuels.

Disposal of Depleted Cobalt-60 Sources

To put the question of depleted Cobalt-60 disposal in perspective, it helps to understand that the Radiochemical Company of AECL offers the following assurances to their customers:

- AECL industrial irradiators which use the Cobalt-60 pencils are designed so that they can be maintained at their maximum licensed source capacity without the need to remove depleted Cobalt-60 for a period of no less than fifteen years;
- Customers are assured that if any quantity of depleted Cobalt-60 needs to be removed from a facility, it will be done by qualified, experienced and licenced AECL technicians; and
- AECL undertakes to recover their depleted Cobalt-60 sources back to Canada for re-processing, re-sale, re-activations or safe disposal.

In practice, only a few industrial irradiation facilities operate at maximum source capacity. A typical irradiator operator usually leaves room in his source-rack for throughput expansion. Since 1965, it has been necessary to remove only a very small amount of depleted Cobalt-60 from one of the first medical products sterilizers in the U.S.A.

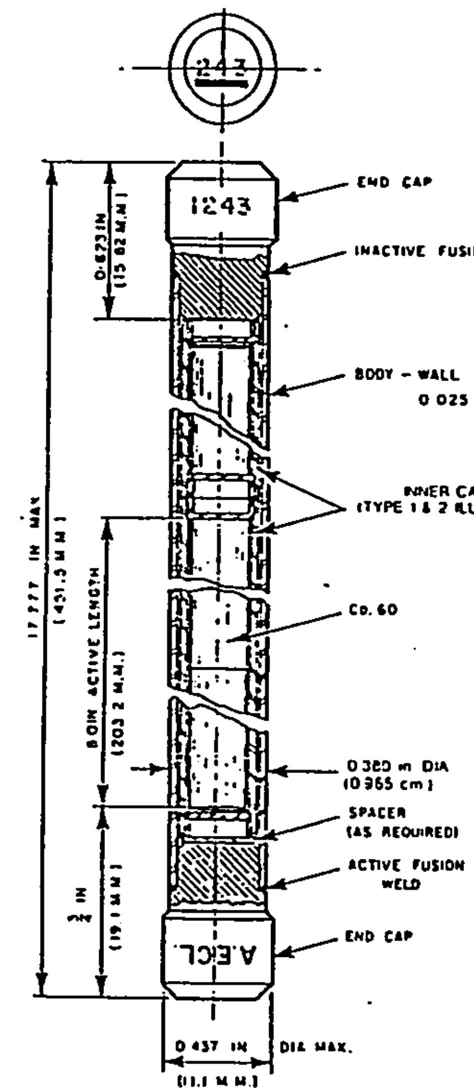
Re-activation of depleted Cobalt-60 sources by inserting them into a reactor for the second time is technically feasible. If, however, re-processing for sale or reactivation are not the preferred alternatives, the cobalt-60 can be disposed of. As of March 1988 there were approximately 100 MCi of AECL supplied Cobalt-60 in service, representing in excess of 22,000 source pencils. If all of this Cobalt-60 was gathered into one stack, it would occupy a space of 1.25 m^3 - the size of a small office desk. After their useful life, the Cobalt-60 source pencils that would require disposal, will have already decayed to at least (4 half-lives) 6% of their original strength. Our current position is that depleted sources will be loaded into standard transport packages, such as the previously mentioned F-168 or F-231 containers, for shipment to our Chalk River disposal site.

Summary Comments

The safe transport and disposal of Cobalt-60 industrial radiation sources is essential to the viability of gamma processing technology world-wide. Producers and users of sources are stringently regulated. Transportation packages are tested. Safe disposal options exist and are undergoing continual review. Primary producers such as AECL cooperate fully with regulatory agencies to improve evaluation technology to keep pace with changing requirements.

The record of the industry in this regard is extremely positive, and my company in particular is proud of its contributions made over the past 30 years.

Figure 1.



TYPE No.	INNER CAPSULE	QTY
1	C177	2*
2	AC181	2*
3	AC185	2*
4	C246	1
5	AC339	2*
6	AC345/C346	1/1

*NOTE:
ALTERNATIVELY, 1 EACH OF ANY COMBINATION OF INNER CAPSULES MODELS (1),(2),(3),OR (5)ONLY, FOR A TOTAL OF 2 INNER CAPSULES, MAY BE CONTAINED IN THE C-188 PENCIL.

NOTES:
1. ALL DIMENSIONS IN INCHES & MILLIMETRES
2. OUTER CAPSULE MATERIAL # 316L STAINLESS STEEL
3. ENGRAVED ON CAPSULE:
(A) UPPER END CAP (FACE): LAST THREE FIGURES OF SERIAL No. UNDERLINED
(DIAMETER): FULL SERIAL No. AND C-188.
(B) LOWER END CAP (DIAMETER) A.E.C.L. Co60.

• DIMENSIONS SHOWN ARE AT 68°F (20°C)

ATOMIC ENERGY OF CANADA LIMITED	TITLE: SOURCE PENCIL ASS'Y			
413 MARCH ROAD, P.O. BOX 13500, KANATA, ONTARIO, CANADA, K2K 1X8 Telex: 053-4082 Cable: NEMOTA Tel. (613) 592-2790	REF. DWG AC5244		REVISED MARCH 1987	
	DATE FEB 3 1967		No. C-188	REV H
	DRAWN D.LeBLANC	CHECKED	APPROVED	SHEET 1 OF 1

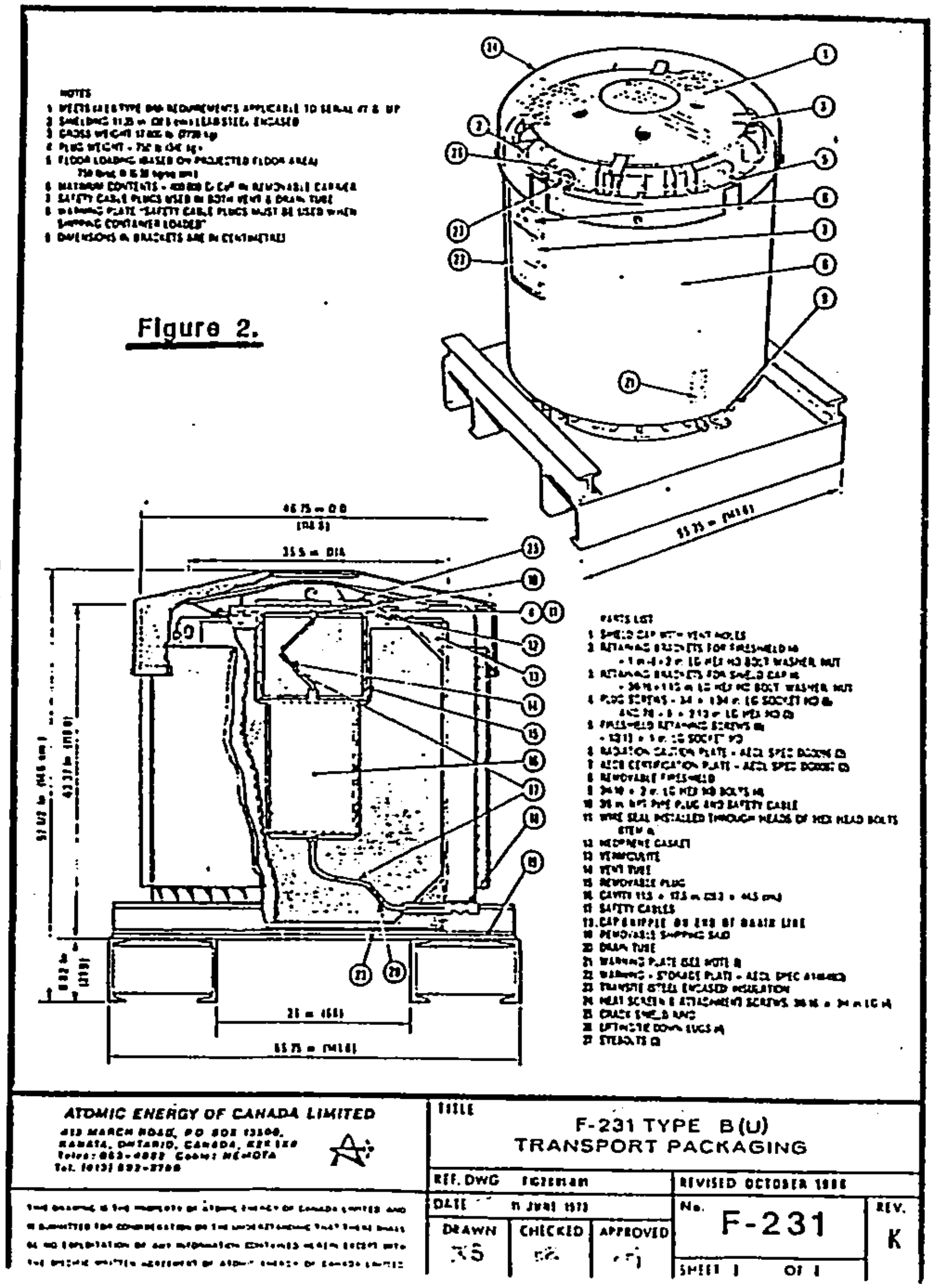


Figure 2.

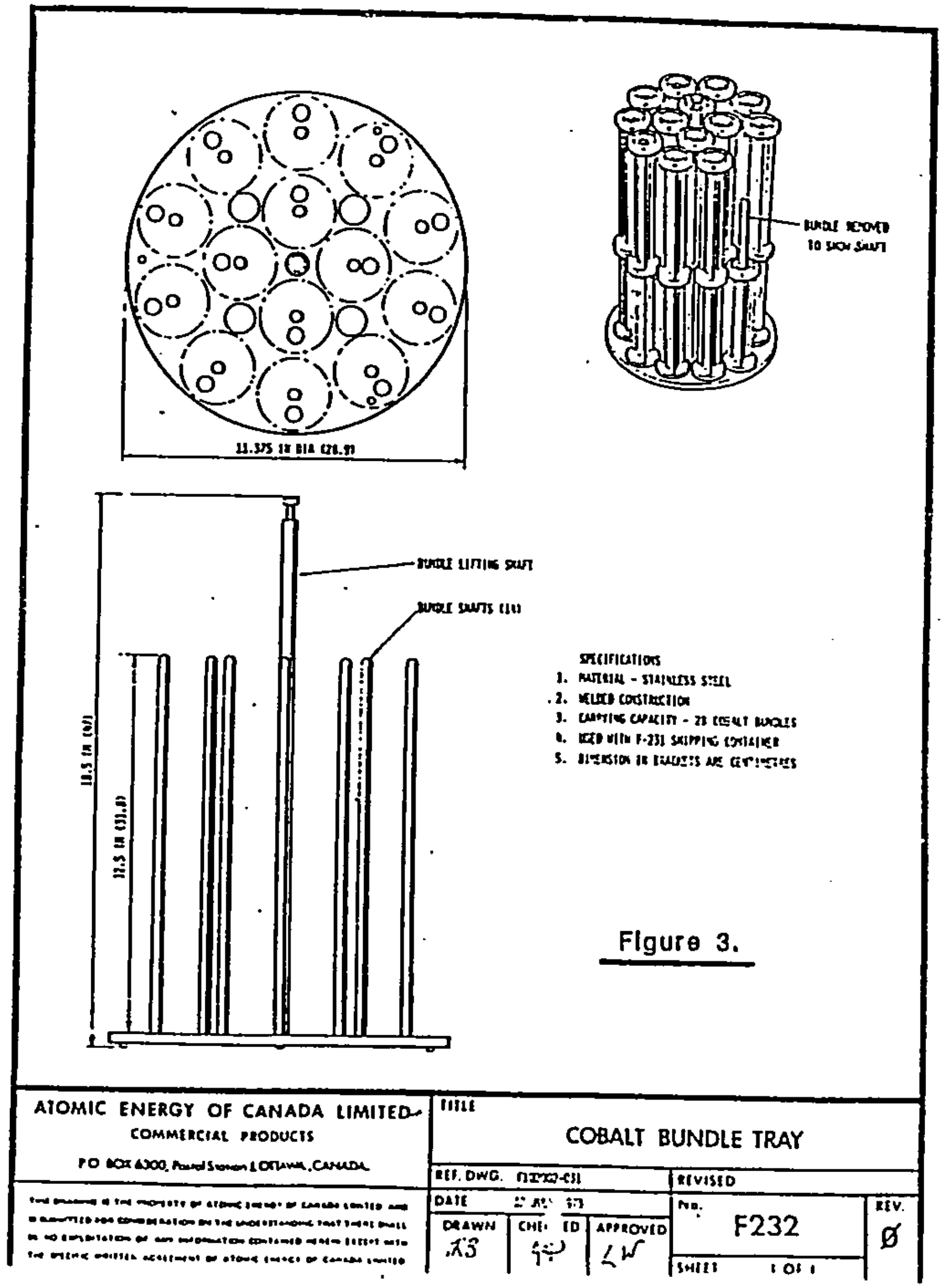


Figure 3.

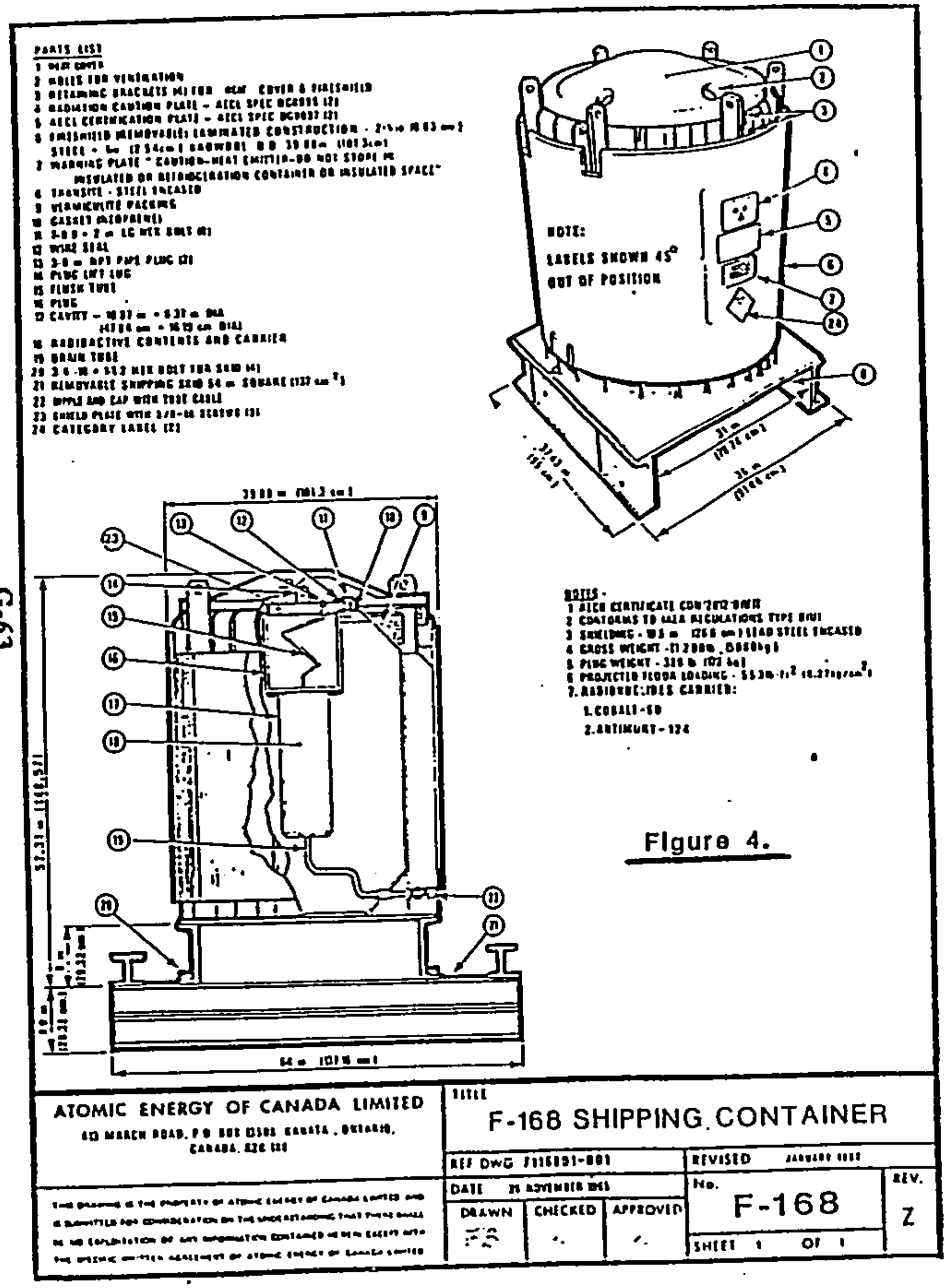


Figure 4.

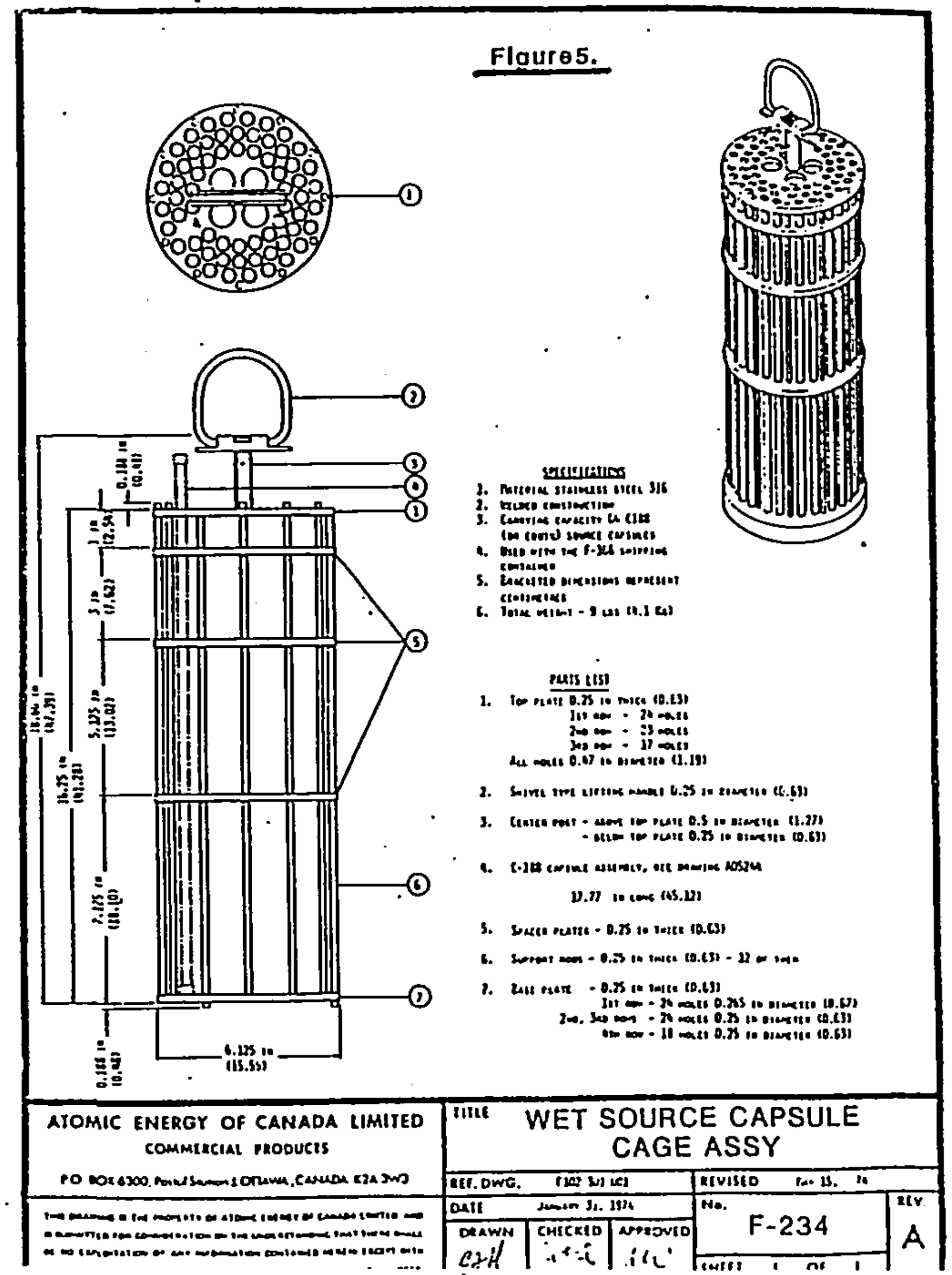


Figure5.

APPENDIX H

RELEVANT REGULATIONS AND GOVERNMENT DOCUMENTS

APPENDIX H
RELEVANT REGULATIONS AND GOVERNMENT DOCUMENTS

Following are copies of some federal government guidelines relevant to the irradiation facility.

federal register

Friday
April 18, 1986

Part III

Department of Health and Human Services

Food and Drug Administration

21 CFR Part 179
Irradiation in the Production, Processing, and Handling of Food; Final Rule

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food and Drug Administration

21 CFR Part 179

[Docket No. 81N-0004]

Irradiation in the Production, Processing, and Handling of Food

AGENCY: Food and Drug Administration.

ACTION: Final rule.

SUMMARY: The Food and Drug Administration (FDA) is amending its regulations to permit additional uses of ionizing radiation for the treatment of food. These regulations: (1) Permit manufacturers to use irradiation at doses not to exceed 1 kiloGray (kGy) to inhibit the growth and maturation of fresh foods and to disinfect food of arthropod pests, (2) permit manufacturers to use irradiation at doses not to exceed 30 kGy to disinfect dry or dehydrated aromatic vegetable substances (such as spices and herbs) of microorganisms, (3) require that foods that are irradiated be labeled to show this fact both at the wholesale and at the retail level, and (4) require that manufacturers maintain process records of irradiation for a specified period and make such records available for FDA inspection. These regulations are promulgated on the agency's initiative and are necessary to permit the safe use of ionizing radiation. This document responds to comments on the February 14, 1984, proposed rule (49 FR 5714).

DATES: Effective April 18, 1986; objections by May 19, 1986.

ADDRESS: Written objections and request for a hearing to the Dockets Management Branch (HFA-305), Food and Drug Administration, Rm. 4-62, 5600 Fishers Lane, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT: Clyde A. Takeguchi, Center for Food Safety and Applied Nutrition (HFF-330), Food and Drug Administration, 200 C St. SW., Washington, DC 20204, 202-472-5740.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Introduction

Under section 409 (b) and (d) of the Federal Food, Drug, and Cosmetic Act (the act), the Secretary may approve a food additive petition from an interested person or may propose the issuance of a food additive regulation upon the Secretary's own initiative (21 U.S.C. 348 (b) and (d)). It is less common for FDA, acting as the Secretary's delegate, to propose and then establish a regulation itself, than to respond to a sponsor's petition. In the case of food irradiation, FDA had, before 1981, approved several food additive petitions for the use of various sources of radiation on certain foods and food-packaging materials (21 CFR Part 179). Subsequent to these approvals, an FDA committee evaluated testing criteria that would be necessary to support the safety of food irradiation for various uses.

In the Federal Register of March 27, 1981 (46 FR 18992), FDA published an advance notice of proposed rulemaking that announced the availability of the Bureau of Foods' (now the Center for Food Safety and Applied Nutrition) Irradiated Food Committee (BFIFC) Report (Ref. 1), which outlined a course of action for assuring the safety of irradiated foods, and requested comments on the overall approach.

In the Federal Register of February 14, 1984 (49 FR 5714), FDA published a proposed rule that would: (1) Establish general provisions for food irradiation, (2) permit the use of food irradiation at doses not exceeding 1 kiloGray (kGy) (100 kilorads; 100 krad) [1] for inhibiting the growth and maturation of fruits and vegetables and for insect disinfestation of food, (3) allow irradiation to be used for microbial disinfection of certain dried spices and dried vegetable seasonings at a dose not to exceed 30 kGy (3 Mrad), (4) eliminate the current irradiated food labeling requirements for retail labeling, and (5) replace the current sections (21 CFR 179.22 and 179.24) dealing with the irradiation of food with new §§ 179.25 and 179.26 (21 CFR 179.25 and 179.26). The proposal responded to comments on the advance notice of proposed rulemaking.

Apart from that ongoing rulemaking, FDA has approved a number of food additive petitions to provide for the safe use of gamma radiation at doses up to 10 kGy (1 Mrad) to control insect infestation and microbial contamination in dried herbs, spices, and vegetable seasonings (48 FR 33313, July 5, 1983; 48 FR 46022, October 11, 1983; 49 FR 24938, June 19, 1984; 50 FR 15415, April 18, 1985) and in dry enzyme preparations (50 FR 24190, June 10, 1985). FDA also issued a final rule on July 22, 1985 (50 FR 29658) which amended 21 CFR 179.22(b) in response to a petition to provide for the safe use of gamma radiation at doses up to 1 kGy (100 krad) to control *Trichinella spiralis* in pork.

The act requires that a food additive, including a source of radiation used to process food, be shown to be safe under the proposed conditions of use before use of the food additive can be approved. That is, the agency must be assured with reasonable certainty that no harm will result from irradiation of food. A source of radiation is specifically defined as a food additive in section 201(s) of the act (21 U.S.C. 321(s)). The Senate report on the Food Additives Amendment of 1958 made clear that "[s]ources of radiation (including radioactive isotopes, particle accelerators and X-ray machines) intended for use in processing food are included in the term 'food additive' as defined in this legislation." S. Rept. 2422, 85th Cong., 2d Sess. 03 (1958).

Section 409 of the act lists the criteria which must be considered by the agency before a food additive regulation is issued. The statute does not prescribe what safety tests should be performed but leaves that determination to the discretion of scientists. The definition of safety, as drawn from the legislative history of the Food Additives Amendment of 1958, has been codified in 21 CFR 170.3(i) as follows:

> "Safe" or "safety" means that there is a reasonable certainty in the minds of competent scientists that the substance is not harmful under the intended condition of use. It is impossible in the present state of scientific knowledge to establish with complete certainty the absolute harmlessness of the use of any substance. Safety may be determined by scientific procedures or by general recognition of safety. In determining safety, the following factors shall be considered:
>
> (1) The probable consumption of the substance and of any substance formed in or on food because of its use.
>
> (2) The cumulative effect of the substance in the diet, taking into account any

[1] The Système International (SI) unit for expressing the amount of absorbed radiation dose is the Gray (contracted form, abbreviated Gy). An older and commonly used unit is the rad. The equivalent value in rads (100 rad = 1 Gy) will be enclosed in parentheses when referring to the amount of absorbed radiation. The prefixes kilo (k) and mega (M) represent a thousandfold and a millionfold, respectively. Thus, kilorad means a thousand rads and a megarad means a million rads.

chemically or pharmacologically related substance or substances in such diet.

(3) Safety factors which, in the opinion of experts qualified by scientific training and experience to evaluate the safety of food and food ingredients, are generally recognized as appropriate.

In passing the Food Additives Amendment of 1958, Congress recognized that it is impossible to establish with complete certainty the absolute harmlessness of any chemical substance. The concept of safety used in the amendment involves reducing uncertainty about the safety of an additive to the point where the agency can reasonably conclude that no harm will result from its proposed use.

This objective can be achieved in a variety of ways. To determine whether consumption of a substance is safe, the agency considers the amount and identity of the substance ingested in light of what is already known regarding its toxicity. Ordinarily, animal feeding tests are essential for assessing toxicity of a substance. Not all situations require the same amount or type of testing, however, to determine whether use of an additive is safe. The degree of effort expended in reducing uncertainty about the safety of an additive must relate in some way to the likelihood that use of the additive poses a potential health risk to the public. Testing that is unlikely to provide information that would reduce uncertainty regarding safety should not be required. To do otherwise would waste scarce scientific resources that could be used for more productive purposes.

II. Comments

The agency received over 5,000 comments on the proposal. Many of the comments simply stated opinions for or against permitting food irradiation or requiring special labeling but identified no substantive issues to which the agency can respond. For example, some comments expressed concern that food might become radioactive, but none provided factual support. Other comments acknowledged that irradiation of food will not make the food radioactive. The agency believes that the proposal adequately addressed the issue of induced radioactivity in food (see 49 FR at 5716). Because no evidence has been submitted to contradict FDA's finding that the irradiation of food does not cause the food to become radioactive, no further discussion of this issue is necessary.

Many of the comments were concerned about the formation and the safety of radiolytic products, and the effect of irradiation on nutrients in food. A majority of those comments stated that more studies were needed because the long-term effects of these radiolytic products have not been ascertained with enough certainty to justify the conclusion that the use of irradiation is safe. The substantive comments and FDA's response to each are discussed below.

A. Safety

Before responding to the substantive comments relating to safety, the agency believes it would be useful to explain again its safety assessment of food irradiation and its conclusions concerning the safety of foods irradiated in compliance with this regulation. A summary of FDA's position on safety is set forth below.

In the proposed rule, the agency stated "[illegible] below 1 kGy (100 krad) has been established * * * because: (1) Irradiation will not make the food radioactive, and thus cannot expose the consumer to radiation; (2) the chemical differences between irradiated foods processed at these doses and nonirradiated foods are too small to affect the safety of the foods; (3) food irradiated at doses up to 1 kGy (100 krad) will have the same nutritional value as similar foods that have not been irradiated; and (4) the balance between microbial spoilage organisms and pathogenic organisms is not adversely affected by radiation doses below 1 kGy [illegible]

The agency has followed the same general procedures in the development of regulations for the use of sources of radiation as are followed in the development of regulations for other food additives. Under the act, the agency's primary responsibility is to determine that the additive is safe under the proposed conditions of use. Since the 1[illegible]'s when the first petition for the treatment of food with radiation sources was submitted, the agency has been confronted with the question of what test procedures are appropriate to establish reasonable certainty of no harm for use of radiation sources in the treatment of food. In the absence of adequate data on the chemical changes in food treated with radiation and information on the nutritional quality of such food, FDA concluded that petitioners should submit long-term animal feeding studies to demonstrate the "wholesomeness" of the irradiated food. In those instances where petitioners have provided adequate chemical and nutritional data to the agency, FDA has not required petitioners to submit long-term animal feeding studies. For example, FDA has issued regulations authorizing the use of x-rays for inspection of food, microwaves for heating food, and ultraviolet radiation for treating food based on chemical analyses (see 21 CFR 179.21, 179.30, and 179.39, respectively).

In 1979, FDA established its Bureau of Foods Irradiated Food Committee (BFIFC) to review the existing agency policy concerning the irradiation of foods. BFIFC's main task was to make recommendations regarding the establishment of those toxicologic testing requirements appropriate for assessing the safety of irradiated foods. BFIFC's recommendation focused on making the degree of testing compatible with the potential risk as indicated by the level of anticipated human exposure. BFIFC recognized that safety assessments of irradiated food should be based on: (1) Projected levels of human exposure to the food; (2) estimates of the identify, amount, and potential toxicity of new chemical constituents generated in the food by the irradiation process; and (3) state-of-the-art sensitive toxicological tests. BFIFC completed its review and submitted its final report in July 1980 (Ref. 1).

BFIFC recognized that no single approach provided sufficient data to estimate the percentage of food consumption that might consist of irradiated food. Hence, in projecting human exposure to irradiated food, BFIFC used estimates of total food consumption, dietary items proposed for irradiation, and the percent of each dietary item which may be irradiated. Using a rough estimate based on these factors, BFIFC suggested that as much as 40 percent of the total diet could be irradiated, but anticipated that actual human exposure would not exceed 10 percent of the diet.

Further, the committee considered those chemical constituents generated by irradiation, also known as radiolytic products. BFIFC assumed that some radiolytic products may be unique to irradiated foods, and created the term "unique radiolytic products" (URP's) to mean substances not known to be present in nonirradiated food. However, BFIFC recognized that scientists do not know the extent to which these substances, although characterized as URP's, may actually be present as common constituents of the human diet.

BFIFC reviewed the available literature dealing with radiation chemistry, the identification and quantification of substances produced in foods as a result of irradiation, and found that the amount of radiolytic products generated is primarily dependent upon the amount of energy

absorbed by the food. Based on data showing how much chemical change is likely to be caused by a given amount of radiation energy, BFIFC concluded that irradiation of food at 1 kGy (100 krad) would generate approximately 30 parts per million (ppm) of radiolytic products. Experiments have shown that very few of these radiolytic products are unique to irradiated foods: approximately 90 percent of the radiolytic products identified by BFIFC are known to be natural components of food (Ref. 1). BFIFC found the remaining 10 percent of the radiolytic products to be chemically similar to known natural food components. Because of this chemical similarity, those radiolytic products are likely to be toxicologically similar also. Because natural components of food are not well characterized at the parts per million level, some radiolytic products assumed by BFIFC to be unique may actually be natural components of foods. However, even if 10 percent of the radiolytic products are unique, their cumulative concentration in food irradiated at 1 kGy (100 krad) would be only 3 per million, one-tenth the concentration of 30 parts per million for all radiolytic products. Moreover, the concentration of any single URP will probably be less than 1 part per million for food irradiated at 1 kGy (100 krad). Because different portions of a food being irradiated will receive different doses, the average radiation dose absorbed by the food will necessarily be less than the maximum permitted dose. Therefore, the concentration of URP's generated in food from irradiation should be even lower than the upper bound estimate calculated by BFIFC.

BFIFC concluded that because of the extremely low potential concentration of individual URP's in foods irradiated at doses below 1 kGy (100 krad), and because any URP's are likely to be toxicologically similar to other food components, it would be virtually impossible to detect potential toxicological properties of these substances. The current state-of-the-art toxicity tests are not sensitive enough to detect the potential toxicity of URP's at these low levels unless the URP's are far more potent than experience in the radiation chemistry of foods and in toxicology would suggest.

Because the potential concentration of URP's in irradiated food is low, BFIFC concluded that food irradiated at doses not exceeding 1 kGy (100 krad) is wholesome and safe for human consumption, even where the food that is irradiated may constitute a substantial portion of the diet. Consequently, the committee recommended that foods irradiated at doses below 1 kGy (100 krad) be considered safe for human consumption without the requirement of toxicological testing. BFIFC based this recommendation on radiation chemistry and on the anticipated low levels of human exposure to any URP's generated in irradiated foods.

The committee further concluded that a food (e.g., nutmeg) that comprises only a small fraction of the human diet (i.e., no more than 0.01 percent of the diet) and that is irradiated at doses up to 50 kGy (5 Mrad) would necessarily contribute far fewer radiolytic products to the daily diet—approximately 20 times less—than a food representing a significant fraction of the diet (e.g., 10 percent) irradiated at 1 kGy (100 krad). Consequently, BFIFC recommended that foods comprising no more than 0.01 percent of the daily diet and irradiated at 50 kGy (5 Mrad) or less also be considered safe for human consumption without toxicological testing. BFIFC based this recommendation on radiation chemistry and the anticipated low levels of human exposure to any URP's generated in irradiated foods.

The agency agreed with the scientific rationale and conclusion reached by BFIFC that an adequate margin of safety could be demonstrated for irradiated foods without the requirement of toxicological testing and adopted its recommendations concerning the safety of foods irradiated at the proposed dosage levels (March 27, 1981; 46 FR 18992).

Subsequently, in 1981, FDA's Bureau of Foods established the Irradiated Foods Task Group to review all available toxicological data concerning foods treated by irradiation. The major objectives of this Task Group were to compile and summarize the toxicology data pertaining to irradiated foods, identify any consistencies with respect to adverse findings, look for patterns or trends in response between studies, and to summarize the experimental results at the end of the review (Refs. 2 and 3).

The data review proceeded in three phases. In phase I, all relevant toxicology studies were identified from FDA files and from the open literature. In phase II, 441 of these studies were obtained in hard copy and summarized. These summaries categorized studies as: (1) "Accepted," if on initial examination the study appeared to be reasonably complete; (2) "accepted with reservation," if the testing, on initial summary review, appeared acceptable but had some serious deficiencies interfering with interpretation of the data; or (3) "rejected," if there were inadequacies of the experimental design or data collection, or if dietary problems existed in the study that would prevent a valid evaluation. In phase III, 69 studies that either raised questions concerning the possibility of adverse effects or that appeared to support a conclusion that the irradiated food studied is safe were examined in detail and reported (Ref. 4).

Based on its examination of all the data, the Task Group concluded that studies with irradiated foods do not show adverse toxicological effects. However, the Task Group further concluded that traditional toxicological testing of food irradiated at doses below 1 kGy (100 krad) cannot be expected to provide meaningful answers to toxicity questions regarding such irradiated foods. The Task Group based this conclusion on several major reasons: (1) Nutritional imbalances created in the test animal fed high levels of irradiated or nonirradiated foods would tend to mask any potential toxicological manifestations; (2) the low concentration of any potentially toxic radiolytic products in the irradiated foods would prevent significant exaggeration of the amount of radiolytic products in a test diet; and (3) such toxicological testing is currently too insensitive to measure toxicity because the concentrations of URP's potentially present in the irradiated foods tested are simply too low. Based on its review of all studies, including those which tested food irradiated at doses more than an order of magnitude higher than 1 kGy (100 krad), the Task Group agreed with BFIFC's conclusion that there was an adequate margin of safety for foods irradiated below 1 kGy (100 krad). Hence, the Task Group also agreed that toxicology tests on foods irradiated at 1 kGy (100 krad) or below are not needed to support a conclusion that such foods are safe.

Based on the findings, rationale, and conclusions of BFIFC and the Task Group, FDA concludes that food irradiated at doses not exceeding 1 kGy (100 krad) is safe for human consumption. The agency further concludes that use of this level of irradiation should be exempt from requirements for toxicological testing because such testing would not be able to measure any toxicological properties of radiolytic products present in irradiated foods. In addition, the agency concludes that irradiation of dry or dehydrated aromatic vegetable substances is safe for human consumption at higher doses. The agency has determined that irradiation at doses no higher than 30 kGy (3 Mrad) will be adequate to accomplish the intended microbial disinfection of dry or dehydrated vegetable substances. The agency emphasizes that although toxicological data may sometimes be helpful in evaluating the safety of irradiated foods, such data are not scientifically necessary for determining the safety of radiation for the uses and doses encompassed by this regulation.

In addition to studies available in the published literature, the U.S. Department of Agriculture (USDA) has made available through the National Technical Information Service (49 FR 40623; October 17, 1984) final reports of certain contracted animal toxicological studies of radiation-sterilized chicken and reports on chemical changes in food caused by irradiation. The agency has reviewed studies involving mice and dogs fed radiation-sterilized chicken meat and concludes that these studies do not show any treatment-related effects (Refs. 5 and 6). These studies are discussed in further detail in the responses to those comments which reference the USDA studies.

1. Radiolytic Products

1. Many comments expressed the opinion that the radiolytic products produced during irradiation would made the food harmful. Some comments stated that the radiolytic products are free radicals and that ingestion of these free radicals would be harmful. Other comments stated that the free radicals may later form toxic substances.

The agency disagrees that free radicals or toxic substances will be produced in food at unsafe levels under the conditions prescribed by this rule. The issue is not whether free radicals, hypothetically, can later form toxic substances, but whether the formation of a toxic substance is sufficiently probable to raise questions about the safety of the irradiated food. Although the generation and subsequent reaction of free radicals comprise the major route by which radiolytic products are formed, such reactions are also common during conventional food processing and storage operations. As was discussed above, substances that are chemically similar to radiolytic products are often formed or are present in foods that are not irradiated.

The important issue the agency must consider with regard to radiolytic products is the probability that a toxic radiolytic end product may be formed and whether such a product would be present in sufficient amounts to make the food unsafe. The agency has no evidence to cause it to change its position that the chemical differences between foods irradiated at the doses allowed by this regulation and nonirradiated foods are too small to cause concern about the safety of the irradiated foods.

2. Some comments expressed the opinion that irradiated foods are unsafe because ingestion of irradiated foods may result directly in toxic free radical and peroxide formation within the body.

The agency disagrees. Although irradiation produces free radicals as reactive intermediates in the food itself, the high water content of all fresh food provides a medium for their rapid degradation after irradiation. Thus, they are not likely to persist or be present at all in food by the time that food reaches the consumer. However, irradiated dry spices and seasonings are examples of foods in which free radicals are known to persist for long periods of time. Nonetheless, the manner in which these foods are used—as ingredients in other foods that contain water—provides a means for rapid dissipation of the free radicals, thereby precluding their ingestion.

While peroxides are sometimes formed in irradiated foods, they are also formed in foods that are not irradiated. The agency has no evidence to suggest that irradiated foods would be metabolized differently from nonirradiated foods and thus form unique or toxic free radicals or peroxides within the body. Therefore, the agency believes that concerns about the safety of irradiated foods as expressed in these comments are unfounded.

3. One comment stated that "[a]ny preservation of foodstuffs by irradiation at any dose may be unwise," and that gaseous oxygen from air gives rise to free radicals, peroxides, and hydroperoxides. The comment also stated that increased concentration of hydrogen peroxide ordinarily results from irradiation. The comment noted that "[t]he addition of hydrogen peroxide to food as a preservative has been prohibited in a number of countries, notably Japan, as a contributor to carcinogenesis."

The formation of detectable quantities of hydrogen peroxide, organic peroxides, and hydroperoxides during irradiation of foods in the presence of oxygen is well documented, and food processors normally try to minimize contact of their products with air during processing and packaging. Peroxides result from free radical chemistry, as discussed earlier, between oxygen and the primary radiolytic products from the carbohydrates, fats and oils, and water present in food. The potential biological consequences of the thermal degradation of the intermediate peroxides and their reactions with the multitude of food components have been addressed by a number of researchers (Refs. 7, 8, and 9).

FDA considered the potential carcinogenicity of hydrogen peroxide in its final rule permitting the use of hydrogen peroxide as an indirect food additive for sterilizing polyethylene food contact surfaces used for food packaging (46 FR 2341; January 9, 1981). The agency had specifically addressed a Japanese report of a bioassay of hydrogen peroxide performed with C57B mice in which the authors had indicated that the chemical may have caused duodenal cancer. Upon review and after consultation with the authors of the study, the agency stated that the evidence was insufficient to conclude that hydrogen peroxide is a carcinogen (46 FR 2341; January 9, 1981).

In that document, the agency also considered the issue of human exposure to hydrogen peroxide in food and concluded that milk packaged in materials sterilized by hydrogen peroxide would contain hydrogen peroxide at a level no greater than 100 parts per billion at the time of packaging. Moreover, after 24 hours, the hydrogen peroxide concentration would fall to about 1 part per billion, i.e., more than 99.9 percent of the hydrogen peroxide will no longer be present in the food.

Similar considerations leads the agency to conclude that any hydrogen peroxide produced during irradiation of fruits and vegetables or meats in compliance with this final rule would be rapidly degraded to negligible levels by natural enzymes and natural antioxidants in the food. Furthermore, any residual hydrogen peroxide, if present, would be considerably less than that encountered ordinarily in foods and environmental sources.

Organic hydroperoxides, formed by reaction of radicals resulting from reaction of oxygen with primary radiolysis products, are both thermally and chemically unstable and decompose to various aldehydes, ketones, alcohols, and hydrocarbons which constitute the primary radiolytic end products also identified as components of both unprocessed and conventionally processed foods. The yields of these substances formed under the conditions of this regulation are sufficiently low as to raise no concerns regarding safety.

Finally, microbiological studies that have reported toxic effects of irradiated aqueous sugar solutions in which peroxides and peroxo radicals are generated are discussed in paragraphs 21 and 22 of this preamble. The agency

has concluded that these studies are inappropriate models for assessing the safety of irradiated foods.

4. Some comments stated that no radiolytic products are unique and noted that the U.S. Army Natick Laboratory found no unique products in irradiated meats. These comments indicated that the term "unique" is misleading and should not be used.

The BFIFC report used the term unique radiolytic products (URP's) to describe substances produced in food during irradiation which have not been shown to be present in nonirradiated food. The BFIFC report recognized, however, that substances characterized as URP's may be normal minor constituents in the human diet that have simply not been detected through routine analysis of nonirradiated food.

As stated in the proposal, the agency agrees that some radiolytic products assumed to be unique may well be natural or common components undetected in nonirradiated food. However, it is impossible to demonstrate with absolute certainty that that will always be the case for all radiolytic products. Therefore, the agency cannot be certain that all radiolytic products are normal components of the human diet. To be prudent, the agency has assumed, for purposes of safety assessment, that some minor radiolytic products present may not be normal components of the human diet, and, thus, may be unique to the process. Based upon such conservative assumptions, the agency concludes that the amount of potential URP's would be so low as not to pose a safety problem.

5. One comment asked, "what happens to pesticide residues on produce when they undergo irradiation treatment? What are the health risks to humans?"

A pesticide chemical, like any other chemical component of food, will possess a certain level of sensitivity to ionizing radiation. The degree of sensitivity of a pesticide chemical to the primary ionizing energy and to chemical reaction with primary radiolytic products from other constituents of a food matrix will depend on the molecular structure of the pesticide. As is the case with other chemical components of a food, the total yield of radiolytic products from irradiation of any given pesticide will be a function of the amount of pesticide present, as well as its sensitivity to radiation.

The BFIFC estimated that the sum of all radiolytic products produced by irradiation at 1 kGy (100 krad) would be no more than 30 parts per million in food. This means the cumulative concentration of all radiolytic products from a pesticide residue would correspond to a concentration of less than 30,000 times smaller than the concentration of the pesticide residue itself. Because such low levels of pesticide residues are expected in food, the agency believes that the total amount of radiolytic products from a pesticide chemical that may be consumed from foods irradiated in compliance with this regulation at doses below 1 kGy (100 krad) will be virtually nil. Therefore, the agency concludes that the potential toxicity of each radiolytic product from a pesticide chemical residue on foods that are irradiated would be negligible and that such pesticide residues do not pose a hazard to health.

2. Spices

6. One comment stated that foods such as spices comprise more than 0.01 percent of the daily diet and that the proposed rule was inconsistent with BFIFC's recommendation that irradiation of foods constituting less that 0.01 percent of the diet be considered safe up to 50 kGy (5 Mrad).

The agency agrees that spices, in total, may constitute more than 0.01 percent of the daily diet. The agency has estimated a probable intake of dried spices and culinary herbs of up to 3 grams per person per day. For the general population, this constitutes 0.1 percent of the total diet of 3 kilograms.

The comment was apparently confused by terminology in the BFIFC report recommending that a "food class" which contributes 0.01 percent or less to the daily diet be considered safe for irradiation at doses up to 50 kGy (5 Mrad). The 0.01 percent in the recommendation was intended to refer to the dietary contribution of an individual spice (e.g., nutmeg or turmeric) as a "food class," not all spices as a "food class." Because radiolytic products from different spices are likely to be different, there is no reason to add the amount of radiolytic products from one spice, such as nutmeg, to another spice, such as turmeric, when evaluating safety. The intent of BFIFC's recommendation was not to set a precise dietary percentage limit of 0.01 percent but rather to acknowledge that the amounts of radiolytic products that would potentially be consumed from irradiated dried spices and seasonings are so small that such irradiated foods can be considered safe as ordinarily used. Neither the proposal nor the final regulation permitting the irradiation of spices at 30 kGy (3 Mrad) is inconsistent with BFIFC's recommendation.

7. Some comments on the proposed rule expressed concern that large amounts of irradiated spices and seasonings used by certain ethnic groups in their food would exceed safe consumption levels. The comments provided no information on which to base such a concern.

The agency recognizes that dietary patterns differ between groups of people and that certain groups consume more spices and seasonings than do other groups. Nevertheless, the agency has no reason to believe that any ethnic group will consume any irradiated spice or seasoning in amounts that would raise any safety concern, even considering dietary variations among ethnic groups. A single spice or seasoning would still be a minor ingredient in the diet. Moreover, as discussed in the previous response, the radiolytic products from one spice are different from those of another spice; therefore, their effects, if any, will not be cumulative.

8. The agency invited comments on the list of spices that is considered appropriate for irradiation. Comments recommended including those substances listed in § 182.10 *Spices and other natural seasonings and flavorings* (21 CFR 182.10), as well as other spices, seeds, and herbs commonly used as minor flavoring ingredients, and including teas and other vegetable seasonings. Some comments also stated that a specific list of spices was unnecessary and a phrase such as "herbs, seeds, and spices" should replace the individual listing of spices. One comment stated that to prohibit treating a spice mix because one minor ingredient is not on the list is not logical and suggested an alternative approach of granting overall approval to seasoning and flavoring substances currently considered generally recognized as safe because their safety would not be significantly changed by irradiation.

The agency disagrees that natural flavors should necessarily be included in the list and is not permitting the use of irradiation for natural flavors at this time. Natural flavors are components of food ingredients that have undergone some processing. Such flavors may be in solid or liquid form. The agency's conclusion that minor ingredients such as dried spices and seasonings may be irradiated safely was based on the fact that the amount of chemical change in the solid, dry state of a food is less then would occur when substantial portions of liquid are present and that dry ingredients would not support the growth of microorganisms that might survive irradiation. The agency has no information from which to conclude that flavors in liquid form can be irradiated safely. Also, the agency has no information indicating that processed flavors require treatment for disinfection. Anyone interested in pursuing this matter further may do so by submitting an appropriate food additive petition.

The agency agrees that a specific list of spices and seasoning agents is unnecessary. Collective terms are used to describe different groups of these minor ingredients and such terms may be more appropriate than a detailed listing. Although herbs may be used for both culinary and medicinal purposes, a food additive regulation applies only to the irradiation of culinary herbs. Therefore, the agency is now modifying the regulation to permit irradiation of dry or dehydrated aromatic vegetable substances: culinary herbs, seeds, spices, teas, and vegetable seasonings.

9. Some comments apparently assumed that the proposed regulation would not permit irradiation of spice blends and requested modification of the regulation to permit such irradiation.

The issue is twofold: (1) Whether blends can be irradiated, and (2) whether the regulation authorizes the irradiation of enough ingredients to make the irradiation of commercial blends practical. The regulation does not preclude the irradiation of spice blends. The agency recognizes that the limited number of spices listed in the proposed rule would have prohibited blends containing other ingredients. As explained above, the agency agrees that the description of the substances that may be irradiated as dry or dehydrated aromatic vegetable substances should be more comprehensive than that listed in the proposed rule. In addition, salt and other adjuvants or minor ingredients (such as anticaking and free flow agents) may be used in a blend of seasoning substances. Under such limited conditions of use, the irradiation of these minor dry ingredients would pose no concern. Therefore, the agency is describing in this final rule the spices and seasonings in general terms and is explicitly authorizing the use of blends of aromatic vegetable substances, as well as salt and other dry foods ordinarily used as minor ingredients in such blends.

H-4

3. Other Minor Foods

10. One comment stated that color additives are important ingredients in the manufacture of processed foods, as well as drugs and cosmetics, and are used in minute amounts in the diet. This comment further stated that turmeric and paprika are color additives that are also included in the list of spices and vegetable seasonings that can be irradiated and suggested that the final regulation be expanded to include other listed color additives.

The agency does not agree that this regulation should include color additives. In preparing its proposed rule, the agency had not considered the ramifications of approving the irradiation of color additives. Such consideration would include whether specifications established for a color additive based on current manufacturing processes would still be adequate for the color additive after irradiation and what doses would be needed to accomplish the intended effects. Persons able to document the safe use of a source or radiation to irradiate color additives may submit a petition to the agency. The agency agrees that turmeric and paprika are both spices and color additives. However, their major use is as seasoning agents, and the agency sees no reason to preclude irradiation of these aromatic vegetable substances when they are also used as color additives (Ref. 10).

11. One comment stated that the rule should allow for the irradiation of dry enzyme preparations for microbial disinfection at a dosage up to 30 kGy (3.0 Mrad) because they are minor food ingredients.

The agency had not considered this specific use of irradiation in developing the proposed rule. However, the agency received a petition to treat dry enzyme preparations at doses up to 10 kGy (1 Mrad), and in the Federal Register of June 10, 1985 (50 FR 24190), the agency amended § 179.22 to permit this use. In this document, the agency is deleting § 179.22 and is incorporating that authorization for irradiation of dry enzyme preparations in new § 179.26(b). Persons able to document the safe use of a source of radiation at dosage levels higher than 10 kGy (1 Mrad) as authorized in new § 179.26(b) to control microbial contamination in dry enzyme preparations may submit a petition to the agency.

4. Destruction of Nutrients

12. Several comments stated that destruction of nutrients should be a concern in this rulemaking. The comments stated that many vitamins are light or heat sensitive, and that irradiation will destroy them. One comment stated that nutritional problems may develop for consumers because of nutrient loss when an entire class of foods is irradiated.

The proposal discussed this issue and explained that the available literature indicated that there are no nutritional differences between unirradiated food and food irradiated at levels below 1 kGy (100 krad). The minor ingredients allowed to be irradiated at higher doses are not sources of nutrients. Therefore, the agency believes it is appropriate to conclude that destruction of nutrients is not an issue in this rulemaking. There have been no additional data submitted to change this conclusion.

5. Selective Destruction of Microorganisms

13. One comment indicated that irradiation could contribute to increased aflatoxin contamination of foods. The comment cited a series of studies published in 1976 and 1979 by researchers from the National Institute of Nutrition of the Indian Council of Medical Research which reported that wheat irradiated at dose levels up to 250 kilorads showed a dose-dependent susceptibility to aflatoxin production (Refs. 11 and 12).

The agency disagrees that irradiation would contribute to increased aflatoxin contamination of foods. The studies referenced do not replicate actual food-handling practices. In the studies, the wheat was irradiated, autoclaved, and then innoculated with an aflatoxin-producing organism. The agency has no evidence that would lead it to conclude that food irradiated and stored under normal handling practices would show increased aflatoxin production. FDA does not believe that the results cited justify a modification of this rule.

14. Several comments stated that irradiation intended to eliminate one food hazard may affect the microbial spoilage patterns of food, thereby creating a new hazard. These comments expressed concern that *C. botulinum* spores would survive irradiation and would produce botulinum toxin without typical signs of food spoilage.

The agency agrees that this is a legitimate concern in some situations, but it does not apply to irradiation of dry foods or foods irradiated below 1 kGy (100 krad). Irradiation of food below 1 kGy (100 krad) will destroy few spoilage bacteria and thus will not change normal spoilage patterns. Furthermore, irradiation of minor ingredients at high doses, as allowed in this rule, would pose no problems because these minor ingredients are dry and dry foods do not provide a growth medium for *C. botulinum* spores.

15. Some comments stated that food irradiation may create or produce potentially harmful radiation-resistant bacteria, new bacteria, or viral mutants. One comment raised the possibility that mutated deoxyribonucleic acid (DNA)

fragments might be incorporated by bacteria, viruses, or cells of the human digestive tracts to create other harmful mutants.

Mutants produced during the irradiation of food are essentially the same as those that occur naturally. The only real difference is in the rate at which mutations occur. Radiation may increase the frequency of mutations and thereby increase the rate of evolution in bacteria or viruses that would occur otherwise through natural evolutionary processes. However, there is no reason to expect that the resulting mutants would be different or more virulent than those created in nature (Ref. 13).

Because bacteria are highly evolved organisms, well adapted to their environment, the vast majority of mutations would tend to be detrimental for the organisms. Mutant organisms that are more radiation resistant than their parents may survive and be present in an environment exposed to frequent sublethal doses of radiation. Such radiation-resistant bacteria, however, would be a problem only if irradiation were essential to produce a safe food. This is not the case and not permitting the use of food irradiation would not prevent such a problem from occurring.

Furthermore, the agency does not believe that such radiation-resistant bacteria or viruses, if they were produced, would be more resistant to other antibacterial agents. Although it is possible that specific conditions and indiscriminate irradiation might produce mutants, the agency concludes that the possibility that such mutants would be more virulent or more harmful is remote (Ref. 13).

There are only a few reports of genetic exchange between bacteria in the mammalian gut (Ref. 14). A few theories state that host cells may incorporate prokaryotic DNA, but it is not clear whether such genetic information is expressed. The agency sees no reason to prevent irradiation of food because of such speculations.

6. Toxicological Studies

16. Many comments claimed that it is FDA's first responsibility to ensure the absolute safety of all food produced and consumed in this country, not simply to make the process of production easier and/or cheaper for producers.

FDA agrees that its responsibility is to ensure that a food additive be demonstrated to be safe under the proposed conditions of use (21 U.S.C. 348(b)), but the agency does not believe that it was the intent of Congress, when formulating the act, that FDA ensure the consumer of absolute safety of all foods. Congress recognized that it would not be possible to determine with absolute certainty that no harm shall result from the intended use of a food additive. The Senate report stated: "Safety requires proof of a reasonable certainty that no harm will result from the proposed use of an additive. It does not—and cannot—require proof beyond any possible doubt that no harm will result under any conceivable circumstances." S. Rept. 2422, 85th Cong., 2d Sess. 6 (1958). As stated earlier, this is the standard of safety applied by FDA in rulemaking for food additives.

On the other hand, the legislative history makes clear that Congress did not intend FDA to make regulatory decisions on the use of an additive based on an arbitrary opinion as to whether the additive should be used. Thus, the agency, in approving the use of a food additive, considers whether the food additive is safe and effective and not whether such approval will be beneficial to the producer of the additive.

17. One comment asserted that FDA's proposed regulation was illegal because it was not based on animal testing. While recognizing that neither the Food Additives Amendment of 1958 nor its legislative history specifies the exact types of tests that must be conducted to establish safe conditions of use of an additive, the comment claimed that a recurrent theme in much of the legislative history is the need for testing in animals to establish the safety of a particular additive.

The agency agrees that much of the testimony before enactment of the Food Additives Amendment of 1958 discussed animal testing of additives. This could be expected because most of the testimony about testing concerned direct food ingredients of unknown toxicity. Congress did not discuss how irradiation of food should be tested for safety. Furthermore, there is no indication in the legislative history that Congress expected every additive, whether an ingredient, a source of irradiation, or an incidental additive, to be tested the same way; nor does the act require such testing. Such a requirement would result in an unnecessary expenditure of resources. Consistent with this view, FDA has never required the same testing regimen for all types of additives.

FDA believes that the testing requirement envisioned by Congress was that there be sufficient testing to support the conclusion that there is a reasonable certainty of no harm from the expected use of the additive. The agency believes that any test that would not contribute to this conclusion should not be required. The agency has not required animal testing in the past under those situations where, by chemical or other testing and sound reasoning, it could conclude that the use of an additive was safe without animal testing. Therefore, FDA concludes that available animal test data are not necessary for determining the safety of those uses of radiation encompassed by this document. Animal testing is too insensitive to show an effect from irradiation of food at the doses allowed and, thus, would not contribute additional information to the evaluation of the safety of such uses.

Nevertheless, the agency reviewed all available animal studies to determine their adequacy and to evaluate the toxicological evidence. FDA's evaluation of these studies confirms the agency's earlier conclusions that such data would not contribute further assurances of safety of foods irradiated in compliance with this rule.

18. One comment stated that food irradiation should be presumed dangerous until adequate scientific information is available for responsible decisionmaking and that FDA should make no decision until more information on hazards versus benefits of food irradiation is available.

For reasons discussed earlier in this section, the agency has determined that adequate information on radiation chemistry of foods is available to conclude that foods irradiated in compliance with this regulation are safe, and that the intended effects are achieved, thus complying with section 409 of the act.

19. One comment was concerned about the reliability of studies where animals were fed an abnormal diet and stated that results from these studies, positive or negative, may be misleading.

The agency agrees that standard toxicology tests where large percentages of the diet are composed of a single food, either irradiated or otherwise, may give results that could be misleading. The major difficulty in toxicological testing of irradiated foods has been to design tests that would provide useful and meaningful information regarding safety. It would be difficult to design a test that would exaggerate greatly the level of radiolytic products that will be ingested from irradiated food because, to accomplish this, the amount of irradiated food—the test substance that will be ingested—may also need to be increased. This increase in dietary intake may not be tolerated and may thereby become an added stress to the animal. A substantial change in diet may also create nutritional imbalances among either macro- or micronutrients of the diet.

FDA believes, however, that useful information has been learned from those feeding studies where there has been some exaggeration of dose relative to that prescribed by this regulation. This information together with knowledge of the chemical changes that occur at low doses of irradiation is sufficient to establish the safety of food irradiated in accordance with this regulation.

20. One comment suggested that FDA should require animal feeding studies in which the animals are feed food irradiated at exaggerated doses to obtain an adequate safety factor.

FDA acknowledges that food additives have typically been tested in animals at levels that greatly exaggerate the proposed levels of use of the additive to establish an adequate margin of safety. This traditional method of establishing a margin of safety is inappropriate when the additive is a source of radiation. FDA has examined many early studies in which food fed to animals was irradiated at exaggerated doses to determine the effect of ingesting increasing amounts of radiolytic products. The agency noted that treatment of food with increasing doses of radiation can destroy essential components (e.g., nutrients) of the food or make the food unpalatable. These factors can confound experimental results.

Because these effects on food do not occur at the lower doses, exposure of the foods to exaggerated radiation doses would not in these instances represent a valid test for determining the safety of foods irradiated at the levels of use prescribed by this regulation. The agency has, therefore, concluded that exposing food to ever increasing doses of radiation as a means of increasing the amount of radiolytic products ingested is generally not appropriate.

21. A number of comments objected to approval of irradiation of any fruit or vegetable because of reports that irradiated sucrose solution caused toxic effects. The comments suggested that sucrose solutions would serve as good models for evaluating the safety of irradiated fruits and vegetables and that the reported toxic effects were reason to disapprove this use of irradiation.

The agency agrees that irradiated solutions of sugars have been shown to cause biological effects in vitro. Certain studies have shown: (1) Abnormal anaphase formation in bean root tips treated with sucrose solutions irradiated at 2 Mrads (Ref. 15), (2) decreased growth in carrot tissue cultures grown in sucrose solution irradiated at doses ranging from 0.05 to 2 Mrad (Ref. 16), and (3) increased revertants in *S. typhimurium* after incubation with irradiated solutions of sucrose and irradiated solutions of glucose and ribose (Refs. 7 and 17). (The agency points out that its use of the term "sugar" in this response is generic. Where appropriate, specific sugars are mentioned by name.)

The biologically active compounds formed during irradiation of sugar solutions in the presence of oxygen are predominantly dicarbonyl sugars produced by reaction of peroxy radicals with suger molecules. These dicarbonyl sugars can then be converted to *alpha, beta*-unsaturated carbonyl sugars which are also present in nonirradiated foods. The yield of biologically active carbonyl sugars will be less in irradiated complex food matrices than in irradiated simple sugar solutions because of reactions with substances such as metal ions and oxygen present in foods (Ref. 9).

The authors of the study using bean root tips (Ref. 15) postulated that the increased amount of abnormal anaphase was due to a drop in the pH of the irradiated sucrose solution. In a subsequent experiment reported in the same paper, the authors concluded that the low pH caused by irradiation of the sucrose solution alone was the cause of the mutagenic effects.

In feeding studies where sugars are present in a typically complex food matrix there is no increase in mutagenicity after irradiation. For example, direct irradiation of mango pulp to 20 kGy (2 Mrad) produced no mutagenic effect (Ref. 7). This study demonstrated that when a food containing sugars is irradiated, the food does not produce the same toxic effects that occur when these sugars are irradiated in simple solution. There is ample evidence (Refs. 7, 18, and 19) that the types and quantities of radiolytic products from irradiation of sugar solutions are not only dose dependent but are also dependent on specific conditions such as oxygen concentration and metal ions present in foods but not present in simple suger solutions. Other studies on irradiated foods such as strawberries, dates, and mangoes likewise show no evidence of toxic effects (Refs. 20 through 26). The other studies that the agency reviewed regarding the toxicity of irradiated sucrose were of such poor quality that the agency does not believe that the data can be evaluated in a meaningful way.

The agency therefore concludes that irradiated aqueous sugar solutions are unsuitable models for predicting and extrapolating toxicity of irradiated foods. Therefore, the effects observed in these types of studies are not considered by the agency to be a reason for concluding that the uses of irradiation set forth in this regulation are not safe. The agency also concludes that there is no evidence that radiolytic products from sugars present in irradiated foods ause toxic effects to animals or humans.

22. One comment stated that a report in *Nature* magazine (Ref. 18) indicates that eating sugars irradiated at doses ranging from 0.05 to 2 Mrad can produce the same genetic changes in humans as exposure to irradiation itself.

The agency has reviewed this study and disagrees with the comment's interpretation of what the study found. Indeed the authors clearly did not reach the conclusions attributed to them by the comment. Furthermore, if humans or animals were irradiated at doses even 1,000 times lower than the levels used in this study, not only sterility but lethality would result within hours. On the other hand, humans and animals have consumed food irradiated at up to 4 Mrads (Refs. 27 through 32) without any indication of adverse effects of any kind. The study the comment referred to involved the effects of radiation on carrot tissue in liquid culture irradiated at 20 kGy (2 Mrads). This study and others concerning the effects of irradiation on solutions of sugars were discussed in the response to the previous comment.

The agency recognizes that irradiated sugar solutions have produced toxicity in vitro. The agency concludes, however, that irradiated sucrose solutions are unsuitable models for predicting and extrapolating toxicity of irradiated foods. Additionally, no evidence indicates that irradiated foods, including those containing sugars, will cause adverse toxic effects to animals or humans.

23. A few comments stated that a study involving hundreds of thousands of humans over 20 or 30 years is necessary before FDA can say irradiated foods are safe.

The agency has never required such long-term testing in humans to approve the use of a food additive and disagrees that such a study is necessary or appropriate. The agency recognizes that it cannot say with absolute certainty that any food, irradiated or not, is absolutely safe for all people under all conditions. The agency believes that the differences between foods irradiated as prescribed by this regulation and nonirradiated foods are so small, particularly compared to normal variations in the diet, that no effect is expected to be observed. The agency

believes that the substantial amount of available toxicological information supports the conclusion that the irradiation of food, as set forth below, is safe. Therefore, there is no basis for delaying for decades a decision to regulate food irradiation to conduct the type of study suggested by these comments.

24. Some comments also stated that many of the long-term toxicity studies on food irradiation were performed by Industrial Bio-Test Laboratories (IBT) and should, therefore, be considered invalid because much of the data generated by IBT had been falsified.

FDA agrees that studies containing falsified data performed by IBT should be rejected. All studies identified in the agency's review of available toxicological literature on food irradiation that had been performed by IBT were rejected. Much of the data compiled by IBT had been falsified or were proven invalid due to flaws in data collection, data reporting, and/or in experimental design. Thus the agency considers such data unacceptable to support safety.

25. Several comments stated that there are only a limited number of adequate chronic feeding studies on irradiated foods and that testing of the long-term health effects of consuming irradiated foods has been inadequate.

The agency has determined that because only minor chemical changes may result in food treated with low doses of radiation, animal feeding studies are not necessary to establish the safety of foods irradiated under conditions prescribed by this regulation. Therefore, it believes that the number of adequate chronic feeding studies on irradiated foods is irrelevant to its safety conclusion. The agency has evaluated those chronic studies that have been properly conducted and are considered to be adequate by current standards. None of those studies show adverse effects from the ingestion of irradiated food.

7. Alleged Adverse Effects

The agency reviewed 441 toxicity studies on irradiated foods (Refs. 2, 3, and 4). Forty-five of these studies dealt with subacute toxicity, 58 with subchronic toxicity, 128 with reproductive toxicity, 14 with teratology, 110 with chronic toxicity, and 102 with genetic toxicity or irradiated foods. Only 5 of the 441 studies reviewed (3 chronic feeding studies (Refs. 20, 33, and 34), 1 reproduction study (Ref. 35), and 1 combined chronic, reproduction, and teratology study (Refs. 36, 37, and 38) were considered by agency reviewers to be properly conducted, fully adequate by 1980 toxicological standards, and able to stand alone in the support of safety. The reports of these five studies indicate no adverse effects from the irradiated foods fed to test animals.

Although most of the studies were generally inadequate by present day standards and could not stand alone to support safety, many contained individual components which, when examined either in isolation or collectively, allowed the conclusion that consumption of foods treated with low levels of irradiation did not appear to cause adverse toxicological effects. Further, many of the studies were deemed useful for resolving certain questions. For example, if a potent toxic material were present at any level of toxicological significance in irradiated foods ingested by test animals, some consistent toxicological signs would be manifest in the studies reviewed. However, agency scientists have seen no such effects that present consistent patterns or trends of adverse effects that might be attributable to exposure to food irradiated at low dose levels. The agency, therefore, concludes that irradiation of foods as prescribed by this regulation is safe.

26. One comment referenced a book, "Consumer Beware" by B. Hunter, which stated that rats fed irradiated bacon and irradiated bacon and fruit mixtures showed increased mortality and an increased incidence of tumors. The author stated that the tumor incidence was increased and longevity was decreased.

Summaries of these studies were submitted in an early petition for sterilization of bacon by irradiation. FDA originally issued a regulation based on this petition (28 FR 1465; February 15, 1963). However, following evaluation of the complete reports of this study, FDA concluded that the sponsor had not met its burden for demonstrating safety (33 FR 12055; August 24, 1968) and rescinded the bacon regulations (33 FR 15410; October 17, 1968). Although previous reviewers asserted that the irradiated bacon studies may have shown adverse effects, the agency, after extensive reexamination of the study, now concludes that the claimed adverse effects cannot be substantiated because: (1) The study was of poor quality, (2) the numbers of animals examined were too small (three rats per group per generation) to have any statistical significance concerning tumors or longevity, and (3) the "total" incidence was only slightly increased in the low-dose group with no apparent dose dependence. Most national and international scientific bodies do not consider an increase in total tumors appropriate criteria indicative of a carcinogenic response (Ref. 40). The important consideration for determining if there is a carcinogenic response is whether there is an increase in the number of tumors at a specific organ site. The Armed Forces Institute of Pathology report (Ref. 39) on this study maintained that the tumors "showed no predeliction for any single organ." The numbers of animals at risk were too few to conclude that there was an effect on tumor incidence or longevity. If such effects had been caused by irradiated bacon, they should have been reproduced in the other irradiated feeding studies, including those the agency considers properly conducted (Refs. 20 and 33 through 38). However, such adverse effects were not observed.

27. One comment referenced a statement in the book "Eating May be Hazardous to Your Health," by J. Verrett and J. Carper that "[i]rradiation at high levels has been shown not only to severely destroy vitamins and minerals in food, but also to cause reproductive problems, a shortening of the life span and other complications in laboratory animals. In some instances—for example, in irradiated jams and fruit compote—cancer is a suspected result." The comment also stated that Dr. Verrett was a biochemist and researcher with FDA for 15 years.

The agency agrees that irradiation at high dose levels has been shown to destroy vitamins and other nutrients in food. As discussed in paragraph 11 of this preamble, however, destruction of nutrients is not a public health problem under the conditions of use approved for sources of radiation by this regulation.

It is not entirely clear which studies the authors were referring to in the statement from their book. The agency acknowledges that Dr. Verrett was an FDA employee during which time she reviewed many of the early petitions on food irradiation. The agency has reevaluated her reviews of the studies contained in these petitions. Judging from the irradiated foods mentioned in the statement quoted from her book and in the memoranda in the petitions, it appears that she is referring to two studies in which rats were fed a diet of (1) irradiated bacon and fruit compote (mixtures) (Ref. 39) and (2) irradiated pork, peaches, jam, carrots, and flour (Ref. 41).

The longevity and tumor (cancer) questions referred to in study 1 are addressed in paragraph 26 of this preamble. The agency has stated that an increase in "total" tumors is not indicative of a carcinogenic response by modern criteria for judging carcinogenicity and the numbers of animals at risk were too low to conclude that there was either a tumor or longevity concern.

During its evaluation of toxicology data in 1982, the Task Group listed reasons for difficulty in evaluating the reproduction data from this study. The reasons include: (1) Inconsistent reporting of the numbers of animals used in each replicate experiment in several summary tables, (2) stillborn animal data not reported for every generation, (3) number of pregnant females not reported for all generations, (4) number of litters cannibalized only reported for the parental generation, (5) no indication given as to how or from which litters subsequent generations were chosen, and (6) replicate experiments not consistently identified in the summary tables.

In the second study (Ref. 41), the authors stated that there was a higher growth rate in the 2d and 3d generation animals and inferior breeding performance. Dr. Verrett was also concerned with reproductive and longevity questions in this study. FDA's reevaluation of this study cannot support Dr. Verrett's claims because the study was of very poor quality. The study pathologist specifically detailed many of the study's shortcomings and stated in the final report that "any conclusions resulting from this work should be drawn from the overall picture rather than the detailed studies of isolated aspects or organs" (Ref. 41).

The agency agrees with the pathologist's statement and has attempted to evaluate the overall picture referred to by the pathologist. As stated earlier, 5 animal feeding studies (Refs. 20 and 33 through 38) concerning longevity and/or reproduction (out of 441 toxicological studies reviewed) were considered by agency reviewers to be well designed, properly conducted, and reported. The reports of these five studies indicate no adverse effects to test animals fed irradiated foods.

The agency review included reports of 44 chronic studies, 60 reproduction studies, and 68 combined chronic reproduction studies. Although most of these studies have been considered less than adequate for a variety of reasons, the agency has been able to conclude from them collectively that no treatment-related adverse effects on the longevity of test animals or their reproduction were evidenced by these studies.

28. One comment referenced the report of a study (Ref. 42) in which statistically significant changes in the weights of ovaries and testes were observed when irradiated onions were fed to mice.

FDA has evaluated the report of this multigeneration reproduction study and notes that it was only an abstract from the "World Health Organization (WHO) and has never been published as a complete report. The effects reported were a decrease in ovarian weight, significant when compared to both the normal control (no onion diet) and the onion control (unirradiated onion diet), and a decrease in testes weight significant as compared with the normal controls only. Histological examination did not reveal any particular changes in the ovary and testes of the group fed irradiated onions. No effects were observed on reproduction, fertility, or other parameters observed. In 1977, a WHO committee reviewed a draft of the manuscript and reported that because there were no observed abnormal histopathology changes or deleterious effects on reproduction, these organ weight changes, if real effects, were not regarded as being treatment related. Other reproduction, subchronic, or chronic studies on irradiated onions (Refs. 37 and 43 through 47) at comparable or higher doses of irradiated food administered to other animals did not report any changes in ovarian or testicular weights. These findings lead the agency to agree with the conclusions of the WHO committee.

29. One comment, citing a review paper (Ref. 48), stated that "when dogs have been fed irradiated egg solids, reproductive failure has occurred, and chicks and rats have died as the result of hemorrhage due to lack of vitamin K."

This statement has been taken out of context. The authors were actually referring to the nutritional imbalances seen in some of these irradiated food studies. The entire quote reads:

> Despite the fact that the experimental animals are provided with diets of known nutritional requirements for adequate growth and development, the high level of test food which is incorporated in the diets may present a completely unrealistic situation which can place a nutritional stress on the animals and result in nutritional imbalances. An example of this situation has been observed in feeding of high levels of irradiated egg solids to dogs where the interrelationship between biotin and avidin was found to exert a role in causing reproductive failure. A related example of difficulty which has been experienced in separating potential toxicity and nutritional adequacy of irradiated foods was the previously mentioned effect of radiation sterilization on vitamin K (antihemorrhagic factor) in certain foods, which resulted in hemorrhage and death in chicks and rats. Careful and detailed studies are necessary to elucidate the mechanisms involved in physiological abnormalities of this nature.

FDA agrees with the authors that nutritional imbalances resulting from feeding large amounts of a single food to animals confound the results of these studies.

30. One comment stated that polyploidy (chromosomal changes) has been shown as a toxic consequence in animals and humans fed irradiated wheat.

The agency does not believe that this is a correct statement. The agency is aware that in several experiments conducted by the National Institute of Nutrition (NIN), Indian Council of Medical Research, Hyderabad, India, the investigators claimed that polyploidy (chromosomal changes) was a toxic consequence in animals and humans fed irradiated wheat. A committee of Indian scientists critically examined the techniques, the appropriateness of experimental design, the data collected, and the interpretations of NIN scientists who claimed that ingestion of irradiated wheat caused polyploidy in rats, mice, and malnourished children. After careful deliberations, this committee concluded that the bulk of these data are not only mutually contradictory, but are also at variance with well-established facts of biology (Ref. 49). The committee was satisfied that once these data were corrected for biases which had given rise to these contradictions, no evidence of increased polyploidy could be associated with ingestion of irradiated wheat.

The agency agrees with the conclusions of the committee of Indian scientists that the studies with irradiated foods do not demonstrate that adverse effects would be caused by ingestion of irradiated foods.

31. One comment disagreed with FDA's conclusion that foods irradiated at doses below 1 kGy (100 krad) are safe and stated that there is little reassurance in the fact that unidentified radiolytic products are present in irradiated foods at low concentrations, particularly if single exotic molecules may be capable of causing carcinogenic chromosomal aberrations.

The agency recognizes that radiolytic products will be formed in irradiated food. Ionizing radiation results in the formation of unstable free radicals and other reactive chemical intermediates which normally undergo rapid reaction to form more stable molecules. Of the total radiolytic products formed, a small fraction may be assumed to be unique or "exotic." Radiolytic products and URP's have been defined both earlier in this section and in the BFIFC report (Ref. 1). Certainly some URP's will be formed

which are structurally atypical of parent food molecules. Such URP's may be free radical coupling products of lipid and protein-derived radicals, dimers, and cross-linked products. However, enzymatic hydrolysis of some of these compounds by normal digestive enzymes is expected to yield normal molecular subunits such as fatty acids, amino acids, monosaccharides, and normal metabolic products of these subunits which would be the same result as from the normal digestion of the original parent molecules.

If exotic molecules of the extreme toxicity implied by the comment were present at any level of toxicological significance in irradiated foods ingested by test animals, some consistent toxicological trends and patterns would be manifest in the studies reviewed. Because it has seen no consistent trends or patterns, the agency concludes that foods irradiated as prescribed by this regulation are safe.

32. One comment referenced a study submitted to FDA by USDA on fruit flies (drosophila) fed irradiated chicken. This study showed a dose-related decrease in offspring (Ref. 50), and the comment stated that this effect is consistent with chromosomal damage.

FDA notes that in the sex-linked recessive lethal study in Drosophila there was no evidence of mutagenicity. Additional data on fertility and fecundity were also included in the study, and a dose-related decrease in offspring was noted. Although there were fewer offspring in the groups raised on irradiated diets than in concurrent controls, the agency concluded that this effect could arise from a host of causes unrelated to reproductive toxicity, and is an unreliable indicator of an adverse reproductive effect. Mammalian data on reproduction are more relevant to humans, and these studies, as stated earlier, demonstrate no consistent patterns or trends indicative of a positive reproductive effect.

33. One comment referenced a study submitted to FDA by USDA and stated that mice fed radiation-sterilized chicken meat showed a significant increase in testicular tumors, increased death rate, increased kidney damage (glomerulonephropathy), and decreased survival. In addition, the comment implied that male dogs fed radiation-sterilized chicken had significantly lower body weights throughout adulthood than dogs fed a frozen control diet, and claimed that this shows toxicity of the irradiated chicken diet.

The agency disagrees with the comment that these studies demonstrate a treatment-related increase in testicular tumors. The studies involving mice and dogs fed radiation-sterilized chicken were carried out at Raltech Scientific Services (Raltech). These studies were initiated under the sponsorship of the U.S. Army and completed under the sponsorship of USDA.

The report prepared by Raltech scientists suggested the possibility that chicken irradiated at approximately 6 megarads produced testicular tumors in CD-1 mice in lifetime feeding studies (Ref. 51). Agency scientists have independently examined the histopathology slides to determine whether testicular tumors were induced by ingestion of irradiated chicken. They concluded that the total histopathological evidence did not support a treatment-related induction of testicular tumors (Ref. 5).

These data were also referred to the National Toxicology Program's Board of Scientific Counselors for peer review. The Board concluded also that the data do not allow the study to be categorized as one demonstrating a carcinogenic response in mice fed chicken meat treated with gamma or electron beam radiation (Ref. 6).

All mice fed chicken meat diets (both nonirradiated frozen chicken meat control diets and irradiated chicken meat diets) showed signs of extensive mineralization and glomerulonephropathy and decreased survival compared to mice fed chow control diets. After careful examination of the studies and comparison of data between the mice fed chicken meat control diets and the mice fed chow control diets, the agency concludes that the effects were due to the high protein content of the chicken diets rather than to the fact that some diets were irradiated.

The agency noted decreased survival in the female mice of the group fed gamma-irradiated chicken. However, because the decreased survival occurred only in one sex group, and the result was only marginally significant ($p = 0.04$), the agency does not consider this effect to be treatment related.

With regard to the dog feeding study, the agency does not consider the body weight decrease to be of toxicological significance because of the nature of the protocol that was followed. The maximum quantity of diet provided for each dog was originally limited to 500 grams per day (approximately 300 grams dry matter per day). However, some dogs fed chicken meat diets (irradiated, frozen, or thermally processed) consistently consumed the entire daily ration and consequently had higher body weights than dogs fed chow control diets. This difference in body weights between the different diet groups is attributable to excessive caloric intake of the dogs fed chicken meat. Assuming that the dogs should maintain an "ideal" weight, the contract laboratory restricted the food intake for "selected" overweight dogs as required to initiate weight loss until acceptable body weights were obtained. The few dogs considered underweight were allowed to feed until their body weight increased to an acceptable level. Because the diet was manipulated in this way, the agency does not consider the changes in body weight to be treatment related.

34. Several comments referenced two Russian reports (Refs. 52 and 53) that found damage to kidneys and testes in rats fed irradiated feed. The authors reported dose-dependent histopathological changes in the kidney and testes of rats fed irradiated lab chow. The changes were claimed to be similar to those changes seen in human autoimmune disease involving these tissues.

FDA has found that information on critical details of the experimental design of the studies is either incomplete or missing. The reproductions of photomicrographs are unusable, and the numerical data are incomplete across dosage groups. There is no information on the survival rates of rats to the end of the experiment. The total number of rats actually examined for histopathologic observation is not stated nor is the scope of such observations. There is a general lack of incidence values and survival information that are critical for interpreting the findings in the kidneys and testes.

The agency notes that the authors had not published any previous studies in which rats were used as experimental models and, therefore, these authors may not have been familiar with common progressive nephrosis of the rat kidney. The qualitative description of the kidney changes reported is generally consistent with kidney disease commonly seen in aged laboratory rats. Many of the features of chronic progressive nephrosis (Ref. 54) common to aged rats are identical with the microscopic changes described in kidneys by the Russian authors. Without information on the comparative incidence and severity of the kidney lesions in all groups, the agency cannot verify that these reported effects are treatment-related, especially considering the inevitability of these types of kidney changes in rats as a result of old age.

FDA reviewed the kidney data in 11 chronic studies (Refs. 28, 33, 34, 55 through 62) in which rats were fed various diets consisting of food or feed irradiated at various doses under a variety of conditions to see if it would be possible to confirm the findings of the Russian authors. An examination of these results revealed no findings or evidence of treatment-related kidney changes as were reported by the Russian authors. One of the 11 studies reviewed, which most closely resembled the Russian study (Ref. 28), had also investigated rats fed a diet consisting wholly of chow irradiated at both a lower (2 kGy, 0.2 Mrad) and higher (25 kGy, 2.5 Mrad) dose. The agency reviewed this study and found no evidence of treatment-related kidney changes as reported in the Russian study.

Further, the treatment-related kidney effects claimed by the Russian authors have not been reported in any other mammalian studies as an effect caused by ingestion of irradiated food. Also, data available on irradiation of animal feeds where the whole animal diet is irradiated have not shown comparable pathology (Ref. 27).

Based on the descriptions of the findings of testicular effects, FDA believes that such findings are probably not induced by radiolytic products in the irradiated diet. Extreme size and weight differences between right and left testes can arise from trauma (e.g., fighting) or may be present from birth. It is not clear whether some of the microscopic changes that are discussed affected both testes or were a feature of the smaller testes. FDA also reviewed 11 studies to verify the testicular lesions reported by Russian authors, and none of the studies reviewed revealed treatment-related testicular changes similar to those reported in the Russian reports. One of the 11 studies reviewed, which most closely resembled the Russian study (Ref. 28), found no evidence of treatment-associated testicular changes similar to those reported in the Russian study.

The agency concludes that, given the paucity of data from these two reports and the considerable, more substantial, evidence from other studies, the results of these Russian reports do not raise valid questions concerning the safety of food irradiated under the conditions of this regulation.

35. One comment claimed that three reports showed dominant lethal effects of irradiated foods (Refs. 63, 64, and 65).

The agency has reviewed these studies, and two of these three studies have been addressed (Refs. 64 and 65) in the response to paragraph 30 of this preamble, the third study (Ref. 63) claimed to have demonstrated an increase in preimplantation deaths. In this study, mice were fed 50 percent of their standard chow diet irradiated at a dose of 50 kGy (5 Mrad). There was no increase in postimplantation losses. Postimplantation losses, determined by counting dead embryos, are believed to be the most reliable and sensitive indicator of dominant lethality. The authors found only preimplantation losses, which are much less sensitive than postimplantation losses and merely a measure of total implants dead or alive subtracted from the total number. In addition to the possibility that results of the study could be spurious, any number of factors other than dominant lethality may cause preimplantation losses, such as a decrease in the number of eggs ovulated.

If these effects were real, one would expect to see some effect on postimplantation losses at a lower dose because postimplantation losses are a much more sensitive indicator than preimplantation losses, as mentioned above.

Although the findings reported may be statistically significant, the authors were uncertain as to what to attribute these results. They concluded that the most probable mechanism by which these effects could be produced would be via chromosomal aberrations. The studies necessary to establish an association between these effects and chromosomal aberrations were not conducted. Additional treatment levels below that conducted as mentioned above to detect postimplantation losses or examination of the 24 to 48 hour fertilized eggs could have provided better evidence of causality; but these studies were not conducted. Thus, although preimplantation losses were observed, FDA concludes that there is no biological significance to this observation because it was not reproducible. In three comparable studies, two in mice and one in rats (Refs. 66, 67, and 68), where 100 percent of the chow diet was irradiated with 25 kGy (2.5 Mrad) giving comparable radiolytic products as those found in Ref. 63, no preimplantation losses were demonstrated.

B. Labeling Issues

Under current regulations (21 CFR 179.22 and 179.21), several specified foods are permitted to be irradiated provided that the label bears the following statements: (1) "Treated with ionizing (or gamma or electron) radiation" on retail packages, or (2) "Treated with ionizing (or gamma or electron) radiation—do not irradiate again" on wholesale packages and on invoices or bills of lading of bulk shipments. In the proposal, FDA stated that it was interested in receiving additional comments discussing: (1) Whether FDA should require any type of label statement on food that has been irradiated; (2) if so, whether the statement should be required only on labels of food that has been irradiated (first generation foods) or also on the label of finished foods which may contain irradiated ingredients (second generation foods); (3) whether any required label statement should remain the same as that provided under existing regulations (i.e., "treated with ionizing (or gamma or electron) radiation") or whether some other phrasing would be more appropriate (e.g., "processed with ionizing energy"); and (4) whether consumers would be more misled by the presence of some type of retail label statement or by the absence of such a statement.

The labeling provisions of this final rule differ from that in the proposed rule and from the current labeling regulations as follows: This regulation requires that the wholesale label bear either the statement "Treated with radiation, do not irradiate again," or the statement "Treated by irradiation, do not irradiate again," and that the retail label bear the following logo:

along with either the statement "treated with radiation," or the statement "treated by irradiation." Throughout the remaining discussion in the preamble about the labeling provisions, the agency has used the terms "treated with radiation—do not irradiate again," and "treated with radiation," to represent both alternatives that the manufacturer may use in its wholesale or retail labeling in order to simplify the discussion. In addition to the mandatory language, the manufacturer may also state on the wholesale or retail label the purpose of the treatment process or expand upon the kind of treatment used. That is, the manufacturer may include in the labeling any phrase, such as "treated with radiation to control spoilage," or "treated with radiation to extend shelf

life," or "treated with radiation to inhibit maturation" as long as the phrase truthfully describes the primary purpose of the treatment. Similarly, the manufacturer may choose to state more specifically the type of radiation used in the treatment, i.e., "treated with x-radiation," or "treated with ionizing radiation," or "treated with gamma radiation," if more specific description is indeed applicable.

The agency recognizes that, because this is a new technology, manufacturers may want to use additional labeling statements as part of a consumer education effort. For example, in addition to the required language, the firm may wish to state that "this treatment does not induce radioactivity." The agency will permit such educational statements if they are truthful and not misleading to consumers.

In lieu of labeling individual items of unpackaged irradiated foods, FDA is allowing the required logo and label to be displayed to the purchaser as a point-of-purchase counter sign or card or on the labeling of the bulk container.

Half the comments specifically addressed the retail labeling issue, and over 80 percent of those comments urged that retail labeling be "required to prevent consumer deception." The remaining comments opposed any retail labeling of irradiated foods. Most comments, however, were in favor of some sort of labeling for wholesale packages of foods still in processing to prevent reirradiation.

In addition, the large number of consumer comments requesting retail labeling attest to the significance placed on such information by consumers. Moreover, several comments argued that irradiation of food altered the organoleptic properties of food, thereby reducing its nutritional value. These changes in the food, the comments asserted, make the irradiation of the food a material fact that must be disclosed under section 403(a) and 201(n) of the act. Because of these comments, FDA had decided to require that the label and labeling of food products bear the appropriate statements to inform consumers that the food has been irradiated. The agency emphasizes, however, that the labeling requirement is not based on any concern about the safety of the uses of radiation that are allowed under this final rule. Further responses to these comments are contained in paragraphs 36 through 43.

36. One comment stated that FDA did not have the authority to require a retail label statement on foods that had been irradiated because such labeling was not a prerequisite for safe use under section 409(c)(1) and (d) of the act. This comment argued that where safety is not at issue, FDA's authority to require special labeling is much less expansive. This comment also stated that if the standard for misbranding under section 403(a)(1) of the act is whether an additive affects organoleptic properties of food (i.e., taste, color, smell, or texture of foods), the presence of many additives now commonly used in foods should be highlighted on current product labels because most additives affect these qualities to some degree. This comment also stated that conventional food-processing methods also affect the organoleptic properties of food.

The agency is of the opinion that there is adequate statutory authority under sections 403(a), 201(n), and 409 of the act to require a retail label statement on foods that have been irradiated even though there is no concern about the safety of such treatment at the doses provided by this final rule. Section 409(c)(3)(B) of the act prohibits the approval of a food additive if a fair evaluation of the data before the Secretary "shows that the proposed use of the additive would promote deception of the consumer in violation of this Act or would otherwise result in adulteration or in misbranding of food within the meaning of this Act." In this case, the standard for misbranding under sections 403(a) and 201(n) of the act is whether the changes brought about by the safe use of irradiation are material facts in light of the representations made, including the failure to reveal material facts, about such foods. Irradiation may not change the food visually so that in the absence of a statement that a food has been irradiated, the implied representation to consumers is that the food has not been processed.

Food ingredients, including food additives that have a functional effect in food, are required to be disclosed on food labels. Food additives such as aspartame that are present as ingredients in foods are required to be included on the ingredient labeling statement on the food's label. Therefore, the consumer is informed of the presence of these ingredients and the representation is not misleading.

The agency agrees that conventional food-processing methods also affect the organoleptic properties of food in material ways but in these cases the processing is either obvious to the consumer or conveyed to consumers through labeling or packaging. Canned foods have obviously been canned and frozen foods have obviously been frozen. Pasteurized milk is not obviously pasteurized but this fact is declared on the label.

Canning, freezing, and pasteurization are, of course, well-established processes with which the consumer is familiar. Whether information is material under section 201(n) of the act depends not on the abstract worth of the information but on whether consumers view such information as important and whether the omission of label information may mislead a consumer. The large number of consumer comments requesting retail labeling attest to the significance placed on such labeling by consumers.

FDA has historically required the disclosure of a food processing agent whenever it is material to the processing of foods. For example, flour is required to be modified by the term "bleached" if bleaching agents are used in processing and modified by the term "bromated" if potassium bromate is used in the processing of the flour. These requirements are part of the standard of identity for various flours (see 21 CFR 137.205).

There are many other examples where processing must be disclosed. Several standards of identity require label disclosure if the product has been enriched or fortified (see 21 CFR 137.305, enriched farina). Several standards of identity for juices require that the label indicate when the product is made from a previously concentrated ingredient (see 21 CFR 146.145, orange juice from concentrate). Orange juice must also be labeled pasteurized when pasteurization is part of the juice's processing (see 21 CFR 146.140, pasteurized orange juice).

Foods made in semblance of a traditional food must disclose the processing difference. Potato chips made from dehydrated potatoes, onion rings made from minced onions, and fish sticks made from minced fish are all required to disclose these material differences in processing.

The agency concludes that requiring a retail label statement that a food has been irradiated is consistent with the agency's statutory authority and current labeling practice.

37. Several comments argued that a retail label requirement was inappropriate because irradiation was used in place of chemical fumigants and FDA does not require that these chemicals be identified on the retail label. One comment stated that "there is more rational basis for labeling adiated foods (at the retail level) than for labeling pesticide residues present in agricultural commodities, indirect additives from packaging, flour and bread from fumigated wheat, or the

current fumigated spices themselves." Another comment pointed out that FDA has long held the position that nonfunctional secondary additives need not be declared on the label and that the policy codified at 21 CFR 101.100 should apply to foods that have been irradiated.

The issue here is whether the irradiation of food is a material fact that must be disclosed to the consumer to prevent deception. As stated earlier, irradiation may change the characteristics of a food in a manner that is not obvious in the supermarket. Packaging materials and incidental additives such as processing aids that have no technical or functional effect in the food and thus do not ordinarily affect the characteristics of the food may be exempted under 21 CFR 101.100 from the normal labeling requirements under the act. Furthermore, Congress specifically exempted pesticide chemicals under section 403(l) of the act from a retail labeling requirement when the food has been removed from its shipping container.

As stated earlier, FDA believes that the irradiation of food is a material fact that must be disclosed. The agency recognizes, however, that the irradiation of one ingredient in a multiple-ingredient food is a different situation, because such a food has obviously been processed. Consumers would not expect it to look, smell, or taste the same as fresh or unprocessed food, or have the same holding qualities. Therefore, FDA advises that the retail labeling requirement applies only to food that has been irradiated when that food has been sold as such (first generation food), not to food that contains an irradiated ingredient (second generation food) but that has not itself been irradiated.

38. One comment stated that a retail label requirement would imply that there is a hazard involved in radiation processing and that such a statement would mislead the public about the safety of the process and have a negative impact on the development of this technology.

Although FDA recognizes the potential for consumer confusion, because there is no safety problem with food irradiated in accordance with this final rule, any confusion created by the presence of a retail label requirement can be corrected by proper consumer education programs, and the presence of a retail label statement should not deter the development of this technology. Consumer comments reflect a growing awareness of the process of food irradiation. Many consumer letters acknowledge that food irradiation, as prescribed by the proposed regulation, will not cause the food to become radioactive. The agency has also received comments stating that experiences in other countries, such as the Netherlands, demonstrate that consumers do not necessarily reject irradiated foods when they are properly labeled.

A recent Good Housekeeping Institute Survey seems to support this view (Ref. 69). In addition, elsewhere in this document the agency has made it clear that manufacturers have the option of providing additional labeling to describe the specific purpose of the treatment provided that such additional labeling is truthful and not misleading.

The agency has also concluded, however, that the original labeling terminology required by existing 21 CFR 179.22 and 179.24 may be overly technical and that the type of radiation being used is not necessarily meaningful to consumers and that the retail label would be just as informative if the required retail statement were "treated with radiation." The regulation has been modified accordingly.

39. Other comments suggested that the retail label statement be revised to state: "treated with ionizing radiation to prolong shelf life to ——— (insert date)."

As explained above, any confusion created by the terms "radiation" or "irradiation" required to appear as part of retail labeling can be corrected by appropriate consumer education programs. Recognizing that labeling itself is a valuable source of consumer education, FDA encourages optional statements to be included on the retail label that expand upon the kind of treatment used or the purpose of the treatment. Such additional explanatory language may be used whenever the additional language is applicable and not misleading.

For example, "treated with radiation to control insect infestation," "treated with radiation to inhibit maturation," and "treated with radiation to inhibit spoiling" are all examples of acceptable alternatives describing the purpose of the treatment if in fact the additional statements reflect the purpose of the treatment. "Treated with electron beam radiation" is an example of an acceptable expansion on the kind of treatment, if in fact an electron source was used. These optional statements would not only have an educational benefit, but would also avoid any possible mistaken inference by the public that the required labeling is a warning statement.

A manufacturer who wishes to label its product as "treated with radiation to extend the shelf life to ——— *(insert date)*" would, of course, be required to possess data substantiating that the radiation treatment would, in fact, extend shelf life until that date.

In addition, a manufacturer who finds that the terms "treated with radiation" or "treated by irradiation" are misinterpreted by a significant number of consumers may petition FDA for approval of alternative language, e.g., "freshness preserved by irradiation." However, the manufacturer would be required to provide adequate evidence demonstrating that the alternative language is both more readily accepted by the public and not misleading as to the nature of treatment as a form of radiation.

40. Several comments took the position that food irradiation is a food-preservation process and should be considered a process instead of a food additive, at least for labeling purposes. Those supporting this view stated that other food processes are not required to be revealed on the label and that food irradiation should be similarly exempt from label declaration. The comments also stated that a retail label statement is not justified on the basis of risk.

The agency agrees that irradiation uses permitted by this final rule are safe. The retail label requirements of existing 21 CFR Part 179 were based on misbranding considerations and not on food safety or health risk considerations. As has been explained before, section 201(s) of the act specifically includes a source of radiation as a food additive (21 U.S.C. 321(s)).

Nor is there any statutory provision that exempts processes from being declared on a food label (49 FR 5718) and the agency must examine whether the failure to declare such processing is misleading to consumers. In this context it is not relevant whether irradiation is considered a process in determining whether retail labeling is appropriate.

41. Most comments written in support of a retail label requirement for irradiated foods stated that the irradiation process has not been demonstrated to be safe, and that if irradiation treatment of food is permitted, the food label should inform consumers about which foods have been irradiated so that consumers can make informed decisions about the kinds of foods they buy.

As discussed elsewhere in this document, the agency has concluded that the irradiation of foods at a maximum dose of 1.0 kGy (100 krad) is safe when used to control arthropod pest infestation or to inhibit the growth and maturation of fresh foods. In view of this fact, the arguments in favor of a

retail label requirement, based solely on the grounds that the irradiated food is not safe, must be discounted.

42. Several comments in favor of a retail label requirement argued that irradiation of food altered the organoleptic properties of food and reduced its nutritional value and that these changes are material facts requiring disclosure under sections 403(a) and 201(n) of the act. The comments stated that consumers have a right to know whether such processing has taken place.

A food is considered misbranded under section 403(a) of the act if its labeling is false or misleading in any particular. In determining whether labeling is misleading, the agency must take into account the extent to which the labeling fails to reveal material facts in light of representations made about the food or consequences that may result from the use of such food (section 201(n) of the act). Therefore, the agency must decide whether the changes in the organoleptic properties of irradiated foods constitute a material fact or whether the information that a food has been irradiated constitutes information that is material to a consumer even if the organoleptic changes were not significant.

The agency agrees that irradiation causes certain changes in foods and that even small changes that pose no safety hazard can affect the flavor or texture of a food in a way that may be unacceptable to some consumers. Even those opposed to a retail labeling requirement agree that under certain conditions irradiation causes substantial changes in the organoleptic properties of some foods. Moreover, as discussed in the response to comment 38, irradiation may not change the food in any way that is visible to the consumer, so a label statement provides the only means of letting consumers know that a food has been irradiated. Thus, the absence of a label statement on retail foods may incorrectly suggest that an irradiated food is essentially unprocessed. Therefore, this regulation provides that the retail label contain a statement that the food has been irradiated.

43. The agency has also reviewed comments that argue both for and against the substitution of the term "ionizing energy" for the term "ionizing radiation" in the proposed wholesale labeling requirement and in any retail labeling requirement that was contemplated but not proposed. Most of the arguments for the substitution stated that they favored use of the term "ionizing energy" to reduce the problem of confusing irradiation with radioactivity and argued that use of the term "ionizing energy" would be less likely to be misunderstood by consumers. Other comments argued that both terms are likely to be misunderstood by consumers.

In view of the fact that the term "energy" could be confused with its more ordinary meaning as applied to foods, namely, a capacity of the food to provide caloric energy, the agency does not agree that substitution of the term "ionizing energy" would be less likely to be misunderstood by consumers. Furthermore, none of the comments offered any substantive evidence that one term would more likely be understood than another, either at the wholesale or retail level.

The agency does recognize that some population groups may harbor a prejudice against anything treated with radiation but is of the opinion that with the labeling flexibilities provided in this regulation, manufacturers will be able to overcome these prejudices as consumers become more educated about the process and the advantages this technology has over alternatives existing in the industry.

44. One comment suggested that the agency use the term "picowave treatment" in order to parallel the term "microwave treatment" that is commonly used for another form of food processing.

The agency gave careful consideration to the use of this term but it finally concluded that it should reject this suggestion because the term "picowave treatment" is not in common use in the industry or in the scientific community and would be neither more informative to the consumers than the label statement "treated with radiation" nor more understood by those in the food-processing industry. In addition, the microwave terminology is associated with complete cooking of the food which in no way parallels irradiation treatment of food as permitted by this final rule.

45. Several comments suggested alternative language for the wholesale label statement based on the assumption that the agency would permit reirradiation of a food provided that the total absorbed dose did not exceed the permitted amount. These comments suggested statements such as "ionization processed with a maximum of ——— kGy" or "processed with electromagnetic energy (or picowaves) or electron beam energy (as appropriate) in the range of 0.5 MeV to 10 MeV with a dose of ——— (blank to be filled in by processor)."

Elsewhere in this document the agency has addressed the issue of reirradiation and has concluded that multiple exposure of foods to radiation is inappropriate. Therefore, there is no need to discuss these comments.

46. A few comments suggested that the wholesale label statement be replaced by a code stamp that would reflect the pertinent information about the treatment similar to that now used for the place and date of production for canned foods.

The agency has rejected this approach because the purpose of requiring a wholesale label is to alert other food processors that a food has been irradiated. The code stamp currently used in the production of canned foods is informative only to the individual canner. Different firms use different codes for their own special tracking of food lots. For a code stamp to be useful at all, there would have to be a universal code used by all manufacturers. Even this approach, however, is unsatisfactory when compared to labeling because there is a greater chance for error in interpreting a code stamp than in reading a statement that the food has been irradiated.

47. A few comments suggested that the agency permit alternative language to be substituted for any required statement to reflect more accurately the type of processing involved. In place of the phrasing "treated with ionizing radiation," the comments suggested statements such as "treated with x-rays" or "treated with gamma radiation from cobalt-60" or "treated with electron beam energy."

In the Federal Register of January 7, 1967 (32 FR 140), the agency proposed that terms such as "processed (or treated) by x-radiation" and "processed (or treated) by gamma radiation" could be substituted for "processed (or treated) by ionizing radiation" at the option of the processor, whenever the more specific treatment was applicable.

The agency concludes that the option to describe the type of radiation should still be made available to food processors. The agency is of the opinion that it is in the public interest for labels to bear a statement that is as descriptive of the process as possible. Permitting these alternative labeling statements will also serve to educate the general public about the various types of treatment used by food processors.

48. Several comments recommended that FDA require a logo to represent "radiation" instead of a worded statement on the label of retail foods that have been irradiated. These comments pointed to the fact that there is a symbol used internationally to convey the fact that food has been irradiated. A comment from the U.S. Environmental Protection Agency (EPA),

although not opposed to the use of a logo to represent use of the irradiation process on food product labeling, expressed concern that the symbol that has been used internationally closely resembles EPA's official logo. EPA asserted that use of the symbol might cause consumer confusion about whether EPA had endorsed use of a product that carried such a logo.

The agency believes that the use of a logo in conjunction with a descriptive label of the process would serve to educate the general public that the logo and the label are synonymous. Thus, the agency is requiring that the label and labeling of retail packages of foods irradiated shall bear the following logo

along with the statement "treated with radiation." This logo derives from the symbol that has been used internationally to convey the fact that the food has been irradiated.

For irradiated foods not in package form, the required logo and phrase "treated with radiation" shall be displayed to the purchaser by other means as discussed elsewhere in this document. In addition, the label and labeling and invoices or bills of labeling shall bear the statement "treated with irradiation—do not irradiate again" when shipped for further processing, labeling, or packaging.

With industry uniformly using this logo in conjunction with the wording "treated with radiation" or "treated by irradiation" and an educational effort to inform consumers about the meaning of the logo, the agency has modified this rule to require 2 years after its publication only the use of the logo without the accompanying terminology. The agency will assess the need for the mandatory language to accompany the logo during this 2-year period. Any extension of the wording requirement will be established through notice and comment rulemaking.

49. Several comments argued that even if a retail label requirement were a part of the regulation that this requirement should not apply to fresh fruits and vegetables because such labeling was impracticable. Other comments simply asked how any retail label requirement would apply to fresh fruits and vegetables sold in bulk retail food stores.

The agency does not agree that retail labeling of fresh fruits and vegetables would be impractical. The final regulation as modified states that packaged fruits and vegetables include the logo and the statement "treated with radiation" on the label. For irradiated fruits and vegetables not in package form, the regulation provides three alternatives for meeting the labeling requirements. As an alternative, each item of irradiated food may be individually labeled. The agency has been informed that some companies plan to label each piece of irradiated food. The required information may be displayed to the purchaser with either: (1) The labeling of the bulk container plainly in view or (2) a counter sign, card, or other appropriate device bearing the logo and the term "treated with radiation" in order to inform the consumer that this product has been treated with radiation. This approach is consistent with the exemption provided in 21 CFR 101.22(e) for bulk fruits and vegetables that may have applied waxes or coatings and for processed foods sold in bulk without packaging.

C. Current Good Manufacturing Practice

FDA has issued general regulations regarding current good manufacturing practices (CGMP) (21 CFR Part 110) as well as specific CGMP regulations for some types of food (21 CFR Parts 113, 114, 118, 123, and 129) or food additives (21 CFR 172.5, 174.5, 182.1, 184.1). Such regulations are based on standard practices of responsible manufacturers in the industry.

The CGMP regulation for irradiated food could not be based solely on current radiation practices because of the lack of substantial experience with food irradiation. However, there has been extensive experience with other types of radiation processing (e.g., hospital supplies), and the industry has established standards in some cases. FDA considered both the experience and standard practices in the nonfood radiation processing industry and CGMP in the food industry in developing its proposed regulation for irradiated food and in evaluating comments.

In general, comments were supportive of the proposed provisions in § 179.25, including the proposed requirement for a scheduled food irradiation process, to establish a standard operating procedure specific to each food and radiation facility. Many comments supported recordkeeping requirements and emphasized the need for personnel training and FDA inspection.

50. One comment on proposed § 179.25(c) was concerned about the training that would be required of the "qualified person with expert knowledge of radiation processing" and what Federal or State agency would license or otherwise certify a radiation processing specialist who is needed to establish scheduled processes. Another comment suggested that FDA convene a panel of experts to develop a protocol for the establishment of scheduled processes for food irradiation instead of leaving it to industry experts. The comment also suggested that the Codex Standards and the Code of Practice for Irradiated food be incorporated or identified as a guideline for the establishment of a scheduled process (Ref. 70). (These documents were developed by the Codex Alimentarius Commission of the Food and Agriculture Organization of the United Nations, and the World Health Organization.)

The agency has no jurisdiction over the licensing or certification of radiation processing specialists. (However, see comments regarding the training of radiation safety personnel required by the Nuclear Regulatory Commission (NRC) in the section on environmental impact elsewhere in this document.) The manufacturer is responsible for choosing individuals who are qualified by appropriate scientific training and applied experience to ensure the integrity of the food irradiation process. FDA believes that there is sufficient incentive for food manufacturers to select qualified people and that FDA need not intervene. Therefore, each manufacturer is expected to select personnel having expertise and experience in the radiation processing of food and knowledge of the requirements of the particular facility. The specialist's work experience must be documented and must demonstrate training and experience in radiation processing of food. FDA believes that a background check for such personnel would be done in any case. FDA has no plans at this time to require the licensing of such individuals or to convene a panel of experts to develop a protocol for the establishment of scheduled processes. The agency agrees that the Codex Alimentarius Standard and Code of Practice is a useful guide but sees no need to require compliance with that code by regulation.

51. One comment on proposed § 179.25(d) asked if food processors who

use irradiated ingredients in their retail products are subject to the recordkeeping requirements of this regulation.

The proposed rule and this regulation limit the maintenance of records to the food irradiation processor. Therefore, a food manufacturer who uses irradiated ingredients in foods designed for retail trade is not required to maintain records related to irradiation treatment.

52. One comment on proposed § 179.25(d) requested clarification about the length of time that records must be maintained. The comment stated that some dry foods, such as spices, may have a very long shelf life that cannot always be predicted by the processor. Another comment suggested that records be maintained only 3 years.

The proposed rule would have required the records to be kept for a period that exceeds the shelf life of the irradiated food by 1 year. FDA agrees that this requirement is not clear and is amending this regulation to require that the indicated records be retained for a period of time that exceeds the shelf life of the irradiated food by 1 year, or for 3 years, whichever period is shorter.

53. One comment stated that the allowed uses of irradiation should be specified in sufficient detail so that Federal and State officials may accurately determine whether a processor is complying with the regulations. The comment suggested that FDA consider specifying sampling procedures to monitor whether a processor is complying with the regulations.

As explained in this document, irradiation of food at the permitted safe levels does not produce amounts of unique radiolytic products sufficient to be detected using conventional food sampling and analysis techniques. Nonetheless, the agency agrees with the comment that specificity of procedures is essential to ensure that radiation processing has been properly carried out. That is why this final rule lists the permitted uses of irradiation and requires that a processor have a scheduled process for each food established by a qualified person with expert knowledge of radiation processing. The scheduled process must specify a dose range that will ensure that the absorbed dose will achieve its intended technical effect on the food being irradiated. The final rule also requires that records be kept that include, among other things, evidence of compliance with the scheduled process, source calibration, and dosimetry. Moreover, these records are to be made available for inspection by authorized employees of FDA. The agency believes that this is sufficient information to determine whether processors are complying with the regulation.

54. One comment stated that no mention is made in the regulation regarding the role of State officials. The comment expressed concern about possible questions regarding State activities in the area. The comment said that State officials might be called upon to assist FDA in enforcing the final regulation and wondered whether the final regulation ought to specify whether State activities involving food irradiation processing would be preempted under the regulation.

The act contains no specific provision preempting the field of food irradiation. The test of whether a State activity is preempted by Federal law and regulations is whether the State activity conflicts with and stands as an obstacle to the Federal program. The comment appeared to be concerned about whether State inspections or other actions in support of this final regulation would be preempted by this regulation. FDA notes that State officials routinely assist FDA in inspecting certain facilities that are within their State in order to conserve scarce agency resources. The agency has, for many years, worked closely with the States through cooperative work-sharing agreements affecting compliance with the act and its implementing regulations. These cooperative efforts would further the goal of this regulation and would not be precluded under any preemption doctrine.

55. Some comments stated that a regulation requiring access only to records is not adequate to ensure compliance, and that FDA should also propose strict monitoring or some degree of official inspection.

The agency has authority to conduct plant inspections for all food-processing plants. FDA did not intend to imply that compliance would be determined solely by inspection of records. FDA officials will inspect food irradiation plants and will copy and review required records to assure that the processor is complying with these regulations. The agency would like to clarify that it considers inspection of records to include copying of the records for further review, and is, therefore, adding the words "and copy" after "inspection" in new § 179.25(e) for the same reasons stated in the proposal for records inspection requirements (49 FR at 5719) based on sections 409, 703, and 704 of the act. Thus, if a food manufacturer chooses to engage in radiation processing of food, FDA will consider that processor to have waived any objections to the agency's requirement of inspecting and copying pertinent records with respect to irradiated foods.

56. One comment stated that testing of food irradiation dosage is limited by the accuracy of the testing dosimetry. The comment stated that the regulation must provide methods for determining the absorbed dose which can be directly related to standards of radiation maintained by the National Bureau of Standards.

The agency agrees that the accuracy of the testing dosimetry is important. Assuring accurate dosimetry is a part of developing a scheduled process. Nevertheless, optimum procedures for dosimetry may change, and FDA does not intend to limit dosimetry to any one specific system at this time. FDA would consider irradiation of food without adequate dosimetry to be a violation of the current good manufacturing practice regulations.

57. A few comments requested that the regulation permit multiple irradiations of food provided that the maximum dose limitation prescribed by regulation is not exceeded. The comments argued that there are conditions where a second radiation treatment would produce a useful effect without exceeding the maximum dose. One comment stated that the Codex Alimentarius standard for irradiated foods does permit reirradiation of foods under limited circumstances.

The agency disagrees that the regulation should permit the multiple irradiation of foods for the following reasons:

(1) An irradiated food that is properly packaged and stored should not require further irradiation to be marketable. Irradiation processing of food is not to be used as a substitute for good food sanitation practices.

(2) Where a food is irradiated more than once, the cumulative radiation dose cannot exceed the maximum allowable dose prescribed in the regulation. The determination of whether those foods that are irradiated more than once are in compliance with the regulation would be difficult and impractical, if not impossible. Inspection of irradiation records alone to determine compliance would be inadequate. Records maintained by different irradiation facilities with respect to the reirradiated food would not be available for inspection simultaneously. Moreover, if a food were irradiated in a foreign country and subsequently irradiated in the United States, the absence of records from the foreign radiation facility would make a determination of compliance with the regulation impossible.

(3) FDA is aware of the Codex Alimentarius standard concerning reirradiation of foods (Ref. 70). The Codex Alimentarius standard does not permit reirradiation of foods, except for foods with low moisture content (cereals, pulses, dehydrated foods, and other such commodities), irradiated for the purpose of controlling insect reinfestation. This same standard, however, states that a food is not considered to have been reirradiated when: (i) The food prepared from materials, which have been irradiated at low dose levels, is irradiated for another technological purpose; (ii) the food, containing less than 5 percent of an irradiated ingredient, is irradiated; or (iii) the full dose of ionizing radiation required to achieve the desired effect is applied to the food in more than one installment as part of procesing for a specific technological purpose. In accordance with 21 CFR 130.6, FDA will review all food standards adopted by the Codex Alimentarius Commission. The agency is not required, however, to accept these standards.

Although the agency may, on its own initiative, propose adoption of a Codex standard under section 401 of the act (21 U.S.C. 311), any interested person may petition the agency to adopt a Codex standard (21 CFR 130.6). Because the agency has not proposed adoption of the Codex standard regarding reirradiation of foods as part of this rulemaking, this issue requires no further discussion at this time.

(4) The agency acknowledges that there could be certain circumstances where a useful effect could be produced by reirradiating a food without exceeding the maximum dose limitation prescribed by the regulation. However, as discussed earlier in this response, the agency believes that efforts to monitor compliance with this regulation through recordkeeping and records inspection would be difficult and impractical, and may even be impossible in certain instances. A further complication that would arise should reirradiation of foods be permitted involves the difficulty of complying with the labeling requirements prescribed by the regulation. Complex labeling at the wholesale level would be needed to ensure that the maximum cumulative dose absorbed by the food does not exceed the maximum dose limitation prescribed by the regulation. Wholesale labeling would also have to convey to what extent a previously irradiated food was treated. Furthermore, such cumulative doses would have to be the minimal radiation dose reasonably required to accomplish the intended technical effects. This minimal radiation dose would be very difficult to determine if it is administered in multiple doses. These complex issues would require careful consideration by the agency during a separate evaluation. For all of these reasons, the agency has concluded that reirradiation of food should not be permitted under this regulation.

58. Some comments questioned the need for a 5 million electron volt limit for x-ray sources and stated that this energy limit should be increased to 10 million electron volts.

The 5 million electron volt limitation for x-ray sources was based on data in an earlier petition and is consistent with recommendations of the Codex Alimentarius Commission. FDA has no data demonstrating the safety of sources operating at higher energy levels; accordingly, this regulation approves the use of x-ray sources of no more than 5 million electron volts. The agency will consider changing the limitation if data supporting the safe use of x-rays produced by machines using energy sources greater than 5 million electron volts are submited in a food additive petition.

D. Other Technical Effects

59. Several comments were opposed to food irradiation because it can theoretically affect the metabolic processes of fresh foods, and thereby conceivably make them less resistant to spoilage by various fungal diseases.

The agency recognizes that irradiation affects the metabolic processes of fresh foods and may sometimes make them less resistant to spoilage. Irradiation, like other processes, will not solve all food-preservation problems and will sometimes be impractical. Food processors would probably not irradiate food if irradiation causes the food to spoil more quickly or to become less marketable. In such cases, irradiating food would be contrary to the processor's self-interest. Because the practicality of using food irradiation makes this process somewhat self-limiting, the agency concludes that it need not restrict the irradiation of fresh foods merely because some foods may be unsuited to such processing.

60. Many comments requested that FDA take a more general approach to permit irradiation up to a dose of 1 kGy on any food for any purpose consistent with current good manufacturing practice. One comment stated that the rule should be extended beyond fruits and vegetables to mushrooms and pork. Several comments asked that the safe dose be raised to 1.5 kGy (150 krad). The comments stated that 0.75 kGy (75 krad) is necessary for maximum shelf life extension of papaya, and the 1.5 kGy safe dose would allow for some latitude in designing a commercial food irradiator. One comment stated that the term "insect control" may be too restrictive and suggested "pest control." Several comments stated that a maximum dose of 1 kGy is effective for trichinae control and for microbial control in some foods.

The agency intended the term "fresh fruits and vegetables" to include mushrooms, which are fruiting bodies of fungi. The agency now believes that the term "fresh foods" may more adequately describe foods such as fruits, vegetables, and mushrooms that are capable of additional growth and maturation but that may be treated with ionizing radiation to inhibit those processes. FDA is revising the regulation accordingly. In addition, the agency agrees that the term "insect control" may be too restrictive. Therefore, the agency is substituting the term "arthropod pests" to include insects, spiders, and mites, but to exclude pests such as bacteria, molds, mice, and rats.

Although the agency believes that the safety of food irradiation below 1 kGy (100 krad) has been established, the agency proposed to limit the use of food irradiation according to intended technical effect rather than simply by dose. This was done both to avoid indiscriminate use of irradiation and to aid enforcement of dose limits because there would be no reason to exceed the permitted dose for the allowed technical effects. For example, overtreatment of fruits and vegetables may adversely affect their marketability. Thus, exceeding the permitted dose would result in a substandard product. In effect, compliance occurs due to a self-limiting factor.

In the specific case of papaya, the agency believes that an adequate commercial radiation facility can be designed for papaya with the current limitation. Alternatively, the agency will review a petition to increase the maximum permitted dose for fresh foods.

The agency is aware that the permitted dose may also be somewhat effective for other uses, such as decreasing the microbial burden in meat, fish, and poultry. FDA did not propose these uses, however, because irradiating at such low doses would not be sufficiently effective for microbial control to be self-limiting. The agency stated in the proposed rule that it would consider other uses below 1 kGy (100 krad) if a petition supported by evidence that a specific technical effect can be

accomplished below 1 kGy (100 krad) and if an appropriate food additive regulation can be promulgated and can be enforced. The agency has received petitions for the use of irradiation to control trichinae in pork at doses below 1 kGy 100 krad). As discussed earlier in this preamble, the agency issued a final rule on July 22, 1985, in response to one petition to control *Trichinella spiralis* in pork (50 FR 29658). In this document, the agency is deleting § 179.22 and is incorporating that authorization for the irradiation of pork in new § 179.26(b).

61. One comment stated that FDA's proposed rule would have relatively little impact on solving the overall problem of food spoilage and contended that FDA is apparently seeking to avoid, delay, or otherwise shelve indefinitely the approval of irradiation at higher dose levels. The comment stated there is no reason for FDA's reluctance to proceed on its own initiative to approve food irradiation at doses above 1 kGy, including radiation sterilization of chicken. Other comments stated that FDA should permit doses up to 10 kGy based on the Codex Alimentarius standard.

FDA's traditional approach to issuing a food additive regulation has been to respond to a properly documented petition. FDA initiated this rulemaking to permit food irradiation because it believed that an agency-initiated rulemaking would be more efficient for those uses where the agency needs no further safety data.

Two considerations prevent the agency, at this time, from proposing a general regulation allowing higher doses. First, at higher doses, irradiation can significantly retard microbial spoilage without killing all spores of *C. botulinum*. Under some conditions, *C. botulinum* can grow and produce a toxin that constitutes a health hazard. Based on current information, the agency is unable to prescribe safe conditions of irradiation at higher doses for foods that would ensure *C. botulinum* organisms would not develop.

Second, at the doses permitted in this regulation, the total amount of radiolytic products consumed is too small to be of concern, either because of low doses or because foods so treated are a minor part of the diet. Further, safety information from animal feeding studies is unnecessary under these circumstances. The proposal stated that FDA is reviewing a number of studies to determine whether foods that are irradiated at doses above 1 kGy (100 krad) can be considered safe without additional toxicological studies. As stated elsewhere in this document, the agency has reviewed these studies and found that five were acceptable by current standards. This data base is inadequate to support a broad decision that all foods may be irradiated safely at higher doses up to 10 kGy (1 Mrad).

Therefore, FDA does not intend to initiate further rulemaking on food irradiation based on the information before it at this time. The agency will, of course, continue to evaluate and respond on a case-by-case basis to all food additive petitions involving irradiation.

62. Several comments discussed using irradiation to control microbial contamination of animal feeds. One comment stated that the agency should consider the use of irradiation to treat all animal feeds up to a maximum dose level of 25 kGy (2.5 Mrad).

The agency agrees that irradiation of animal feeds to control microbial contamination could be addressed, but not necessarily as part of this rulemaking. Ralston Purina Co. filed a food additive petition (FAP 2198) (December 18, 1984; 49 FR 49181) proposing that the regulations be amended to provide for microbial disinfection of laboratory diets for rats, mice, and hamsters by radiation treatment. The agency responded to this petition in the Federal Register of February 19, 1986 (51 FR 5992). Any interested person able to document the safe use of a source of radiation to treat animal feeds may submit an animal food additive petition for that use under the provisions of 21 CFR Part 571.

63. One comment stated that the agency should permit the use of radiation to sterilize meals to provide a more nutritious and palatable diet for persons who require sterile meals.

The agency is considering a separate rulemaking to permit the investigational use of unapproved food additives under section 409(i) of the act (21 U.S.C. 348(i)). That issue is not relevant to the uses of food irradiation permitted under this regulation.

64. Several comments stated that there were other alternatives to irradiation for insect control or for growth and maturation inhibition of fresh fruits and vegetables and that, therefore, there was no need to permit food irradiation.

The agency agrees that there are other methods both for insect control and to inhibit the growth and maturation of fresh fruits and vegetables. However, the existence of such methods is not a reason to prohibit equally safe alternatives, nor does the act authorize FDA to arbitrarily limit the safe alternatives that are to be allowed. The agency believes that the marketplace should determine which alternative treatment method is used when safety is not an issue.

E. Packaging

65. One comment stated that FDA should consider the possible migration of toxic substances from packaging materials to food during irradiation. Several comments noted that the proposed rule does not discuss packaging materials and that this omission may create confusion with respect to § 179.45. In addition, one comment asked specifically whether the irradiation of bulk packaging materials such as fiber drums and burlap bags is permitted even though they are not listed in § 179.45. The comment questioned the need for § 179.45 and suggested, as an alternative, granting approval for irradiation of all substances that are currently generally recognized as safe as packaging materials.

FDA points out that all packaging materials or components of packaging material that may reasonably be expected to migrate to food must comply with appropriate regulations authorizing their use. Components of packaging materials that have been irradiated may migrate to food to a different degree than components of an unirradiated material.

There are two aspects to this problem: (1) A packaging material that is irradiated before food contact may degrade or undergo crosslinking or some other change so that it is significantly different from the nonirradiated material and (2) packaging material irradiated while in direct food contact may produce low modecular weight materials that might migrate into the food.

In the first case, the irradiated material may be tested to see whether it is suitable for use in contact with food and complies with appropriate regulations. If the irradiated material is still suitable for use and complies with the applicable regulations, no additional regulations are required. If the irradiated material no longer complies with applicable regulations, interested persons may submit a food additive petition to amend the regulations accordingly.

In the second case, volatile materials migrating into prepackaged foods during irradiation would not have been considered in evaluating whether the packaging material was safe for its intended use, unless the packaging material had been specifically authorized under § 179.45. Section 179.45 lists packaging materials that may be formed into containers for holding or packaging food intended to be irradiated and which may be subjected to incidental irradiation during the radiation treatment of prepackaged foods. This regulation was issued in response to petitions for packaging materials used with food during irradiation in anticipation of expanded uses of food irradiation in the 1960's. Therefore, the agency disagrees with the comment that § 179.45 is unnecessary.

Section 179.45, however, does not list packaging materials that are generally recognized as safe (e.g., glass, wood, natural fibers) but which may exhibit different characteristics of migration to food during irradiation. FDA knows of no information on such materials during irradiation by which they could be generally recognized as safe. Therefore, FDA does not consider such materials to be generally recognized as safe when used in packaging that is irradiated in contact with food. The agency invites petitions to amend § 179.45 to include generally recognized as safe packaging materials and other packaging materials not currently in § 179.45.

The agency agrees that the failure to address packaging in the proposal may cause confusion. Because of the possible confusion, FDA is adding a new paragraph in § 179.26 clarifying the intended requirement that packaging materials containing food during irradiation must comply with § 179.45.

F. Public Education

66. Many comments stated that a need exists for a public education campaign supported by the government and industry.

The agency agrees that there is a need for public education in this area. However, the agency is responsible for ensuring that food additives including a source of radiation are safe; FDA has no proper role as a promoter of a specific food additive or food process. The agency believes that the primary responsibility for such educational activities remains with industry in this instance.

G. Impact Analyses

The agency stated in the proposed rule that existing safeguards in regulations issued by the Occupational Safety and Health Administration (OSHA), the Nuclear Regulatory Commission (NRC), the Department of Transportation (DOT), and FDA are adequate to ensure that there will be no adverse environmental effect. However, many comments expressed concerns about the environmental impact of this regulation. These comments can be separated into three categories: (1) Radiation safety within the facility (worker safety), (2) waste storage and disposal, and (3) transportation. FDA requested a response to these comments from OSHA (Ref. 71), NRC (Ref. 72), and DOT (Ref. 73) and has summarized their responses below.

67. Several comments were concerned with worker exposure and with plant safety and claimed that current safety standards are inadequate to protect workers employed in industries handling radioactive materials.

A facility using radioactive material must first obtain a license from NRC or the corresponding agency in an agreement State. NRC has informed FDA that in order for a firm to be licensed to possess and use radioactive material in an irradiator, the firm must file an application with NRC or the corresponding State agency. The information that needs to be submitted includes the training and experience of individuals responsible for the radiation safety programs, the training provided to persons who will work under the supervision of the responsible individuals, a description of the facility, the safety systems designed to protect personnel from exposure to radiation, and the radiation protection program.

NRC states that the regulatory "Guide for the Preparation of Applications for Licenses for the Use of Panoramic Dry Source-Storage Irradiators, Self-contained Wet Source-Storage Irradiators, and Panoramic Wet Source-Storage Irradiators" (Ref. 74) provides guidance to potential applicants about specific details needed in an application for possession and use of radioactive material in an irradiator. The NRC staff reviews the application to determine that (1) the applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life and property, (2) the applicant is qualified by training and experience to use the radioactive material for the purpose requested and in such a manner as to protect health and minimize danger to life and property, and (3) the program described will result in compliance with NRC's regulatory requirements. If the information provided in an application is satisfactory, a license is issued. After issuance, NRC conducts periodic inspections of irradiator facilities. In 1978 and 1979, NRC collected exposure data from all licensees. The average annual measurable dose for persons engaged in irradiation operations was 160 millirems. (The maximum permissible ionizing radiation dose for workers is 5,000 millirems per year.)

68. One comment stated that OSHA's ionizing radiation standard (29 CFR 1910.96) would apply to worker exposures from machine-produced radiations, but questioned the organization's ability to ensure worker safety.

In response to this comment, OSHA confirmed that its current ionizing radiation standard (29 CFR 1910.96) would apply to worker exposures to radiation from machine-produced sources. As in the past, OSHA will concentrate its inspectional resources on high priority problems, and will consider additional action should information develop indicating a need for concern.

69. Many comments were concerned about the safety of transporting radioactive materials, in general, and also argued that implementation of this regulation would lead to increased amounts of radioactive materials being transported.

Both DOT and NRC have responded to this comment. They stated that the transportation of radioactive materials is an activity which is highly regulated by both the Federal and State governments. Both DOT and NRC have regulatory requirements that govern all aspects of transportation in detail, from quality assurance in packaging to requirements for posting information that is clearly visible on transporting vehicles.

The overall safety of transporting radioactive materials was evaluated in the NRC report entitled "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (NUREG-0170) (Ref. 75). The report concluded that the total risk from all transportation of such materials was acceptably low. NRC has concluded, after review of the subject, that the regulations are adequate to protect the public against unreasonable risks from the transport of radioactive materials (46 FR 21619; April 13, 1981). NRC believes such shipments can be made safely because licensees shipping radioactive material for use in food irradiators are required to comply with an NRC regulatory program.

Food irradiation sources are held in the form of welded, sealed sources and are transported in accident-resistant packaging. There has never been a release of radioactive materials from one of these packages in the United States as a result of a transportation accident, even when transporting powders, liquids, or gases. The transportation of sealed sources would make a release even more unlikely.

70. One comment stated that DOT, NRC, and the States are ineffective in their regulation of transportation of radioactive materials.

DOT disagreed and stated in a letter to FDA that the approach being used by NRC, DOT, and the States has been effective in ensuring safety.

71. One comment stated that the absence of effective regulations for transporting radioactive materials has prompted over 200 local communities to impose bans or restrictions on nuclear cargo transportation in defiance of Federal preemption.

DOT advised FDA that this is a misleading statement. DOT has no evidence that the transportation of radioactive materials has caused any safety problem. DOT pointed out that there may be a myriad of reasons behind these local restrictions, many of which may be unrelated to safety. Finally, the existence of local restrictions against the transport of radioactive material provides no evidence that there is or has been a safety problem associated with such transportation.

72. One comment stated that the history of monitoring transportation of radioactive materials leaves much to be desired. The comment cited incidents reported over the past 2 years where (1) sources were simply "lost" or were found by children in public, unrestricted areas; (2) sources were accidentally mixed with scrap metal; or (3) offsite contamination from radiation byproduct facilities resulted in widespread contamination. The comment further questioned what would happen when millions of curies are added to the commercial sector, if the Federal government cannot keep track of the approximately 17,000 sources in the United States.

DOT advised FDA that the references made by the comment to lost sources are misleading. The incidents referred to did not involve sources as large as those to be used in a food irradiator. Sources that have been lost in transit in the United States have been those of very low activity or empty packages that pose relatively small risks. High activity sources such as those used for food irradiation are transported in large, heavy packages which are not likely to be easily lost. Additionally, DOT's regulations require that the shipper of such packages notify the consignee when a shipment is made so that the consignee expects it and can take prompt action if it is not delivered on time. The comment about radioactive material being mixed with scrap metal refers to an incident in which a radioactive source was incorporated into steel made from scrap metal. This incident involved international licensing authorities and had nothing to do with domestic transport.

The agency has determined that the existing controls over the transportation of radioactive materials are adequate to ensure safety even when the number of radiation sources increases, as might be expected as a result of this rule.

73. Many comments expressed concern that an increased use of radioactive materials will lead to a corresponding increase in problems regarding proper disposal of radioactive wastes and possible environmental contamination.

Under NRC's regulations, sealed sources used in an irradiator may be disposed of by transfer to an authorized recipient as specified in 10 CFR 20.301(a). An authorized recipient could be the original supplier of the sealed sources, another licensee which is authorized to possess the sealed sources, or a facility licensed to receive and dispose of radioactive wastes.

In practice, a cobalt-60 sealed source is usually returned to the original supplier at the end of its useful life. Disposal of the sealed sources could be accomplished by transfer to one of the existing facilities authorized to dispose of radioactive waste materials. In the United States, these facilities are located in the States of South Carolina, Nevada and Washington. With respect to the cesium-137 capsules which the Department of Energy (DOE) has available for use in irradiators, DOE will lease the capsules to licensees and the capsules will be returned to DOE at the end of their useful life.

The agency believes that these measures are adequate to safeguard against possible environmental contamination.

74. Many comments were concerned that food irradiation might cause formation of mutant pathogens. One comment stated that an environmental impact statement must be filed for this reason by the agency before further action is taken.

The agency considered the potential environmental impact of permitting food irradiation and concluded that an environmental impact statement was not required, and submitted this finding of no significant impact and environmental assessment to the docket for public review, as noted in the proposal. No new information or comments have been received that would alter the agency's previous determination. A response to the comment that mutant pathogens may result during food irradiation has been provided earlier in this document.

75. Various comments on the economic impact of this process stated that this process would provide consumers with a greater variety and quantity of foods than that now available because of quarantine restrictions or limited shelf life. Other comments stated that the process is expensive and thus would increase the price of food. Comments from industry stated that the costs involved in commissioning a facility would require a broader range of uses to make the operation financially viable.

The agency believes that the marketplace will determine whether irradiation of food is economically feasible. No information was provided to suggest that issuance of this final rule would pose an unacceptable economic burden on society.

III. Objections

Any person who will be adversely affected by this regulation may at any time on or before May 19, 1986 submit to the Dockets Management Branch (address above) written objections thereto and may make a written request for a public hearing on the stated objections. Each objection shall be separately numbered and each numbered objection shall specify with particularity the provision of the regulation to which objection is made. Each numbered objection on which a hearing is requested shall specifically so state; failure to request a hearing for any particular objection shall constitute a waiver of the right to a hearing on that objection. Each numbered objection for which a hearing is requested shall include a detailed description and analysis of the specific factual information intended to be presented in support of the objection in the event that a hearing is held; failure to include such a description and analysis for any particular objection shall constitute a waiver of the right to a hearing on the objection. Three copies of all documents shall be submitted and shall be identified with the docket number found in brackets in the heading of this regulation. Received objections may be seen in the office above between 9 a.m. and 4 p.m., Monday through Friday.

IV. References

The following sources referred to in this document are listed below. Documents with an asterisk (*) have been placed on display in the Dockets Management Branch (address above), and may be seen between 9 a.m. and 4 p.m., Monday through Friday. All the references not on display are available as published articles, reports, and books.

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67. *Chauhan, P.S., et al., "Studies on Dominant Lethal Mutations in Third Generation Rats Reared on an Irradiated Diet." *International Journal of Radiation Biology*, 28:215-223, 1975.
68. *Leonard, A., M. Willcox, and W. Schietecatte, "Mutagenicity Tests with Irradiated Food in the Mouse." *Strahlentherapie*, 153:349-351, 1977.
69. Consumer Research Department, "Women's Attitudes Toward New Food Technologies," A Good Housekeeping Institute Report, February 1983.
70. *Secretariat of the Joint FAO/WHO Food Standards Programme, "Codex General Standard for Irradiated Foods and Recommended International Code of Practice for the Operation of Radiation Facilities for the Treatment of Foods," Codex Alimentarius Commission, FAO/WHO, CAC/Vol. XV, Ed. 1, Rome, 1984.
71. *Vance, R.L., OSHA Letter to S.A. Miller, Director, Center for Food Safety and Applied Nutrition, October 31, 1984.
72. *Cunningham, R.E., NRC Letter to S.A. Miller, Center for Food Safety and Applied Nutrition, March 13, 1985.
73. *Santman, L.D., DOT letter to S.A. Miller, Center for Food Safety and Applied Nutrition, October 26, 1984.
74. *U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, "Guide for the Preparation of Applications for Licenses for the Use of Panoramic Dry Source-Storage Irradiators, Self-contained Wet Source-Storage Irradiators, and Panoramic Wet Source-Storage Irradiators." Division 10, Task FC 403-4, January 1985.
75. *U.S. Nuclear Regulatory Commission, Office of Standards Development, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (NUREG-0170), 1977, Docket No. PR 71, 73 (40 FR 23768).

V. Agency Action

FDA has evaluated over 5,000 comments as well as information already in FDA's files and concludes that the proposed use of ionizing radiation is safe and that the regulation should be amended as set forth below.

The agency assessed the impact of the proposed rule on current and future uses of irradiation technology (February 14, 1984; 49 FR 5714). This assessment demonstrated that the proposed rule was not a major rule as defined by Executive Order 12291.

Further, it was determined that th. rule would not have a significant impact on a substantial number of small entities under the Regulatory Flexibility Act. In order to accurately reflect changes in this final rule made in response to comments, FDA has prepared a revised threshold assessment of the economic effects of this rule. The findings of this assessment do not alter the agency's previous assessment. Therefore, the agency hereby finds that this is not a major rule as defined by that Order and certifies in accordance with section 605(b) of the Regulatory Flexibility Act that the rule will not have a significant economic impact on a substantial number of small entities.

The agency has previously considered the environmental effects of this rule as announced in the proposed rule (February 14, 1984; 49 FR 5714). No new information or comments have been received that would affect the agency's previous determination that there is no significant impact on the human environment and that an environmental impact statement is not required.

Section 179.25(e) of this final rule contains a collection of information requirement. FDA submitted a copy of the proposed rule containing the same requirement to the Office of Management and Budget (OMB). This collection of information requirement was approved for use through March 31, 1987 (OMB Control No. 0910-0186).

List of Subjects in 21 CFR Part 179

Food additives, Food packaging, Irradiation of foods.

Therefore, under the Federal Food, Drug, and Cosmetic Act, Part 179 is amended as follows:

PART 179—IRRADIATION IN THE PRODUCTION, PROCESSING, AND HANDLING OF FOOD

1. The authority citation for 21 CFR Part 179 is revised to read as set forth below and the authority citations under 21 CFR 179.21 and 179.15 are removed.

Authority: Secs. 201(s), 409, 72 Stat. 1784-1788 as amended (21 U.S.C. 321(s), 348); 21 CFR 5.10; §§ 179.23 and 179.26 also are issued under secs. 402, 403, 703, 704, 52 Stat. 1046-1048 as amended, 1057, 67 Stat. 477 as amended (21 U.S.C. 342, 343, 373, 374); 21 CFR 5.10, 5.11.

§ 179.22 [Removed]

2. By removing § 179.22 *Gamma radiation for the treatment of food.*

§ 179.24 [Removed]

3. By removing § 179.24 *Low-dose electron beam radiation for the treatment of food.*

4. By adding new § 179.25, to read as follows:

§ 179.25 General provisions for food irradiation.

For the purposes of § 179.26, current good manufacturing practice is defined to include the following restrictions:

(a) Any firm that treats foods with ionizing radiation shall comply with the requirements of Part 110 of this chapter and other applicable regulations.

(b) Food treated with ionizing radiation shall receive the minimum radiation dose reasonably required to accomplish its intended technical effect and not more than the maximum dose specified by the applicable regulation for that use.

(c) Packaging materials subjected to irradiation incidental to the radiation treatment and processing of prepackaged foods shall comply with § 179.45.

(d) Radiation treatment of food shall conform to a scheduled process. A scheduled process for food irradiation is a written procedure that ensures that the radiation dose range selected by the food irradiation processor is adequate under commercial processing conditions (including atmosphere and temperature) for the radiation to achieve its intended effect on a specific product and in a specific facility. A food irradiation processor shall operate with a scheduled process established by qualified persons having expert knowledge in radiation processing requirements of food and specific for that food and for that irradiation processor's treatment facility.

(e) A food irradiation processor shall maintain records as specified in this section for a period of time that exceeds the shelf life of the irradiated food product by 1 year, up to a maximum of 3 years, whichever period is shorter, and shall make these records available for inspection and copy by authorized employees of the Food and Drug Administration. Such records shall include the food treatment, lot identification, scheduled process, evidence of compliance with the scheduled process, ionizing energy source, source calibration, dosimetry, dose distribution in the product, and the date of irradiation.

(Collection of information requirements approved by the Office of Management and Budget under control number 0910-0186)

5. By adding new § 179.26, to read as follows:

§ 179.26 Ionizing radiation for the treatment of food.

Ionizing radiation for treatment of foods may be safely used under the following conditions:

(a) *Energy sources.* Ionizing radiation is limited to:

(1) Gamma rays from sealed units of the radionuclides cobalt-60 or cesium-137.

(2) Electrons generated from machine sources at energies not to exceed 10 million electron volts.

(3) X-rays generated from machine sources at energies not to exceed 5 million electron volts.

(b) *Limitations.*

Use	Limitations
For control of Trichinella spiralis in pork carcasses or fresh, non-heat-processed cuts of pork carcasses.	Minimum dose 0.3 kGy (30 krad); Maximum dose not to exceed 1 kGy (100 krad).
For growth and maturation inhibition of fresh foods.	Not to exceed 1 kGy (100 krad).
For disinfestation of arthropod pests in food.	Do.
For microbial disinfection of dry or dehydrated enzyme preparations (including immobilized enzymes).	Not to exceed 10 kGy (1 Mrad).
For microbial disinfection of the following dry or dehydrated aromatic vegetable substances: culinary herbs, seeds, spices, teas, vegetable seasonings, and blends of these aromatic vegetable substances. Turmeric and paprika may also be irradiated when they are to be used as color additives. The blends may contain sodium chloride and minor amounts of dry food ingredients ordinarily used in such blends.	Not to exceed 30 kGy (3 Mrad).

(c) *Labeling.* (1) The label and labeling of retail packages of foods irradiated in conformance with paragraph (b) of this section shall bear the following logo along with either the statement "Treated with radiation" or the statement "Treated by irradiation" in addition to information required by other regulations. The logo shall be placed prominently and conspicuously in conjunction with the required statement.

(2) For irradiated foods not in package form, the required logo and phrase "Treated with radiation" or "Treated by irradiation" shall be displayed to the purchaser with either (i) the labeling of the bulk container plainly in view or (ii) a counter sign, card, or other appropriate device bearing the information that the product has been treated with radiation. As an alternative, each item of food may be individually labeled. In either case, the information must be prominently and conspicuously displayed to purchasers. The labeling requirement applies only to a food that has been irradiated, not to a food that merely contains an irradiated ingredient but that has not itself been irradiated.

(3) For a food, any portion of which is irradiated in conformance with paragraph (b) of this section, the label and labeling and invoices or bills of lading shall bear either the statement "Treated with radiation—do not irradiate again" or the statement "Treated by irradiation—do not irradiate again" when shipped to a food manufacturer or processor for further processing, labeling, or packing.

(4) The wording requirements of paragraphs (c)(1) and (2) of this section pertaining to the label and labeling of retail packages of food shall expire April 18, 1988, unless extended by the Food and Drug Administration by publication for notice and comment in the Federal Register.

Frank E. Young,
Commissioner of Food and Drugs.

Dated: March 29, 1986.

Otis R. Bowen,
Secretary of Health and Human Services.

[FR Doc. 86-8681 Filed 4-15-86; 11:05 am]

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

DRAFT REGULATORY GUIDE AND VALUE/IMPACT STATEMENT

January 1985
Division 10
Task FC 403-4

Contact: N. Bassin (301)427-9027

RECEIVED MAR 25 1988

GUIDE FOR THE PREPARATION OF APPLICATIONS FOR LICENSES FOR THE USE OF PANORAMIC DRY SOURCE-STORAGE IRRADIATORS, SELF-CONTAINED WET SOURCE-STORAGE IRRADIATORS, AND PANORAMIC WET SOURCE-STORAGE IRRADIATORS

This regulatory guide and the associated value/impact statement are being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. They have not received complete staff review and do not represent an official NRC staff position.

Public comments are being solicited on both drafts, the guide (including any implementation schedule) and the value/impact statement. Comments on the value/impact statement should be accompanied by supporting data. Comments on both drafts should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch, by April 1, 1985.

Requests for single copies of draft guides (which may be reproduced) or for placement on an automatic distribution list for single copies of future draft guides in specific divisions should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Technical Information and Document Control.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 PURPOSE OF GUIDE

The purpose of this regulatory guide is to provide assistance to applicants and licensees in preparing applications for new licenses, license amendments, and license renewals for the use of sealed sources and devices for gamma irradiation in panoramic dry source-storage irradiators, self-contained wet source-storage irradiators, and panoramic wet source-storage irradiators.

This regulatory guide is intended to provide you, the applicant and licensee, with information that will enable you to understand specific regulatory requirements and licensing policies as they apply to gamma irradiators. The information in this regulatory guide is not a substitute for training in radiation safety and for developing and implementing an effective radiation safety program.

After you are issued a license, you must conduct your program in accordance with (1) the statements, representations, and procedures contained in your application, (2) the terms and conditions of the license, and (3) the Nuclear Regulatory Commission's (NRC's) regulations. The information you provide in your application should be clear, specific, and accurate.

1.2 APPLICABLE REGULATIONS

NRC regulations applicable to irradiators are in 10 CFR Part 19, "Notices, Instructions and Reports to Workers; Inspections"; 10 CFR Part 20, "Standards for Protection Against Radiation"; 10 CFR Part 21, "Reporting of Defects and Noncompliance"; 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 71, "Packaging and Transportation of Radioactive Material"; and 10 CFR Part 170, "Fees for Facilities and Materials Licenses and Other Regulatory Services Under the Atomic Energy Act of 1954, as Amended." It is your responsibility as an applicant and as a licensee to have copies of, to read, and to abide by each regulation. As a licensee, you are subject to all applicable provisions of the regulations as they pertain to gamma irradiators.

This regulatory guide identifies the information needed to complete NRC Form 313 when applying for a license to use sealed sources and devices for gamma irradiation. The information collection requirements in NRC Form 313 have been cleared under OMB Clearance No. 3150-0120.

1.3 AS LOW AS IS REASONABLY ACHIEVABLE (ALARA) PHILOSOPHY

Paragraph 20.1(c) of 10 CFR Part 20 states "...persons engaged in activities under licenses issued by the Nuclear Regulatory Commission pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974 should, in addition to complying with the requirements set forth in this part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable." Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," provides the NRC staff position on this important subject. As an applicant, you should consider the ALARA philosophy as described in Regulatory Guide 8.10 in the development of plans for work with licensed radioactive materials.

2. FILING AN APPLICATION

You, as the applicant for a materials license, should complete NRC Form 313 (see Appendix A to this guide). You should complete Items 1 through 4, 12, and 13 on the form itself. For Items 5 through 11, you should submit the information on supplementary pages. Each separate sheet or document submitted with the application should be identified and keyed to the item number on the application to which it refers. All typed pages, sketches, and, if possible, drawings should be on 8-1/2 x 11 inch paper to facilitate handling and review. If larger drawings are necessary, they should be folded to 8-1/2 x 11 inches. You should complete all items in the application in sufficient detail for the NRC to determine that your equipment, facilities, training and experience, and radiation safety program are adequate to protect health and to minimize danger to life and property.

You should file your application in duplicate. Retain one copy for yourself because the license will require that you possess and use licensed material in accordance with the statements and representations in your application and in any supplements to it.

Federal agencies should file applications with the U.S. Nuclear Regulatory Commission, Division of Fuel Cycle and Material Safety, Washington, DC 20555.

If you are located in an Agreement State, you should file applications with the NRC only if you wish to possess and use licensed material in States subject to its jurisdiction. All other persons should file applications with the NRC Regional Office for the State in which they are located.

If you are located in Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, or Vermont, send your applications to the U.S. Nuclear Regulatory Commission, Region I, Nuclear Material Section B, 631 Park Avenue, King of Prussia, PA 19406.

If you are located in Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, or West Virginia, send your applications to the U.S. Nuclear Regulatory Commission, Region II, Material Radiation Protection Section, 101 Marietta Street, Suite 2900, Atlanta, GA 30323.

If you are located in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, or Wisconsin, send your applications to the U.S. Nuclear Regulatory Commission, Region III, Material Licensing Section, 799 Roosevelt Road, Glen Ellyn, IL 60137.

If you are located in Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, or Wyoming, send your applictions to the U.S. Nuclear Regulatory Commission, Region IV, Material Radiation Protection Section, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 76011.

If you are located in Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, or U.S. territories and possessions in the Pacific, send your applications to the U.S. Nuclear Regulatory Commission, Region V, Material Radiation Protection Section, 1450 Maria Lane, Suite 210, Walnut Creek, CA 94596.

3. CONTENTS OF AN APPLICATION

The following comments apply to the indicated items of NRC Form 313.

Item 1 - LICENSE INFORMATION

For a new license, check subitem A. For an amendment to an existing license, check subitem B. For a renewal of an existing license, check subitem C.

Item 2 - NAME AND MAILING ADDRESS OF APPLICANT

If you are an individual, you should be designated as the applicant only if you are acting in a private capacity and the use of the radioactive material is not connected with your employment with a corporation or other legal entity. Otherwise, you, the applicant, should be the corporation or other legal entity applying for the license.

The address specified here should be your mailing address for correspondence. This may or may not be the same as the address at which the material will be used, as specified in Item 3.

Item 3 - LOCATIONS OF USE

You should specify each location of use by the street address, city, and State or other descriptive address (such as 5 miles east on Highway 10, Anytown, State) to allow us to easily locate your facility. A Post Office Box address is not acceptable.

Item 4 - PERSON TO BE CONTACTED ABOUT APPLICATION

You should name the individual who knows your proposed program and can answer questions about the application, and you should note his or her telephone number. If the contact changes, the NRC should be notified. Notification of a contact change is for information only and would not be considered an application for a license amendment.

Item 5 - MATERIAL TO BE POSSESSED

1. Identify the radioisotope that will be in each sealed source in the irradiator.
2. Identify the manufacturer and model number of each sealed source in the irradiator.
3. Specify the total amount of radioactive material that you will possess at any one time and the maximum amount of radioactive material that will be in any single sealed source.
4. Identify the manufacturer and model number of the irradiator.

The information specified above is available from the supplier of the irradiator.

Item 6 - PURPOSE FOR WHICH LICENSED MATERIAL WILL BE USED

Specify the purpose for which the irradiator will be used. For purposes of public health and safety, you should include a statement that explosives, flammables, and corrosives will not be irradiated. If you plan to irradiate food, you should state that distribution for consumption in the United States will be done in accordance with the Food and Drug Administration's regulatory requirements.

Item 7 - INDIVIDUALS RESPONSIBLE FOR RADIATION SAFETY PROGRAM--THEIR TRAINING AND EXPERIENCE

Paragraph 30.33(a)(3) of 10 CFR Part 30 specifies that you must be qualified by training and experience to use the material for the purpose requested in such a manner as to protect health and minimize danger to life or property before an application for a license is approved.

You need to include a commitment that, whenever the irradiator is in operation, a "responsible individual" will be on duty and immediately available in the irradiator facility. This commitment is necessary to ensure that there will always be a trained individual who is in a management or supervisory capacity on duty who can take appropriate steps in the event of an emergency or other situation that requires corrective action. The title of the individual is not important. Whether the person is called the radiation safety officer (RSO), radiation protection officer (RPO), supervisor, etc., is not critical. It is important that the persons responsible for the program be specifically named.

You should provide the following information about the individual or individuals who will be responsible for your radiation safety program ("responsible individual").

1. The name of each individual.
2. Specific dates each individual's training was completed and where and by whom the training was conducted. As a minimum, any "responsible individual" should have successfully completed a training course of approximately 40 hours in the following topics:

- Principles and fundamentals of radiation protection and good safety practices related to the use of radioactive materials.
- Radioactivity measurements, use of radiation detection and measuring instruments, and monitoring techniques.
- Mathematics and calculations basic to the use and measurement of radioactivity.
- Biological effects of radiation.

3. Specific dates of each individual's actual experience in irradiator use, the type of irradiator used, and its location. As a minimum, each "responsible individual" should have at least 3 months (full-time equivalent) of actual experience in the use of the same type irradiator specified in the application and in operations associated with irradiator use. The 3 months of experience may include some preoperational involvement while the irradiator is being constructed if the individual works with the personnel of the firm constructing the irradiator and learns about the irradiator, its safety systems, and how the irradiator functions. The actual experience in irradiator operations after the irradiator goes into operation should be for a minimum of 4 weeks.

Item 8 - TRAINING PROVIDED TO OTHER USERS

Individuals who will operate the irradiator under the supervision of a "responsible individual" (described in Item 7) do not need to be designated by name. The following information should be provided:

1. An outline of the training program, including the topics that will be covered and the time that will be spent on each topic. Examples of topics to be included in the training program are (1) the principles and fundamentals of radiation safety and good safety practices related to the use of radioactive materials, (2) the use of radiation detection instruments, (3) your operating and emergency procedures, and (4) the design and operation of the irradiator. This training should be approximately 40 hours in length. The training program should include an examination to test the understanding and knowledge of the individuals who have completed the training program. The examination should have approximately 50 questions that cover all aspects of the training program.

2. Copies of the examination, the correct answers, the passing grade, and a discussion of additional instruction for individuals who are found to be deficient.

3. A discussion of the on-the-job training that will be given to individuals. This training should consist of a minimum of 1 month of on-the-job training in the actual operation and use of the irradiator. The on-the-job training should be conducted by a "responsible individual" specified in Item 7.

4. The name of the course instructor. If this person is not a "responsible individual" specified in Item 7, submit this person's qualifications. The minimal qualifications for a course instructor should be the same as those for a responsible individual specified in Item 7.

5. A commitment that records documenting the training of each individual will be maintained for a period of 3 years.

Item 9 - FACILITIES AND EQUIPMENT

Paragraph 30.33(a)(2) of 10 CFR Part 30 states that an application will be approved if, among other things, the applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life or property. Therefore, you should provide information concerning your equipment and facilities.

9.1 Basic Facility Design and Construction

Include a sketch or drawing of the irradiator facility and its surroundings, together with an accompanying narrative, and provide the following information:

1. The scale to which the sketch or drawing is made (the same scale should be used for all sketches and drawings). The recommended scale is 1/4 inch = 1 foot.

2. The type, thickness, and density of shielding materials on all sides, including the floor and roof.

3. The locations of entrances and other points of access into the irradiator room and locations of control devices, alarms, and signals.

4. A description of the nature of the areas adjacent to the facility and the distance to these areas.

5. A description of the safety systems, including control devices, alarms, and signals. Explain how the regulatory requirements of each subitem in paragraph 20.203(c)(6) of 10 CFR Part 20 are met. In order to meet these requirements, the safety systems and the radiation control program must:

- Have an entry control device that functions automatically to prevent an individual from entering when the radiation level is above the normal shielded level. The control device must be a physical barrier such as a door.
- Permit entry only after actuation of a control device that causes radiation to be reduced so that an individual could not receive a dose of more than 100 mrem in an hour.
- Prevent source operation if the resulting radiation level could result in a dose to an individual in excess of 100 mrem in an hour.
- Ensure that the entry control devices will not prevent an individual from leaving the area.
- Have additional control devices that will reduce the radiation level in case the primary entry control devices fail so that an individual could not receive a dose of more than 100 mrem in an hour. The devices must generate audible and visible alarm signals to warn individuals attempting to enter and must make at least one other individual aware of the attempted entry.

- Have additional control devices that will reduce the radiation level so that, if the shielding fails, an individual will not receive a dose of more than 100 mrem in an hour. The devices must generate visible and audible alarm signals. However, this requirement does not apply to irradiators with permanent structural components with no credible probability of failure.
- Have devices that will automatically generate visible and audible-alarm signals to alert personnel before the source can be put into operation and that will allow an individual enough time to operate a control device to prevent source operation.
- Have administrative procedures and devices to ensure that no individual is in the irradiation area when the source is taken from the shielded position to the exposed position.
- Require a physical radiation survey before an individual enters the irradiation area to ensure that the radiation is below the level that could cause the individual to receive a dose of more than 100 mrem in an hour.
- Require testing of the control devices each day in which operations are not continued from the previous day. Records of these required tests should be maintained for 2 years from the date of performance of each test.
- Have control devices and administrative procedures that protect and warn against inadvertent entry into the entry and exit portals used for transporting materials to and from the irradiation area.
- Have a detector at each exit portal to signal the presence of loose radiation sources and a control system to prevent the loose sources from being carried out of the area.

In preparing the annotated sketch or drawing and the description of the control devices, alarms, and signals, you should ensure that the design of the facility satisfies the following safety conditions:

1. The radiation level in the area immediately outside the shielded room where the sealed sources are located should not exceed 2 milliroentgens per hour when the sealed sources are exposed. The design must take into account potential increases in the amount of radioactive material that could be used in the irradiator.

2. All entrances, points of access, and exits to and from the area in which the sealed sources are located should have control devices, alarms, and signals that comply with the requirements in paragraph 20.203(c)(6) of 10 CFR Part 20.

3. All areas in which control and interlock systems are required, including roof areas, should be locked and secured against unauthorized access when authorized personnel are not present.

9.2 <u>Other Safety Considerations</u>

In addition to the items specified in Item 9.1, consider the safety features identified below as applicable to the design of the irradiator facility. List those features that will be in the irradiator design and provide a brief description of the design criteria for each. For features that are not included, submit a brief statement of why they are not included.

1. If the facility has a water storage pool:

a. The pool construction should provide for water circulation, treatment, monitoring, and makeup systems.
b. The pool should be watertight.
c. Permanent pool components should be made of material that reduces the possibility of corrosion that could cause leakage of radioactive material from the sealed sources.
d. A means should be provided to automatically replenish water losses from normal evaporation.
e. The pool should be equipped with a system capable of keeping the water clean; the level of conductivity should not exceed 10 microsiemens per centimeter.
f. The means used to monitor storage pool water should be capable of detecting any leakage of radioactivity from the sources in the water.
g. There should be no penetration (e.g., pipes or plugged holes) through the bottom of the pool. There should be no penetration through the walls of the pool more than 12 inches (30 cm) below normal water level.

h. A means should be provided to prevent the migration of pool water into municipal water supply systems.

2. If in-air irradiation is to be performed, the facility should have a ventilation system to keep ozone, nitrogen oxides, and other noxious gases below values listed in the "Threshold Limit Values for Chemical Substances in Workroom Air"* so that employees are not exposed to concentrations in excess of the threshold limit values.

3. The facility should have heat- and smoke-sensing devices to detect combustion in the irradiator room, and these devices should have audible and visible alarms. The sensing system should be designed so that the sources will be automatically placed in the fully shielded position if either the heat- or smoke-sensing device is activated.

4. The irradiation room should be provided with an automatic fire extinguishing system.

5. Product carriers, packages, and totes should be designed and maintained so that they cannot interfere with the source holder or source elevating and lowering mechanisms.

<u>Item 10 - RADIATION PROTECTION PROGRAM</u>

You, as the licensee, are responsible for the conduct of the irradiator program and all actions of your employees.

10.1 <u>Personnel Monitoring Equipment</u>

Section 20.202 of 10 CFR Part 20 requires that personnel monitoring equipment be used by individuals entering restricted areas who receive or are likely to receive a dose in excess of 25% of the dose specified in paragraph 20.101(a) of 10 CFR Part 20. The specified doses per calendar quarter are 1-1/4 rems to the whole body, head and trunk, active blood-forming organs,

*Adopted by the American Conference of Governmental Industrial Hygienists (ACGIH), P.O. Box 1937, Cincinnati, Ohio 45201. The threshold limit values are reassessed and published annually by ACGIH; you should use the most recent edition of these values.

or gonads; 18-3/4 rems to the hands and forearms or feet and ankles; and 7-1/2 rems to the skin of the whole body. Individuals under 18 years of age need to use personnel monitoring equipment if they receive or are likely to receive a dose in excess of 5% of the specified calendar quarter doses in paragraph 20.101(a). In addition, any individual who enters a high radiation area must use personnel monitoring equipment.

All your personnel should wear either a film badge or a thermoluminescent dosimeter (TLD) when they use the irradiator. State the type of personnel monitoring equipment you will use and the frequency at which the film badges or TLDs will be changed. The frequency of change should be at intervals not to exceed 1 month for film badges and 3 months for TLDs.

10.2 Radiation Detection Instruments

Paragraph 20.201(b) of 10 CFR Part 20 specifies that you, as the licensee, must make such surveys as are necessary to evaluate the extent of radiation hazards that may be present and to comply with regulatory requirements. In order to perform appropriate surveys, you need to have operable, calibrated instrumentation.

State that you will have available for use at all times a calibrated, operable survey meter that can measure up to 1 roentgen per hour. You do not need to name the manufacturer or the model number of the survey meter.

In order to perform appropriate surveys, the instruments must be operable and calibrated with an appropriate radiation source. State that the instruments will (1) be calibrated so that the readings are ±20% of the actual values over the range of the instrument, (2) have a calibration chart or graph that shows the results of the calibration, the date of the last calibration, and the due date for the next calibration affixed to the survey meter, and (3) be calibrated at intervals not to exceed 12 months and after servicing. Also state that calibration records will be kept for a minimum of 2 years after each calibration and identify who will calibrate the instruments. If a person or firm outside your organization will perform the calibration, identify each person or firm by name and NRC or Agreement State license number. If the person or firm is not a licensee, provide a copy of the procedure used for instrument calibration for NRC review.

Note: A person or firm in a non-Agreement State who uses radium for instrument calibration would not be an NRC licensee because NRC does not have authority to license naturally occurring radioisotopes such as radium. If you use such a calibration service, you must provide the NRC with a copy of the procedures used.

For detailed information about survey instrument calibration, refer to ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration."*

10.3 Leak-Testing

As a licensee, you must perform such tests as the NRC deems appropriate pursuant to § 30.53, "Tests," of 10 CFR Part 30. The NRC requires tests to determine whether or not there is any leakage from sealed sources.

An acceptable method of leak-testing for wet source-storage irradiators that have an ion exchange system is to monitor the ion exchange resin filter bed at least once a week. The measurement does not need to be quantitative, and your survey instrument may be used. If any radioactivity is detected, a source leak should be assumed and you should take steps to identify the specific source that may be leaking. You should submit your procedure for identifying the leaking source and the action you will take to remove the source from use.

Another acceptable method is to equip the ion exchange resin filter bed with a continuous radiation monitoring device with an alarm that will sound if any radioactivity is detected. You should then identify the specific source that may be leaking. You should submit your procedure for identifying the leaking source and the action you will take to remove the source from use.

For panoramic dry source-storage irradiators, an acceptable method for checking for leakage is (1) wiping accessible surfaces around the sealed source rack and measuring the leak-test sample or (2) actually wiping each sealed source and measuring the leak-test sample. The leak tests should be quantitative and sufficiently sensitive to detect 0.05 microcurie of radioactivity. The tests should be performed at intervals not to exceed 6 months, and records of the tests should be maintained for 3 years.

*Copies may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

You should specify the type of leak test that will be performed and the means to determine the specific leaking source if more than 0.05 microcurie of radioactivity is found on a leak-test sample.

If the wipe-test method is used, specify the following:

1. The leak-test method used.
2. Instrumentation used for measurement.
3. The identity of the individual or firm performing the test. If a commercial firm or consultant will perform the test, specify the name and the NRC or Agreement State license number of the commercial firm or consultant.

10.4 Operating and Emergency Procedures

You should provide your personnel with written operating and emergency procedures, and you should state to the NRC that you will provide copies of the procedures to each person who uses the irradiator. It is not necessary to submit the detailed operating and emergency procedures to the NRC. However, you should list the topics covered in your procedures, and you should state that your procedures include instructions in the following topics:

1. Use of personnel monitoring equipment. All personnel engaged in irradiator operations should wear their personal dosimeters while working around the irradiator.

2. Irradiator startup and shutdown. In the step-by-step procedures for these operations, clearly state the precautions to be taken before startup such as ensuring that the entry controls, alarms, and signals are in operating condition, that no one is in the irradiation room, that the survey meter is in operating condition, and that the product conveyor system, totes, and packages are in satisfactory condition.

3. Performance of radiation surveys to ensure compliance with the provisions of paragraph 20.203(c)(6) of 10 CFR Part 20.

4. Emergencies that can occur and actions to be taken. Take into account any situation that can cause an emergency shutdown, such as a trip of the emergency system in the irradiation room, violation of any entry point into the irradiation room, source jams, etc. The individual responsible for the irradiator program must be notified of any emergency.

5. Associated irradiator operations. If personnel perform associated irradiator operations (for example, maintenance, leak-testing, instrument calibration), include appendices that contain the step-by-step procedures for performing the associated operations and the performance standards for these operations.

10.5 Hospital Arrangements

You should make arrangements in advance with a local hospital to accept an individual for treatment in the event of an accident or injury resulting from irradiator operation. The hospital's acceptance is particularly important if an individual has received a radiation exposure. Include a copy of the hospital's commitment to accept an individual for treatment. A letter from the hospital's management is preferable.

Item 11 - WASTE MANAGEMENT

Section 20.301 of 10 CFR Part 20 specifies the general requirements for disposal of licensed material, i.e., the sealed sources. Because of the nature of the licensed material contained in irradiators, your only option for disposal is to transfer the material to an authorized recipient as specified in paragraph 20.301(a). You should state that disposal will be in accordance with paragraph 20.301(a) of 10 CFR Part 20.

Authorized recipients are the original supplier of the irradiator and source, a commercial firm licensed by the NRC or by an Agreement State to accept radioactive waste from other persons, or another specific licensee authorized to possess the licensed material. No one else is authorized to dispose of your licensed material.

Item 12 - LICENSE FEES

An application fee paid in full is required by paragraph 170.12(a) of 10 CFR Part 170 for most types of licenses, including applications for license amendments and renewals. You should refer to § 170.31, "Schedule of Fees for Materials Licenses and Other Regulatory Services," of 10 CFR Part 170 to determine the amount of the fee that must accompany your application. Applications for which no fee is received may be returned to you. All application fees may be charged irrespective of the NRC's disposition of your application or your withdrawal of the application.

Item 13 - CERTIFICATION

If you are an individual applicant acting in a private capacity, you yourself are required to sign the form. Otherwise, your application should be dated and signed by a representative of the corporation or legal entity who is authorized to sign official documents and to certify that the application contains information that is true and correct to the best of your knowledge and belief. Unsigned applications will be returned for proper signature.

4. AMENDMENTS TO A LICENSE

After you are issued a license, you must conduct your program in accordance with (1) the statements, representations, and procedures contained in your application, (2) the terms and conditions of the license, and (3) the Nuclear Regulatory Commission's regulations.

It is your obligation to keep your license current. You should anticipate the need for a license amendment insofar as possible. If any of the information provided in your application is to be modified or changed, submit an application for a license amendment. In the meantime, you must comply with the terms and conditions of your license until it is actually amended; NRC regulations do not allow you to implement changes on the basis of a submission requesting an amendment to your license.

An application for a license amendment may be prepared either on the application form (NRC Form 313) or in letter form and should be submitted in duplicate to the address specified in this guide in Section 2, "Filing An Application." Your application should identify your license by number and should clearly describe the exact nature of the changes, additions, or deletions. References to previously submitted information and documents should be clear and specific and should identify the pertinent information by date, page, and paragraph. For example, if you wish to change the "responsible individual," your application for a license amendment should specify the new individual's name, training, and experience. The qualifications of the new individual should be equivalent to those specified in Item 7 of this guide.

You must send the appropriate fee for license amendment with your application. The NRC will not accept an application for filing or processing before the proper fee is paid in accordance with § 170.12 of 10 CFR Part 170.

5. RENEWAL OF A LICENSE

Licenses are issued for a period of up to 5 years. You must send an application for renewal to the address specified in this guide in Section 2, "Filing An Application." You may submit an entirely new application for renewal as if it were an application for a new license without referring to previously submitted information.

As an alternative, you may:

1. Review your current license to determine whether the information concerning the sealed sources and the irradiator accurately represents your current and anticipated program. Identify any additions, deletions, or other changes and then prepare information appropriate for the required additions or changes.

2. Review the documents you have submitted in the past to determine whether the information in them is up to date and accurately represents your facilities, equipment, personnel, radiation safety procedures, locations of use, and so on. The documents you consider to represent your current program should be identified by date. Any out-of-date or superseded documents should also be identified, and changes should be made in the documents as necessary to reflect your current program.

3. Review NRC regulations to ensure that any changes in the regulations are appropriately covered in your program description.

4. If you have not made a commitment that "responsible individual" who has the minimal training and experience outlined in Item 7 will be on duty and immediately available in the irradiator facility whenever the irradiator is in operation, include this commitment in your application for license renewal.

5. After you have completed your review, submit a letter to the NRC in duplicate, with the proper fee, requesting renewal of your license and providing the information specified in Items 1, 2, 3, and 4, as necessary.

6. Include the name and telephone number of the person to be contacted about your renewal application and include your current mailing address if it is not indicated correctly on your license.

If you file your application for license renewal at least 30 days before the expiration date of your license and include the appropriate fee for license renewal, your license will automatically remain in effect until the NRC takes final action on your application. However, if you file an application less than 30 days before the expiration date and the NRC cannot process it before that date, you would be without a valid license when your license expires.

It is important that the appropriate fee accompany your application for license renewal. In accordance with § 170.12 of 10 CFR Part 170, the NRC will not accept an application for filing or processing before the proper fee is paid.

If you do not wish to renew your license, you must dispose of all licensed radioactive material you possess in a manner authorized by 10 CFR Part 20. Complete NRC Form 314, "Certificate of Disposition of Materials," and send it to the NRC before the expiration date of your license with a request that your license be terminated.

If you cannot dispose of all the licensed radioactive material in your possession before the expiration date, you must request a license renewal for storage only of the radioactive material. The renewal is necessary to avoid violating NRC's regulations that do not allow you to possess licensable material without a valid license.

NRC FORM 313
(1-84)
10 CFR 30, 32, 33, 34, 35 and 40

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB
3150-0120
Expires 8-31-87

APPENDIX A
APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

FEDERAL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR (Check appropriate item)
- A. NEW LICENSE
- B. AMENDMENT TO LICENSE NUMBER ____________
- C. RENEWAL OF LICENSE NUMBER ____________

2. NAME AND MAILING ADDRESS OF APPLICANT (Include Zip Code)

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION | TELEPHONE NUMBER

SUBMIT ITEMS 5 THROUGH 11 ON 8½ × 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS

9. FACILITIES AND EQUIPMENT

10. RADIATION SAFETY PROGRAM

11. WASTE MANAGEMENT

12. LICENSEE FEES (See 10 CFR 170 and Section 170.31)
FEE CATEGORY | AMOUNT ENCLOSED $

13. CERTIFICATION (Must be completed by applicant) THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE – CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE

14. VOLUNTARY ECONOMIC DATA

A. ANNUAL RECEIPTS		B. NUMBER OF EMPLOYEES (Total for entire facility, excluding outside contractors)	D. WOULD YOU BE WILLING TO FURNISH COST INFORMATION (Dollar and/or staff hours) ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? NRC regulations permit it to protect confidential commercial or financial-proprietary information furnished to the agency in confidence.
<$250K	$1M – 3.5M		
$250K – 500K	$3.5M – 7M	C. NUMBER OF BEDS	
$500K – 750K	$7M – 10M		YES
$750K – 1M	>$10M		NO

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS	APPROVED BY
AMOUNT RECEIVED	CHECK NUMBER			DATE

PRIVACY ACT STATEMENT ON THE REVERSE

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93 579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 313. This information is maintained in a system of records designated as NRC-3 and described at 40 Federal Register 45334 (October 1, 1975).

1. **AUTHORITY:** Sections 81 and 161(b) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2111 and 2201(b)).

2. **PRINCIPAL PURPOSE(S):** The information is evaluated by the NRC staff pursuant to the criteria set forth in 10 CFR Parts 30, 32, 33, 34, 35 and 40 to determine whether the application meets the requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations, for the issuance of a radioactive material license or amendment thereof.

3. **ROUTINE USES:** The information may be (a) provided to State health departments for their information and use; and (b) provided to Federal, State, and local health officials and other persons in the event of incident or exposure, for their information, investigation, and protection of the public health and safety. The information may also be disclosed to appropriate Federal, State, and local agencies in the event that the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, or local agency to the extent relevant and necessary for an NRC decision or to an appropriate Federal agency to the extent relevant and necessary for that agency's decision about you.

4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** Disclosure of the requested information is voluntary. If the requested information is not furnished, however, the application for radioactive material license, or amendment thereof, will not be processed. A request that information be held from public inspection must be in accordance with the provisions of 10 CFR 2.790. Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned need to inspect the document.

5. **SYSTEM MANAGER(S) AND ADDRESS:** U.S. Nuclear Regulatory Commission
Director, Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
Washington, D.C. 20555

NRC FORM 313

DRAFT VALUE/IMPACT STATEMENT

1. BACKGROUND

The NRC issues licenses for the possession and use of byproduct material contained in irradiators. The NRC issued Regulatory Guide 10.9 in April 1980 to provide guidance for the preparation of license applications for all gamma irradiators in conformance with Form NRC-313I. A proposed revision to Regulatory Guide 10.9 was issued in April 1982 to incorporate guidance and procedures on fire protection for irradiators. In July 1984, the NRC issued a new application form, NRC Form 313, which superseded Form NRC-313I. It was decided to revise Regulatory Guide 10.9, in conformance with the new NRC Form 313, to apply only to applications for self-contained dry source-storage irradiators and to issue a new regulatory guide to cover applications for all other types of irradiators.

2. PROPOSED ACTION

2.1 Description

An applicant for a license to use byproduct material in irradiators is required to develop a program that complies with NRC regulations and to describe this program in the application for a license. The proposed action is to issue a new regulatory guide to provide guidance on establishing programs for the use of panoramic dry source-storage irradiators, self-contained wet source-storage irradiators, and panoramic wet source-storage irradiators. This guidance will be used in the preparation of applications for licenses on the new NRC Form 313.

2.2 Need

A new regulatory guide is needed to provide guidance to license applicants for the other types of irradiators in conformance with the new NRC Form 313.

2.3 Value/Impact

2.3.1 NRC

The review and approval of applications for the use of byproduct material in irradiators other than self-contained dry source-storage would be facilitated by the instructions and guidance to be provided in the new regulatory guide. The proposed action would clearly list the regulations to be followed and would describe the information required for licensing and implementing an acceptable program for the use of irradiators. Staff review time would be shortened because there would be a reduction in correspondence resulting from a lack of sufficient detail in license applications.

2.3.2 Other Government Agencies

Other government agencies would not be affected.

2.3.3 Industry

The proposed action would contribute to a reduction in the time spent preparing license applications. Applicants would spend less time trying to interpret NRC regulations and requirements for information. More importantly, the proposed action would provide information for the design and implementation of a more effective radiation safety program, thereby minimizing the exposure of workers to radiation.

2.3.4 Public

No impact on the public is foreseen.

2.3.5 Worker

The worker would benefit from the proposed action through reduced exposure to radiation as discussed in Item 2.3.3.

2.4 Decision

A new regulatory guide should be prepared to provide guidance to license applicants for the use of panoramic dry source-storage irradiators, self-contained wet source-storage irradiators, and panoramic wet source-storage irradiators.

3. TECHNICAL APPROACH

Not applicable.

4. PROCEDURAL APPROACH

4.1 Alternatives

The alternative is to write individual letters to applicants to provide guidance.

4.2 Discussion

A regulatory guide is the most effective way to transmit information about regulations and licensing requirements. A regulatory guide ensures uniform transmission of information to applicants. Individual letters would be inefficient and, depending on the reviewing official, may not uniformly convey the same information to each applicant. Issuance of a new regulatory guide is the most effective alternative.

5. STATUTORY CONSIDERATIONS

5.1 NRC Authority

Authority for the proposed action is derived from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended, and implemented through the Commission's regulations.

5.2 Need for NEPA Assessment

Issuance or amendment of guides for the implementation of regulations in Title 10, Chapter I, of the Code of Federal Regulations is a categorical exclusion under paragraph 51.22(c)(16) of 10 CFR Part 51. Thus, an environmental impact statement or assessment is not required for this action.

6. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS OR POLICIES

No conflicts or overlaps appear to exist.

7. SUMMARY AND CONCLUSIONS

The guide, when disseminated, will assist the NRC in its review of applications for the use of byproduct material in irradiators other than self-contained dry source-storage irradiators and will provide applicants with guidance on submitting applications in conformance with the new NRC Form 313. The proposed regulatory guide should be issued.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

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TITLE 11

ADMINISTRATIVE RULES

DEPARTMENT OF HEALTH

CHAPTER 40

RADIATION PROTECTION

TITLE 11

DEPARTMENT OF HEALTH

CHAPTER 40

RADIATION PROTECTION

§11-40-1 Purpose
§11-40-2 Definitions
§11-40-3 General prohibition
§11-40-4 Exemptions
§11-40-5 Standards
§11-40-6 Registration
§11-40-7 Maximum permissible dose and concentration
§11-40-8 Personnel monitoring: Area radiation surveys
§11-40-9 Radiation-exposure records and reports
§11-40-10 Responsibility
§11-40-11 Storage of radioactive materials
§11-40-12 Radioactive-contamination control
§11-40-13 Radiation information labeling
§11-40-14 Disposal of radioactive wastes
§11-40-15 Examination for compliance: Statement of noncompliance
§11-40-16 Proceedings before director
§11-40-17 Inspections and investigations: Maintenance of records
§11-40-18 Penalties and injunctions
§11-40-19 Severability

H-27

Historical Note: Chapter 40 of Title 11, Administrative Rules, is based substantially on Public Health Regulations Chapter 33, Radiation Protection, Department of Health, State of Hawaii, except that references to the National Committee on Radiation Protection and Measurements and the National Bureau of Standards are amended to refer to the National Council on Radiation Protection and Measurements, which is the successor to the National Committee on Radiation Protection and Measurements. [Eff. 11/14/60; R [illegible] 1981]

§11-40-1 Purpose. This chapter seeks to ensure the maximum health and safety of all persons at, or in the vicinity of, the place of use, storage, or disposal of radiation machines and radioactive materials. These rules are intended to be consistent with the best use of radiation machines and radioactive materials. [Eff. [illegible] 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-2 Definitions. For the purposes of these rules the following definitions shall apply:

"Absorbed dose" of any radiation means the amount of energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest.

"Adult" means a person of age eighteen or more. This age limitation is for radiation protection purposes only and bears no relationship to age limits for social, political, or other legal considerations.

"Body burden" means the amount of radioactive material in the body of a human being at the time of interest.

"Controlled area" means a defined area under the administrative control of the user in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. The boundaries of a controlled area shall be determined by, or under the advice of, the qualified expert.

"Critical organ" means that part of the body that is most susceptible to radiation damage under the specific conditions considered.

"Director" means the director of the department of health, State of Hawaii, or a duly authorized agent.

"Excessive radiation dose" means a dose of radiation in excess of the maximum permissible dose.

"Exposure dose" of ionizing radiation at a certain place means a measure of the radiation that is based upon its ability to produce ionization.

"Handbook" means NCRP Report No. 19, Regulation of Radiation Exposure by Legislative Means, issued December 9, 1955, published by the National Council on Radiation Protection and Measurements.

"Harmful effect" means any bodily injury, disease, death, or impairment, except where such condition is transitory, infrequent, or of short duration, and does not endanger persons so affected.

"Installation" means the area of radiation hazard under the administrative control of the person or organization possessing the source of radiation.

"Maximum permissible dose" means a dose of radiation that, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his lifetime. The maximum permissible dose for an individual shall be considered to include all doses, from internal and external sources, from all types and energies of radiation, whether delivered simultaneously or successively, to the region of interest, during the period of measurement. The exposure dose will be used in all cases where the absorbed dose has not been determined.

"NCRP" means the National Council on Radiation Protection and Measurements.

"Person" means a person of either sex, firm, partnership, corporation, or any other association of natural persons.

"Personnel monitoring" means the determination of the radiation dose received by a person during a specified period.

"Population group" means a civilian community in geographic proximity and generally dependent upon the same sources of food and water.

"Qualified expert" means a person fitted by training and experience to perform dependable radiation surveys, to oversee radiation monitoring, and to estimate the degree of radiation hazard. If the ability of a qualified expert is questioned, the director shall be the judge of those qualifications, in regard to which the director may consider the testimony of other persons who are deemed experts.

"Rad" means the unit of absorbed dose and is equal to one hundred ergs per gram. It is a measure of the energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest.

"Radiation" means gamma rays and x-rays, alpha and beta particles, high-speed electrons, neutrons, protons, and other nuclear particles; but not sound or radio waves, or visible, infrared, or ultraviolet light.

"Radiation hazard" means any condition that might result in the exposure of persons to radiation in excess of the maximum permissible dose.

"Radiation machine" means any device that produces radiation when the associated control devices are operated.

"Radioactive material" means any material, solid, liquid, or gas, that emits radiation spontaneously.

"Registrant" means any person who has registered any radiation machine or radioactive material pursuant to §11-40-6 of this chapter.

"Relative biological effectiveness" (rbe) means the biological effectiveness of one type and energy of radiation, relative to that of lightly filtered x-rays generated at potentials of two hundred to three hundred kilovolts, for the particular biological system and biological effect, and for the conditions under which the radiation is received.

"Roentgen equivalent man" (rem) means the quantity of any radiation such that the energy imparted to a biological system (cell, tissue, organ, or organism) per gram of living matter by the ionizing particles present in the region of interest, has the same biological effectiveness as an absorbed dose of one rad

from lightly filtered x-rays generated at potentials of two hundred to three hundred kilovolts. A dose in rems is equal to the dose in rads multiplied by the appropriate rbe.

"Sealed source" means a quantity of radioactive material so enclosed as to prevent the escape of any radioactive material, but at the same time permitting radiation to come out for use.

"Survey" means the evaluation of radiation near a source by, or under the supervision of, a qualified expert.

Other scientific and technical terms not herein specifically defined shall be used in accordance with the definitions in NCRP Reports No. 22, issued June 5, 1959; No. 32, issued July 1, 1966; No. 35, issued March 9, 1970; No. 36, issued August 15, 1970; No. 39, issued January 15, 1971; No. 42, issued November 15, 1974; No. 45, issued November 15, 1975; No. 48, issued August 1, 1976; No. 49, issued September 15, 1976; No. 59, issued December 15, 1978; and No. 65, issued April 15, 1980. [Eff [illegible] 1981]
(Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-3 General prohibition. (a) No person shall manufacture, use, store, handle, transport, or dispose of radiation machines or radioactive material in such manner that any person receives an excessive radiation dose therefrom.

(b) The manufacture, use, storage, handling, transportation, or disposal of radiation machines and radioactive materials shall comply with the specific rules provided below.

(c) For the purpose of these rules, radiation machines and radioactive materials used by, or in the possession of, an employee within the scope of the employee's duties shall be considered to be in the possession of the employer. [Eff [illegible] 1981]
(Auth: HRS §§321-10, 321-11, 321-71)
(Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-4 Exemptions. (a) This chapter shall not apply to the following materials, machines, or conditions:

(1) Natural radioactive materials of an equivalent specific radioactivity not exceeding that of natural potassium.
(2) Radioactive material in such quantity that if the entire amount were taken internally, continuously, or at one time by a person, no harmful effect would be likely to result.

Listings of the upper limits of quantities of radioactive materials that shall be exempt from these rules and from registration are given in section 15.c and table 1 of the handbook. These limits apply only for radioactive material not contained in sealed sources.

(3) Radioactive materials in sealed sources in total quantities not exceeding one millicurie for a given installation.

(4) Timepieces, instruments, novelties, or devices containing self-luminous elements, except during manufacture or repair of the self-luminous elements themselves.

(5) Electrical equipment that is primarily not intended to produce radiation and that, by nature of design, does not produce radiation at the point of nearest approach at a weekly rate higher than one tenth the appropriate permissible dose for any critical organ exposed. The production testing or production servicing of such equipment shall not be exempt.

(6) Radiation machines not being used in such manner as to produce radiation.

(7) Radiation machines or radioactive materials found by the director to be without hazard may be labelled as exempt with the approval of the director.

(8) Radioactive materials to the extent that they are preemptively regulated by the U. S. Nuclear Regulatory Commission pursuant to 42 U. S. C. 5801 et seq.

(b) Nothing in these rules shall be construed to limit the kind and amount of radiation that may be intentionally applied to a person for diagnostic or therapeutic purposes by, or under the direction of, persons licensed as physicians, dentists, or chiropractors in the State of Hawaii provided their machines have been registered with the director in accordance with §11-40-6 of these rules and provided they conform to the provisions of applicable NCRP Reports as listed in §11-40-5. [Eff. [illegible]] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-5 Standards. Recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports No. 8, issued 1951; No. 9, issued 1951; No. 12, issued 1953, No. 16, issued 1954; No. 19, issued 1955; No. 22, issued 1959; No. 23, issued 1960; No. 25, issued 1961; No. 27, issued 1961; No. 30, issued 1964; No. 32, issued 1966; No. 33, issued 1968; No. 35, issued 1970; No. 36, issued 1970; No. 37, issued 1970; No. 38, issued 1971; No. 39, issued 1971; No. 40, issued 1972; No. 41, issued 1974; No. 42, issued 1974; No. 43, issued 1975; No. 44, issued 1975; No. 45, issued 1975; No. 46, issued 1975; No. 47, issued 1976; No. 48, issued 1976; No. 49, issued 1976; No. 50, issued 1976; No. 51, issued 1977; No. 52, issued 1977; No. 53, issued 1977; No. 54, issued 1977; No. 55, issued 1977; No. 56, issued 1977; No. 57, issued 1978; No. 58, issued 1978; No. 59, issued 1978; No. 60, issued 1978; No. 61, issued 1978; No. 62, issued 1979; No. 63, issued 1979; No. 64, issued 1979; and No. 65, issued 1980 shall be used as guides or standards or as a basis for calculations of excessive doses of radiation to obtain or maintain safe working conditions within the meaning of the regulations herein. [Eff. [illegible]] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-6 Registration. (a) Any person using or operating any radiation machine, or storing, manufacturing, using, or handling any radioactive material, shall notify the director of the fact in writing within ten days after said use, operation, manufacturing, storage or handling begins or sixty days after this rule becomes effective in 1981, whichever is later.

(b) The notice required by subsection (a) above shall state the location, nature, and scope of such operation, use, manufacture, handling, or storage, and shall identify the persons responsible for the radioactive materials or radiation machines.

(c) The person filing the notice or responsible for the radiation machines or radioactive materials shall review the notice at least annually and update the notice when necessary. The notification shall include an estimate of any further accession of radiation machines or radioactive material expected during the ensuing year. Any accession in excess of the estimate shall be registered within ten days of accession.

(d) Acknowledgement of registration shall not imply the approval by the director of the manufacture, storage, use, or operation described in the registration, but shall merely indicate that the director has a record of the locations and establishments where radiation machines or radioactive materials are used. [Eff. [illegible]] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-7 Maximum permissible dose and concentration. (a) The exposure of persons to radiation shall always be kept to the lowest practicable level.

(b) When the source of radiation is outside the body, the maximum permissible dose equivalent for radiation workers in controlled areas shall not exceed those values specified in chapter 8 of NCRP Report No. 39.

(c) Quantities of radioactive material on the surface of the body of a radiation worker, or on clothing worn by a radiation worker, shall not cause radiation doses to any portion of the body greater than the applicable permissible value specified in chapter 8 of NCRP Report No. 39.

(d) For radiation workers in controlled areas the radiation dose to the tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which radioactive materials are taken into the body either by inhalation or by ingestion. Where such intake results from the occurrence of a radioisotope in air or water, the average concentration of the radioisotope in the air or water used by the individual shall not exceed the maximum permissible concentration specified in table 1 of NCRP Report No. 22, as modified by the assumptions and restrictions described in section 3.1 of that report.

(e) For persons who are not radiation workers and are outside of controlled areas, although within areas under the administrative control of the user, the maximum permissible external radiation dose to the whole body, head and trunk, active blood-forming organs, gonads, or lens of the eye, due to sources within the controlled area or to radioactive materials escaping the controlled area, shall not exceed 0.5 rem in any one year. In meeting this requirement, the user shall ensure that persons who are not radiation workers cannot be subjected to:

(1) Radiation levels which, if an individual were continuously present in the area, could result in that person receiving a dose in excess of two millirems in any one hour; or
(2) Radiation levels which, if an individual were continuously present in the area, could result in that person receiving a dose in excess of one hundred millirems in any seven consecutive days; or
(3) Radiation exposures to the whole body, head and trunk, active blood-forming organs, gonads, or lens of the eye, due to sources within the controlled area or to radioactive materials escaping the controlled area, in excess of 0.5 rem in any one year.

(f) For persons who are not radiation workers and are outside of controlled areas, although within areas under the administrative control of the user, the maximum permissible external radiation dose to tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which such materials are taken into the body. Where this intake results from the occurrence of radioactive materials in the air or water, the average concentrations of the radioisotopes in the air or water shall not exceed one-tenth the maximum permissible concentrations allowed in air, water, and foodstuffs for continuous occupational exposure, based upon the value in the figures in columns under 168 hour week exposure in table 1 of NCRP Report No. 22.

(g) The director shall be guided by the requirements of subsection (e) and (f) when determining acceptable levels of population group dose from all existing sources of radiation, with due allowance for future uses. However, notwithstanding the requirements of subsections (a) through (f), the director may require an individual user, or a group of users, to maintain doses and dose rates substantially lower than the maximums herein permitted, based upon:

(1) A determination of the user's ability to provide adequate control of the sources of radiation; or
(2) Other users' typical experience with similar sources; or
(3) The need to maintain lower exposures because of unusual population distributions in the area under consideration; or
(4) Unusual environmental factors.

(h) The determination of the dose received by persons and degree of hazard in all places to which these regulations apply shall be determined in accordance with provisions contained in the NCRP Reports listed in §11-40-5. [Eff.NOV. 5 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71).

§11-40-8 <u>Personnel monitoring: Area radiation surveys.</u> (a) <u>All accessible areas in the vicinity of radiation-producing sources shall be surveyed by, or under the direction of, a qualified expert using suitable instruments and methods for measuring radiation, to determine the maximum levels of radiation to which persons may be exposed. To protect workers, radiation exposure limits shall be calculated in weekly doses, taking into consideration the amount of time the radiation is being produced, the work week, and the fraction of the week that any person might be exposed to the radiation.

(b) Until an actual survey can be performed, a written statement made by a qualified expert based on an analysis of the situation shall be acceptable as evidence of the absence of radiation hazard in a given area.

(c) Personnel monitoring shall be required for each individual for whom there is any reasonable possibility of receiving a total weekly dose of radiation exceeding one-quarter of the maximum permissible dose, taking into consideration the use of protective gloves, aprons, or other radiation-limiting devices; except that continuation of personnel monitoring shall not be required if the average dose over a period of eight weeks proves to be less than one-half the maximum permissible dose for one week. If the specified operating conditions are changed, a new monitoring test over an eight-week period shall be made.

(d) Routine monitoring of persons occupationally exposed to radiation from radiation machines shall not be required when all of the following conditions are met:

(1) A qualified expert has specified the operating conditions under which there is no reasonable chance that any person will be exposed to more than one-quarter the maximum permissible dose.
(2) The operating conditions in paragraph (1) are known to all persons who may be occupationally exposed to the radiation.
(3) The installation continues to operate only under the specified conditions.

(e) Regularly-scheduled monitoring of the air within the installation for radiation or radioactive content shall be required when there is any reasonable possibility that the average levels of activity therein may exceed one-quarter the amount specified in table 1 of NCRP Report No. 22. Measurements averaged over periods not greater than one year shall be permissible, but in any case there shall be sufficient monitoring to insure that no radiation hazard exists.

(f) Periodic surveys shall be made of sealed sources and sealed storage areas to ensure the integrity of the containment. [Eff. NOV 5 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-9 Radiation-exposure records and reports. (a) Records of all measurements required under §11-40-8 above shall be kept by the registrant and made available for inspection by the director. Personnel-

monitoring records shall include the social security numbers of the workers concerned as an aid in keeping track of an individual's total exposure.

(b) Records of the amount, kind and disposition of radioactive materials purposefully removed from the installation shall be maintained by the registrant and made available for inspection by the director.

(c) Upon termination of employment of a person, the director shall, upon request, be supplied with a summary statement of that person's total radiation dose. (The estimated maximum dose shall be stated if no personnel monitoring has been carried out.) This record shall include statements of any circumstances wherein the dose to the worker, from any source of radiation, exceeded that specified in these rules.

(d) When it is known or believed that an accidental dose to a person in or outside of the installation may have exceeded five times the maximum permissible dose, all facts relative to the occurrence shall be reported in detail by the registrant to the director within seven days of the discovery thereof, and a copy of the report shall be put in that person's personnel file. The cause of the overexposure shall immediately be sought out and corrected. [Eff. NOV 5 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-10 Responsibility. (a) All work performed in an installation where radiation may be present shall be under the direction of a person responsible for the radiation health and safety measures covered by these rules. That person's name shall be reported to the director by the registrant.

(b) The person in charge of radiation health and safety in an installation shall have the following responsibilities:

(1) Be informed of the hazards attendant upon the presence of radiation in the installation and, if necessary to this end, obtain the services of a qualified expert.
(2) Provide, or cause to be provided, any necessary instruction concerning the attendant radiation hazards and safe working practices:
   (A) To all employees whose duties necessitate the handling of radioactive material or the operation of any machines that produce radiation in an amount that leads to radiation hazard; and
   (B) To all other employees who are not regularly employed at such work but who may occasionally be exposed to radiation.

(3) Ensure beyond reasonable doubt that all persons working with radiation machines or radioactive materials, and all authorized visitors to areas where radiation may be present are:
  (A) Properly and adequately instructed in the use of all necessary safeguards and procedures; and
  (B) Supplied with such auxiliary devices as may be necessary for health and safety.

(4) Ensure beyond reasonable doubt that no radioactive material (including that in patients, animals, and equipment) is allowed to leave the jurisdiction of the radiation user under circumstances that may subject other persons to radiation in excess of the maximum permissible dose.

(5) Ensure beyond reasonable doubt that any area, inside or outside the installation, normally occupied by adults not primarily engaged in radiation or associated work, cannot be subjected to radiation levels exceeding the maximum permissible dose.

(6) Ensure beyond reasonable doubt that any area, inside or outside the installation, that may be habitually occupied by persons not engaged in radiation work, cannot be subjected to radiation levels and exposures exceeding the specifications listed in §11-40-7(e).

(7) Notify the building manager of the facility or other appropriate official of the existence of any areas not normally occupied but in which hazardous radiation exposure may take place; e.g., an air conditioning equipment room beneath x-ray installation.

(8) Notify the building manager of the facility or other appropriate official of the existence of any conditions or situations that, while not normally considered a radiation hazard, may become a hazard under special or unusual circumstances; e.g., entrapment of waste in a drainage line.

(9) Ensure, by means of appropriate surveying or monitoring procedures, that radioactivity discharged to the atmosphere, at any point where persons may breathe the air, shall be maintained at an average concentration of radioactivity below the maximum permissible levels indicated in §11-40-7 of these rules.

(10) Take all necessary precautions to determine that every employee and authorized visitor shall use such health and safety devices as are furnished for their protection and

carry out all radiation health and safety rules that concern or affect their conduct.

(c) The designation of a person responsible for radiation health and safety shall in no way relieve the owner, management, or user from responsibility for compliance with the provisions of these rules. [Eff. 10/ , 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-11 <u>Storage of radioactive materials.</u> (a) Radioactive materials shall be stored or kept in such a manner as to ensure that the dose rate therefrom shall not exceed the maximum permissible dose.

(b) Vaults or rooms in which radioactive materials are stored shall be so located or constructed that no person shall be exposed to radiation therefrom in excess of the maximum permissible dose.

(c) Radioactive materials in a workroom or other location where persons are regularly or frequently present shall be enclosed in containers of such thickness, materials, and construction, or otherwise shielded in such manner, that no person will be exposed to radiation greater than the maximum permissible dose.

(d) Vaults or rooms used for storing materials that may emit radioactive gases shall be suitably ventilated in such a manner that the gases do not constitute a radiation hazard.

(e) When there is any possibility that chemical, radiation, or other action might weaken or rupture the container of radioactive material sufficiently to cause leakage therefrom, the container shall be provided with a suitable secondary tray or catchment adequate to retain the entire amount of radioactive material.

(f) Each container of radioactive material in storage shall, in addition to the standard radiation-hazard symbol (see §11-40-13(c) of these rules), be labeled in such manner that the kind and quantity of material, the date of measurement, and the name of the person responsible for the material can be easily and quickly determined.

(g) Storage containers for radioactive material in excess of one curie shall be designed to be resistant to fire and earthquake damage, and to maintain reasonable temperatures. Containers shall be structurally sound over the period of intended use with due regard to corrosion, radiation, and temperature effects that may develop.

(h) Suitable provision shall be made to minimize the radiation hazard to emergency workers in the event of fire and in situations where earthquake, flood, and windstorm potentials exist. [Eff. , 1981]

(Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-12 Radioactive-contamination control. (a) All work with radioactive materials shall be carried out under such conditions as to minimize the possibility of any contamination that would result in the release into air or water of any concentration of radioactive material in excess of the limits specified in table 1 of NCRP Report No. 22.

(b) Where a person or the person's clothing may become contaminated to such degree as to present a radiation hazard, the person and the clothing shall be suitably monitored. Any contamination leading to doses in excess of the maximum permissible dose shall be removed from the contaminated person before that person is permitted to leave the work area. Clothing or other material having contamination leading to doses in excess of the maximum permissible dose shall not be taken from the work area or released to public laundries or cleaners.

(c) Under conditions in which the director considers it advisable the director may devise or approve suitable work rules applicable to individual users.

(d) Every person using radioactive materials not enclosed in a sealed source shall have on hand or immediately available an instrument or instruments suitable for detecting and measuring contamination in accordance with the requirements of this section. These instruments shall be maintained in proper calibration. Under special circumstances, the director may require the same or similar instrumentation for users of radioactive materials in sealed sources.

(e) Any escape of radioactive material from the control or jurisdiction of the installation shall be reported to the director immediately. [Eff. , 1981] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-13 Radiation information labeling. (a) All radiation machines shall be clearly labeled. For example:

"CAUTION--X-RAYS

This equipment produces x-rays when energized."

(b) All radioactive material not in use or in possession of the user shall be clearly labeled as follows:

H-33

(1) Containers for sealed sources of external radiation hazard only:

"CAUTION--RADIATION"

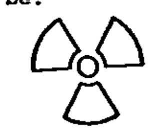
(Where a time limit is specified, it shall be posted.)

(2) Radioactive material in loose bulk or unsealed containers--internal radiation hazards primarily:

"DANGER--RADIOACTIVE MATERIAL

The material contained herein should not be allowed to enter the body either by inhalation, ingestion, or through wounds in the skin." (Labels as required under Title 10, Code of Federal Regulations, chapter 1, may be substituted, where appropriate, for the above labels.)

(c) The standard symbol for designating any radiation hazard shall be:



The standard color specification shall be a background of yellow with lettering and distinctive symbol in magenta or purple. The use of this symbol for any other purpose is expressly prohibited. The symbol and lettering shall be as large as practical, consistent with size of the equipment or material.

(d) All radioactivity containers, storage areas, work areas, or other normally occupied areas where a radiation hazard may exist shall be posted with accepted radiation hazard labels.

(e) Any areas where a radiation hazard may exist on a frequent or infrequent basis, but which are not readily accessible and are so situated as to be occupied only under infrequent and special circumstances, shall be posted with accepted radiation hazard labels.

(f) All areas that are readily accessible but not normally occupied, and where a radiation hazard may exist on a frequent or infrequent basis, shall be suitably fenced off and posted with the accepted radiation hazard label.

(g) All radiation hazard labels posted when a radiation hazard existed shall be removed when the hazard is no longer present. [Eff.] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-14 Disposal of radioactive wastes. (a) Users of radioactive materials shall release these materials only in such manner that the radioactive material discharged, in combination with that discharged by other users, will not cause contamination of the environment that may result in a person or persons receiving an excessive radiation dose. If several users are discharging radioactive wastes into the same environment, they, upon being notified of the fact, shall cooperate in limiting the release and shall file with the director a statement of their agreed pro-rata release. If this is not done within a reasonable time the director may arbitrarily assign quotas to them severally.

(b) Users who release radioactive material may take reasonable advantage of the environmental factors (dilution, dispersion, etc.) to minimize the cost of disposal, provided they meet the performance requirements indicated in subsection (2). Nothing in these rules shall be construed as permitting release of materials that would be unlawful for other reasons.

(c) Prior to and during design and construction of facilities for the handling and disposal of radioactive wastes, users of radioactive materials may obtain opinions from the director regarding the probability of meeting these rules. This shall be done according to the Department of Health Rules of Practice and Procedure. However, the user shall remain responsible for meeting the performance standards related to radioactivity established by the director and shall allow the director to inspect and evaluate the methods of treatment and release.

(d) To protect population groups, specific limits of radioactivity resulting from disposal of radioactive material shall be determined by the registrant on the following basis:

(1) The average concentration of that isotope in air at points where it is commonly used by humans or in water at points of supply exclusive of treatment, if any, prior to use by humans shall not exceed ten per cent of the maximum permissible levels recommended in table 1 of NCRP Report No. 22. Concentrations lasting only over a period of a few days may be allowed to exceed the values given in table 1 of NCRP Report No. 22, provided the average concentration over any interval of one year does not exceed ten per cent of these values. For the purpose of this paragraph, the concentrations in water and air in the columns under "for 168 hour week" shall be used.

(2) Average rates of radiation dose to persons from radioisotopes outside their bodies shall not exceed ten per cent of the values specified for radiation workers in sections 2 and 3 of NCRP Report No. 22.

(3) Average concentrations in portions of public waterways not used as sources for human consumption shall be consistent with health, economic, and recreational uses of the water and the future plans for its use that are under consideration by responsible authorities.

(4) For any radioisotope the term "average" as used above shall mean the arithmetic mean of a series of determinations representative of plant operations and environmental conditions taken over periods not greater than one year.

(5) If the permissible average concentration of a mixture of radioisotopes in air or water depends almost entirely on the concentration of one of the radioisotopes involved, for routine practical estimates the contributions of the other radioisotopes in the mixture may be neglected. Where more than one isotope is important, the permissible concentration shall be arrived at by adding the exposures to be received from each significant component.

(e) Radioactive wastes may be disposed of by incineration, dumping or burial only in areas previously approved in writing by the director for that purpose. Areas approved for this purpose shall be designed and operated so that they comply with the other provisions of these rules. [Eff. [illegible]] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-15 Examination for compliance: Statement of noncompliance. (a) The director shall inspect and examine such sources of radiation as the director desires, in order to determine their compliance with this chapter.

(b) If such inspection and examination indicates that the source of radiation is not in compliance with this chapter, the owner, operator, or user shall be so notified in writing, with full particulars regarding any deficiencies. [Eff. [illegible]] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-16 Proceedings before director. (a) When the director has grounds to believe that anyone has violated any provision of these rules or of any order of the director, the director may notify the alleged violator or violators of the alleged violation order and may require that the alleged violations be corrected or that the alleged violator appear before the director at a time and place specified in the notice, and answer the allegations. The notice and order shall comply with the chapter 91, HRS, procedures for contested cases.

(b) Whenever the director finds that an emergency exists and requires immediate action to protect the public health or welfare, the director may, without prior notice or hearing, issue an emergency order describing the emergency and requiring such corrective action as is deemed necessary to meet the emergency. Notwithstanding the provisions of subsection (a), such order shall be effective immediately. Any person to whom such order is directed shall comply therewith immediately, but may apply to the director for a hearing which shall be held as soon as possible. Following such hearing the director shall continue, revoke, or modify the emergency order. [Eff.] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-17 <u>Inspections and investigations: Maintenance of records.</u> (a) The director may enter at reasonable times upon any private or public property for the purpose of inspecting and investigating conditions relative to the purposes of these rules; except that such entry into security areas under the direct or indirect jurisdiction of the federal government shall be permitted only by and with the concurrence of the federal government agency or its duly designated representative.

(b) The director may examine any records or memoranda pertaining to the operation of radiation machines and radioactive materials. The director may require the maintenance of records relating to the operation of disposal systems. Copies of such records shall be submitted to the director upon request. [Eff.] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-18 <u>Penalties and injunctions.</u> (a) Any person who violates any provisions of this chapter is subject to penalties pursuant to §321-18, HRS, and injunctions pursuant to §603-23, HRS.

(b) Any person who violates §11-40-14, HRS, is additionally subject to the penalties and remedies provided in §§342-8, 342-11, 342-11.5, and 342-12, HRS.

[Eff.] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

§11-40-19 <u>Severability.</u> If any provision of this chapter, or its application to any person or circumstance, is held invalid, the application of such provision to other persons or circumstances, and the remainder of this chapter, shall not be affected thereby. [Eff.] (Auth: HRS §§321-10, 321-11, 321-71) (Imp: HRS §§321-1, 321-11(21), 321-71)

The Department of Health authorized the repeal of Chapter 33, Public Health Regulations and the adoption of Chapter 40 of Title 11, Administrative Rules on SEP 30 1981 following public hearing held on Oahu on August 26, 1981, on Hawaii on August 25, 1981, on Kauai on August 31, 1981, on Maui on August 24, 1981 after public notice was given in the Honolulu Star-Bulletin on August 3, 1981, in the Hawaii Tribune-Herald on August 3, 1981, in the Garden Isle on August 3, 1981, and in the Maui News on August 3, 1981.

Chapter 40 of Title 11, Administrative Rules and the repeal of Chapter 33, Public Health Regulations shall take effect ten days after filing with the Office of the Lieutenant Governor.

GEORGE YUEN
Director
Department of Health

APPROVED:

GEORGE R. ARIYOSHI
GOVERNOR
STATE OF HAWAII

Dated: 10-24-81

APPROVED AS TO FORM:

Deputy Attorney General

Filed: OCT 26 1981

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U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards

American National Standard N43.10

Safe Design and Use of Panoramic Wet Source Storage Gamma Irradiators (Category IV)

AMERICAN NATIONAL STANDARD N43.10

The National Bureau of Standards[1] was established by an act of Congress on March 3, 1901. The Bureau's overall goal is to strengthen and advance the nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, the Institute for Computer Sciences and Technology, and the Center for Materials Science.

The National Measurement Laboratory

Provides the national system of physical and chemical measurement; coordinates the system with measurement systems of other nations and furnishes essential services leading to accurate and uniform physical and chemical measurement throughout the Nation's scientific community, industry, and commerce; provides advisory and research services to other Government agencies; conducts physical and chemical research; develops, produces, and distributes Standard Reference Materials; and provides calibration services. The Laboratory consists of the following centers:

- Basic Standards[2]
- Radiation Research
- Chemical Physics
- Analytical Chemistry

The National Engineering Laboratory

Provides technology and technical services to the public and private sectors to address national needs and to solve national problems; conducts research in engineering and applied science in support of these efforts; builds and maintains competence in the necessary disciplines required to carry out this research and technical service; develops engineering data and measurement capabilities; provides engineering measurement traceability services; develops test methods and proposes engineering standards and code changes; develops and proposes new engineering practices; and develops and improves mechanisms to transfer results of its research to the ultimate user. The Laboratory consists of the following centers:

- Applied Mathematics
- Electronics and Electrical Engineering[2]
- Manufacturing Engineering
- Building Technology
- Fire Research
- Chemical Engineering[2]

The Institute for Computer Sciences and Technology

Conducts research and provides scientific and technical services to aid Federal agencies in the selection, acquisition, application, and use of computer technology to improve effectiveness and economy in Government operations in accordance with Public Law 89-306 (40 U.S.C. 759), relevant Executive Orders, and other directives; carries out this mission by managing the Federal Information Processing Standards Program, developing Federal ADP standards guidelines, and managing Federal participation in ADP voluntary standardization activities; provides scientific and technological advisory services and assistance to Federal agencies; and provides the technical foundation for computer-related policies of the Federal Government. The Institute consists of the following centers:

- Programming Science and Technology
- Computer Systems Engineering

The Center for Materials Science

Conducts research and provides measurements, data, standards, reference materials, quantitative understanding and other technical information fundamental to the processing, structure, properties and performance of materials; addresses the scientific basis for new advanced materials technologies; plans research around cross-country scientific themes such as nondestructive evaluation and phase diagram development; oversees Bureau-wide technical programs in nuclear reactor radiation research and nondestructive evaluation; and broadly disseminates generic technical information resulting from its programs. The Center consists of the following Divisions:

- Inorganic Materials
- Fracture and Deformation[3]
- Polymers
- Metallurgy
- Reactor Radiation

[1] Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Gaithersburg, MD 20899

American National Standard N43.10;

Safe Design and Use of Panoramic, Wet Source Storage Gamma Irradiators (Category IV)

American National Standards Institute
Subcommittee N43-3.4

Under the sponsorship of the
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Gaithersburg, MD 20899

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American National Standard

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Preface

(This preface is not a part of American National Standard N43.10, Safe Design and Use of Panoramic, Wet Source Storage Gamma Irradiators.)

The 1950's and 1960's can be characterized as the research era for radionuclide applications. Based on this research, a number of commercial gamma irradiators started operation in the early 1960's. Their number has been increasing with source storage capacity of individual irradiators reaching the multi-megacurie range by the mid-1970's.

Gamma irradiators are used for a variety of purposes in research, industry, and other fields. Typical uses are:

1. Sterilization or microbial reduction in medical and pharmaceutical supplies.
2. Preservation of foodstuffs.
3. Radiation effects studies.
4. Chemical and polymer synthesis and modifications.
5. Insect eradication through sterile male release programs.

The number and types of irradiators supporting these and other applications are continually growing. Source requirements for any particular irradiator may vary from a few curies to several million curies. Irradiator designs can be many and varied to suit individual needs; therefore, it is essential to establish basic criteria to ensure a high standard of radiation safety in the design and use of irradiators, but in a way which does not unnecessarily restrict the logical use and growth of radionuclide applications.

This standard sets forth bas.c safety requirements which shall be met in irradiator design and use. Its use by Regulatory Authorities, relative to the review of radionuclide applications, is encouraged.

Because of the variety of designs, four general categories of irradiators have been established to facilitate preparation of standards. A separate standard establishes the criteria to be used in the design, fabrication, installation, use, and maintenance for each irradiator category.

The categories are as follows:

Category I—Self-contained, dry source storage irradiator. American National Standard N43.7.

An irradiator in which the sealed source is completely contained in a dry container constructed of solid materials, the sealed source is shielded at all times, and human access to the sealed source and the volume undergoing irradiation is not physically possible in its designed configuration.

Category II—Panoramic, dry source storage irradiator. American National Standard N43.12.

A controlled human access irradiator in which the sealed source is contained in a dry container constructed of solid materials, and the sealed source is fully shielded when not in use; the sealed source is exposed within a radiation volume that is maintained inaccessible during use by an entry control system.

Category III—Self-contained, wet source storage irradiator. American National Standard N43.15.

An irradiator in which the sealed source is contained in a storage pool (usually containing water), the sealed source is shielded at all times, and human access to the sealed source and the volume undergoing irradiation is physically restricted in its designed configuration and proper mode of use.

Category IV—Panoramic, wet source storage irradiator. American National Standard N43.10.

A controlled human access irradiator in which the sealed source is contained in a storage pool (usually containing water), and the sealed source is fully shielded when not in use; the sealed source is exposed within a radiation volume that is maintained inaccessible during use by an entry control system.

The American National Standards Committee, N43, on Equipment for Non-Medical Radiation Application, which processed and approved this standard, had the following personnel at the time it approved this standard:

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(National Bureau of Standards)

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(National Bureau of Standards)

Organization Represented

Alliance of American Insurers

American Conference of Governmental Industrial Hygienists
American Crystallographic Association
American Insurance Association
American Iron and Steel Institute

American Nuclear Society

American Public Health Association, Inc

American Society of Mechanical Engineers
American Society for Nondestructive Testing, Inc

American Society for Testing and Materials

American Welding Society
Conference of Radiation Control Program Directors

Health Physics Society

Institute of Electrical and Electronics Engineers, Inc.
Instrument Society of America
International Association of Machinists and Aerospace Workers
International Brotherhood of Electrical Workers
Motor Vehicle Manufacturers Association

National Bureau of Standards

National Council on Radiation Protection and Measurements
National Electrical Manufacturers Association
Underwriters' Laboratories, Inc.
U.S. Nuclear Regulatory Commission
U.S. Department of the Air Force, Office of the Surgeon General
U.S. Department of the Army, Office of the Surgeon General
U.S. Department of Defense

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CONTENTS

Abstract

This standard applies to panoramic, wet source storage irradiators (Category IV) that contain sealed gamma emitting sources for the irradiation of objects or materials. It establishes the criteria to be used in the proper design, fabrication, installation, use, and maintenance of these irradiators which will ensure a high degree of radiation safety at all times. The requirements of the standard are grouped as 1) general considerations, 2) manufacturer's responsibility, and 3) owner's responsibility. Included in the first group are general radiation protection criteria, sealed source performance requirements, and radiation survey needs. Among the manufacturer's responsibilities are criteria for maximum external radiation levels, integrity of shielding, and controls and indicators. The requirements for users include safety-related servicing, administrative procedures, operator qualifications, and routine safety tests.

Key words: gamma radiation; irradiation; irradiator; national standard; radiation safety; radiation source; safety standard.

American National Standard

Safe Design and Use of Panoramic, Wet Source Storage Gamma Irradiators (C .tegory IV)

1. Scope

This standard applies to panoramic, wet source storage irradiators (Category IV) that contain sealed gamma emitting sources for the irradiation of objects or materials. The standard establishes the criteria to be used in the proper design, fabrication, installation, use, and maintenance of these irradiators which will ensure a high degree of radiation safety at all times.

Note regarding units: In this standard, SI units are used for non-radiation quantities. However, since SI units have not been generally accepted and adopted for radiation quantities in the United States, only customary units are used in this standard for radiation quantities. As a result, this standard is consistent with current practices of our authoritative national organizations that issue recommendations, of our instrument manufacturers, and of our pertinent regulatory or controlling authorities. To convert from customary to SI units, the following factors may be used:

1 rem = 0.01 sievert (Sv)
1 roentgen (R) = 2.58×10^{-4} $C \cdot kg^{-1}$
1 curie (Ci) = 3.7×10^{10} becquerel (Bq)

2. Definitions

The definitions and terms contained in this standard, or in other American National Standards referred to in this document, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard.

Accessible Surface—that surface of the irradiator to which human access is possible without the use of tools or without penetration of the structural radiation shield.

Authorized Personnel—those individuals authorized by the pertinent regulatory or controlling authority to:

a. operate and control access to the irradiator,
b. perform periodic contamination detection tests on the irradiator,
c. install, maintain, and service the irradiator.

Capsule—protective envelope used for prevention of leakage of radioactive material.

Contaminated Material—any material or object other than a s'aled source that contains a radioactive substance ·r substances) in average concentration or total quantity such that disposal procedures must be approved by the pertinent regulatory or controlling authority.

Device—see *Irradiation Device*.

Fully Shielded—the condition in which the source is stored so that the radiation level in the radiation room does not exceed the levels specified in Part 7.3.2 of this standard.

Fully Vented—a design characteristic of hollow tools, tubes, or control rods, that allows air to escape from the tool at a rate sufficient to allow water to flood the immersed section as it enters the water.

High Radiation Area—any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

Installation of Irradiator—the construction, source loading, and the commissioning of an irradiator.

Interlock—see *Safety Interlock*.

Irradiation Device—that portion of an irradiator facility that includes the sealed source, radiation shield, and mechanisms that move or position the source.

Irradiator—a device or facility which contains and uses sealed sources for the irradiation of objects or materials. See Panoramic Wet Source Storage Irradiator.

Leakage Radiation—that radiation emitted by the sealed source at the accessible surface of the radiation room shield and at the surface of the source storage pool.

Maximum Permissible Dose Equivalent (MPD)—the maximum dose equivalent that the body of a person or specific parts thereof shall be permitted to receive in a stated period of time. For the radiation considered here, the dose equivalent in rems may be considered numerically equal to the absorbed dose in rads and the exposure in roentgens.

Operator—an authorized individual who controls the use of the irradiator.

Panoramic Wet Source Storage Irradiator—a controlled human access irradiator in which the sealed source is contained in a storage pool (usually containing water), and the sealed source is fully shielded when not in use; the sealed source is exposed within a radiation room that is maintained inaccessible during use by interlocked controls.

Product—the objects or materials which are intentionally irradiated in a commercial or research process.

Product Positioning System—the means by which the product to be irradiated is conveyed around the sealed source under the source-in-use condition.

Qualified Expert—a person having the knowledge, training, and experience necessary to perform a task in his/her field or specialty, in a competent and proficient manner.

Quality Assurance—all those planned and systematic actions necessary to provide adequate confidence that an item or a facility will perform satisfactorily in service.

Quality Control—those quality assurance actions which provide a means to control and measure the characteristics of an item, process, or facility to established requirements.

Radiation Room—that region of the irradiator that is enclosed by radiation shields and is made inaccessible when the source is in use.

Radiation Shields—the materials which have as their primary function the attenuation of radiation emitted by the sealed source to acceptable levels.

Restricted Area—that region of the irradiator to which human access is controlled for radiation safety purposes.

Safety Interlock—a device for precluding exposure of an individual to a hazard either by preventing entry to the hazardous area or by automatically removing the hazard.

Safety-Related Service—any service work which could affect the radiation safety of an irradiator such as source loading, replenishment, removal, or redistribution; bypassing any of the safety interlocks; or modification to the radiation shields which could result in radiation levels in excess of those specified in Part 7 of this standard.

Sealed Source—radioactive material sealed in a capsule, the capsule being strong enough to prevent dispersion of the radioactive material under the conditions of use for which it was designed. Also an assemblage of sealed sources in an array utilized in an irradiator.

Shall—indicates a recommendation that is necessary to meet the standards of protection of this document.

Should—indicates an advisory recommendation that is to be applied when practicable.

Source—see *Sealed Source*.

Source Holder—that component of the irradiator into which the source is positioned, including any retaining screws, pins, clips, etc.

Source in Use—that status of an irradiator during which the sealed source is not fully shielded.

Unrestricted Area—any region to which human access is not controlled for radiation safety purposes.

Visible Indication—a visual signal provided as an indication of the status of an irradiator component.

3. General Considerations

3.1 Health Warning

An overexposure to the whole body or critical organs of only a few hundred rads may produce acute radiation syndrome with severe illness and possible death. The nature, severity, and duration of these effects depend, among other factors, on the dose and type of radiation, rate of exposure, portion of the body exposed, and individual sensitivity.

In irradiators, ozone and other noxious gases are produced by radiolysis. As these gases may be harmful to health, their nature and concentration shall be determined, and effective measures taken to protect personnel from exceeding the allowable limits set by the pertinent health authority. (See Part 8.21.)

3.2 Radiation Protection Criteria

3.2.1 Basis of Protection Criteria. Recommendations for maximum permissible doses of ionizing radiation are established by national and international authorities such as the National Council on Radiation Protection and Measurements (NCRP) [1] and International Commission on Radiological Protection

(ICRP) [2]. These recommendations are expressed in terms of a maximum permissible dose equivalent (MPD). The MPD values listed in table 1 shall not be exceeded and should be kept as low as is reasonably achievable. Regulations which pertain to MPD have been promulgated by the United States Nuclear Regulatory Commission [3] and the Occupational Safety and Health Administration [4].

3.2.2 Protection of Public. The dose limit in any one year for individual members of the public shall be limited to one-tenth the corresponding MPD in any one year for occupational exposure noted in table 1. The whole body dose limit in any one year for individual members of the public is given as 0.5 rem.

3.2.3 Protection of Students. Students exposed to radiation should not receive a whole body dose exceeding 0.1 rem per year due to their educational activities. This is considered to be a part of the annual dose limit of 0.5 rem for individual members of the public, not supplemental to it.

TABLE 1. *Maximum Permissible Dose Equivalent Values (MPD) for Occupational Exposure* [1]

Exposure of patients for medical and dental purposes is not included in the maximum permissible dose equivalent.

	Maximum 13-week dose	Maximum dose in any one year	Maximum accumulated dose
	rem	rem	rem
Whole body, gonads, lens of eye, red bone marrow	3	5	5(N−18)*
Skin (other than hands and forearms)	—	15	—
Hands	25	75	—
Forearms	10	30	—
Other Organs	5	15	—

*N = Age in years and is greater than 18. When the previous occupational history of an individual is not definitely known, it shall be assumed that the MPD permitted by the formula 5(N−18) has already been received

3.2.4 Protection of Fetus. The maximum permissible dose equivalent to a fetus from occupational exposure of an expectant mother during the entire gestation period should not exceed 0.5 rem.

3.2.5 Protection of Workers. Table 1 summarizes current MPD recommendations for occupational workers age 18 and over. An essential criterion for occupational exposure of individuals is the maximum accumulated dose represented by the quantity 5(N−18) in table 1. This restriction supersedes all other quantities in the table. Individuals under 18 years of age shall not exceed the dose limit specified for individual members of the public.

3.3 Achieving Safe Operation

The safety of an irradiation facility depends mainly on design features and administrative controls. The former concerns the design and construction of radiation shields and devices such as interlocks and other mechanical controls for assuring acceptably low levels of radiation in occupied areas. The latter concerns how personnel use the facility.

Responsibility for the safe design of the irradiation device interlocks, controls, etc., lies with the manufacturer. The radiation shield design shall be compatible with the irradiation device and it shall, insofar as radiation protection is concerned, be designed by a qualified expert and be approved by the pertinent regulatory or controlling authority.

Safe operation of a facility requires thorough understanding by personnel of why and how it functions. This is always important but is particularly important when safety-related services such as inspection and repair of interlocks or source replenishment are performed. These activities shall be performed by or under the supervision of personnel who understand the design and construction of the facility and its safety concepts and who will restore all safety componen to their operational design condition upon com etion of servicing.

4. Sealed Sources

4.1 ι neral

For general sealed source requirements, refer to American National Standard N43.6 [5], Sealed Radioactive Sources, Classification. In addition to the general requirements, the manufacturer and user shall consider the possible effects of fire, explosion, corrosion, and continuous use of the sealed source. Factors which should be considered are:

a. Consequences of failure of source integrity influenced by:
   i) Quantity of radioactive material contained in the sealed source,
   ii) Radiotoxicity, leachability, and solubility,
   iii) Chemical and physical form of the radioactive material.
b. Environment in which the source is stored, moved, and used.
c. Protection afforded the sealed source by the irradiator.

4.2 Performance Requirements and Classification

Using the American National Standard N43.6 sealed source classification system, sources used in Category IV irradiators shall have a minimum classification of either C53424 or E53424, and meet the bend test requirement specified in Part 4.2.1.

To improve sealed source corrosion resistance, all outer encapsulation components (including any weld filler material which may be utilized) shall meet the same material specification. Consideration shall be given to the selection of materials to reduce thermal fatigue of the source during irradiator operation.

All outer capsule material shall be compatible with the permanent pool components to reduce the possibility of corrosion. (See Part 10.1.2.)

4.2.1 Bend Test Classification Requirement.

Sealed sources used in Category IV irradiators shall have a minimum bend test classification of 5 based on the bend test procedures shown in Part 4.3, "Sealed Source Bend Test."

Compliance with the test is determined by the ability of the sealed source to maintain its integrity, after the test is performed, as defined in 4.1.5 of American National Standard N43.6.

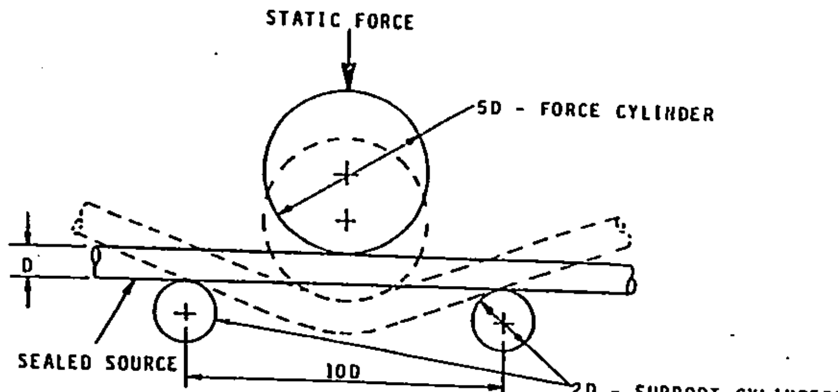
A source shall have complied with the bend test if the source, due to its flexibility, passes through the test rig while under test (the center of the force cylinder passes through the centerline of the two support cylinders) and maintains its integrity.

4.3 Sealed Source Bend Test

Bend tests shall apply for all sources having an $\frac{L}{D}$ of 15 or more, where L=active length and D=minimum outer capsule diameter of the active length or the smallest cross-sectional dimension of non-circular sources.

Bend test classifications are based on applied static force, using the following test parameters. All three cylinders shall not rotate and shall have longitudinal axes that are parallel to each other. The cylinders shall have smooth surfaces and shall be of sufficient length to accommodate the full contact surface of the capsule during the test procedure. All cylinders are to be of a solid nature. Cylinder hardness—ROCKWELL 'C' 50–55. In applying the static force, care should be taken not to apply this force suddenly as this will increase the effective force.

The applicable static force shall be applied at the most vulnerable part of the sealed source.



BEND TEST	CLASS						
	1	2	3	4	5	6	X
STATIC FORCE	NO TEST	100 N (10 2 kg.)	500 N (51 kg.)	1,000 N (102 kg.)	2,000 N (204 kg.)	4,000 N (408 kg.)	SPECIAL TEST

Figure 1 *Bend test parameters*

4.4 Certification and Documentation

The source manufacturer or supplier shall maintain records relating to the sealed source(s) and provide this information to meet requirements such as those of licensing and transportation. The records shall include the following:

a. Model number and identification number of the source(s), the contained radionuclide, source activity, and date of measurement.
b. ANSI classification certificate.
c. Bend test certificate.
d. Leak test certificate.
e. Contamination test certificate.
f. Special form test certificate if required by the transportation authorities.
g. Any other documentation required by the pertinent regulatory or controlling authority.

4.5 Periodic Contamination Tests

Periodic contamination tests shall be conducted as described in Part 16.

4.6 Removal of Sources

For removal, transfer, and disposal of sources and contaminated material see Part 18.

5. Radiation Measurements

5.1 General

Normally there are three types of radiation measurements required during installation and use of an irradiator. These are as follows:

a. Surveys of the radiation shields. (See Part 7.)
b. Radiation checks during room entry. (See Part 8.1.)
c. Contamination tests. (See Parts 16 and 17.)

Appendix A describes currently acceptable radiation measurement methods and instrument considerations.

5.2 Surveyor Qualifications

The surveyor shall have the knowledge and training necessary to select and use suitable survey instruments for the measurement of ionizing radiation.

5.3 Instrument Calibration

The survey instrument(s) shall be calibrated at intervals not exceeding 6 months and before use following repair.

5.4 Survey Report of Radiation Levels Outside the Radiation Shields

The surveyor shall record the survey data in writing, and they shall indicate whether or not the irradiator is in compliance with this standard. A copy of the survey report shall be retained by the owner or person in charge of the irradiator for inspection by the pertinent regulatory or controlling authority.

The survey report shall include the following information:

a. Identity of the irradiator by manufacturer, model, and serial number.
b. Location of the irradiator.
c. Type of radionuclide and calculated activity on survey date.
d. Date of survey.
e. Measured radiation levels outside the radiation shield under the source-in-use condition. (See Part 7.)
f. Measured radiation levels inside the radiation room under the fully shielded condition. (See Part 7.)
g. Survey instrument identification by manufacturer, model, and serial number.
h. Date of the most recent instrument calibration.
i. The correction factors, if used, to compensate for survey instrument variables and environmental conditions.
j. The identity of the individual responsible for the survey report.

5.5 Contamination Test Report

The surveyor shall record the contamination test results in writing. The report shall indicate whether or not the irradiator is in compliance with this standard. Contamination test reports shall be maintained by the owner or person in charge of the irradiator for inspection by the pertinent regulatory or controlling authority.

Results sh[illegible] be recorded in units of microcuries and the report shall include the following information:

a. Identity of the irradiator by manufacturer, model, serial number, and type(s) of radioactive material.
b. [illegible]cation of irradiator.
c. [illegible]te of test.
d. Test sample collection method.
e. Measuring instrument identification by manufacturer, model, and serial number.
f. Date of the most recent measuring instrument calibration.
g. The correction factors, if used, to compensate for measuring instrument variables and environmental conditions.

h. The conversion factor(s) used to convert from mR/h or cpm to microcurie for the type(s) of radioactive material under test.
i. Measuring instrument reading of test sample.
j. Measuring instrument background reading.
k. Calculation of activity detected: (i−j)xhxg microcurie.
l. Evaluation of test results.
m. Action taken.
n. The identity of the individual responsible for the test.

6. Manufacturers' Responsibility

6.1 General

Responsibility for safe design of the irradiation device, interlocks, and controls lies with the manufacturer. Responsibility for construction in accord with the design lies with the contractor. The manufacturer should observe the construction to determine that the design intent is realized during construction.

Manufacturers shall provide with the irradiator written instructions for the safe operation and maintenance of the irradiator and procedures to follow in case of an emergency.

6.2 Operating Instructions

The operating instructions shall include a general description of the irradiator and detailed operating procedures.

6.3 Maintenance

Instructions shall be provided for periodic inspection and maintenance of the irradiator and shall include test procedures for contamination detection in accord with Part 16 of this standard, and for the testing of interlocks, Part 17.2.

6.4 Emergency Procedures

Instructions shall be provided specifying procedures to be followed in an emergency situation which has caused or may cause a radiation hazard to any individual. (See Part 14.4.)

6.5 Quality Assurance

An adequate quality assurance program, including appropriate quality control measures, shall be employed in both the design and manufacture of irradiators. Subjects which should be considered for an adequate program are:

a. Quality Control Organization
b. General Quality Policy
c. Design Control
d. Vendor Qualifications
e. Inspection of Incoming Material and Components
f. Non-Conforming Items Policy
g. Test Procedures
h. Operating Procedures
i. Personnel Training
j. Document Control
k. Equipment Calibration
l. Quality Audits and Reports

Information included in the following documents may also be useful:

ANSI Z1.1. Guide for Quality Control
ANSI Z1.3. Control Chart Method of Controlling Quality During Production
ANSI Z1.8. General Requirements for a Quality Program

6.6 Records

Manufacturers shall establish and maintain copies of all drawings, operating and service manuals, radiation surveys, and other records relating to the irradiator and its source of radiation until such time that the irradiator has been disposed of in accordance with requirements of the pertinent regulatory or controlling authority.

6.7 Service

Manufacturers shall have available, and provide if necessary, services to maintain and repair the irradiator and take prompt corrective action in the case of emergencies relating to the irradiator and its source of radiation.

6.8 Safety Advisory

If a manufacturer of irradiators becomes aware of a condition or circumstance involving a basic irradiator component or system that could contribute to, or cause, the exceeding of a limit as defined in this standard, the manufacturer shall advise the pertinent regulatory or controlling authority and all users of irradiators of this manufacture of the situation and the corrective action required.

7. Maximum Permissible Radiation Levels Outside the Radiation Shields

7.1 Instrumentation

For instrument requirements to measure radiation levels, refer to Part 5 and Appendix A.

7.2 Measurement Configuration

The exposure rates measured at 30 cm from the accessible surface of the radiation shield to the effective center of the detector chamber shall be averaged over an area of not more than 100 square centimeters having no linear dimension greater than 20 cm.

7.3 Radiation Levels[1]

7.3.1 **Unrestricted Areas.** All Category IV irradiators shall have sufficient shielding such that the exposure rate from leakage radiation measured at 30 cm from the accessible surface of the radiation shield shall not exceed an average of 0.25 mR/h. Exposure rates of up to 2 mR/h averaged over any 100 square centimeter area are allowed, providing these contributions do not raise the average exposure rate to more than 0.25 mR/h over a one meter square area parallel to the accessible surface of the radiation shield.

7.3.2 **Restricted Areas.** All Category IV irradiators shall have sufficient shielding such that the exposure rate from leakage radiation measured at 30 cm from the accessible surface of the radiation shield shall not exceed an average of 2.5 mR/h. Exposure rates of up to 20 mR/h averaged over any 100 square centimeter area are allowed, providing these contributions do not raise the average exposure rate to more than 2.5 mR/h over a one meter square area parallel to the accessible surface of the radiation shield.

Special cases may arise where, in normally restricted areas, the exposure rates specified above may be exceeded, e.g., a roof area occupied only for occasional maintenance or a manipulator port well above head height.

7.3.3 **Irradiator Control Console.** The radiation level in the vicinity of the irradiator control console shall not exceed the radiation levels specified in paragraph 7.3.1. of this standard.

8. Operational Safety Features

This section covers radiation safety features which are not specifically covered in other parts of this standard.

It shall not be possible to resume irradiator operations after any return of the source to the fully shielded condition without complying with the requirements of Part 8.1.

Safety features for a typical Category IV irradiator are shown in figure 2.

[1] The shielding requirements in this section are stated in a manner commonly used in building specifications and recognize minor variables inherent in construction. Compliance with this section should result in radiation doses well within the limits in table 1 and be consistent with maintaining doses as low as reasonably achievable.

8.1 Operating Procedures and Sequentially Interlocked Controls

Sequentially interlocked controls shall be provided for personnel access, radiation room lockup sequence, and source exposing operations. The controls shall be designed such that any attempt to preempt or apply the controls out of sequence will automatically abort the intended operation.

An example of these sequential control operations is:

a. *Personnel Access*
   1. Ensure that the radiation room access controls are energized at the control console with the single multi-purpose key.
   2. Test the radiation room monitor (detector and electronics) for proper function and verify that the radiation level in the room is acceptable. (See Part 8.4.)
   3. Open the access door with the multi-purpose key. (See Part 8.2.)
   4. Continuously monitor the radiation levels with the portable radiation survey meter on entry. (See Part 8.3.)
b. *Radiation Room Lockup Sequence*
   1. Actuate the safety delay timer in the radiation room with the multi-purpose key (See Part 8.7.)
   2. Close and lock the radiation room access door.
c. *Source Exposure Operation*
   1. Actuate the source exposure mechanism at the control console with the single multi-purpose key before the preset safety delay time period has elapsed.
   2. The irradiator is now in full operation and it shall not be possible to remove the single multi-purpose key without aborting irradiator operation.

8.2 Single Multi-Purpose Key

The irradiator controls shall be designed such that a single multi-purpose key is necessary to operate the irradiator during normal use. This key is used to operate the control console, to gain access to the radiation room, and to actuate the safety delay timer.

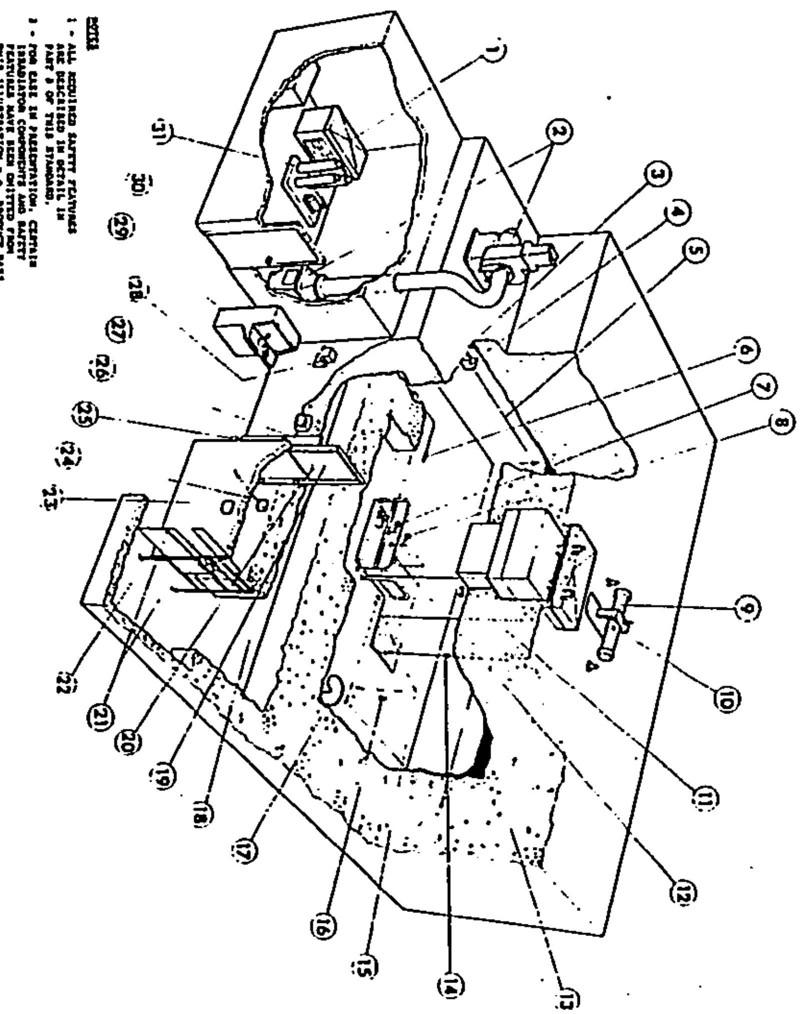
The single multi-purpose key shall be attached to the portable radiation survey meter or audible warning device (chirper) by a chain or cable long enough to allow easy operation of all keyswitches. Only one operating key shall be available to all authorized personnel.

8.3 Portable Radiation Survey Meter and Check Source

A portable radiation survey meter, or a portable audible warning device (chirper), with the single

Key for figure 2 with reference to the pertinent part of this standard.

1. Water Cooler 10.4
2. Radiation Room Ventilation System 8.21.2
3. Radiation Room Monitor Probe 8.4
4. Safety Delay Timer Alarms 8.7
5. Emergency Stop Device 8.9
6. Heat and Smoke Sensors 8.20.2
7. Water Level Control—Normal 10.2.1
8. Water Level Control—Abnormal (Low) 10.2.2
9. Source Hoist 8.13
10. 'Source Down' Switch 8.13
11. Roof Plug Interlock Switch(s) 8.15
12. Pool Guard 8.19
13. Radiation Room Shield—Concrete 9.2
14. 'Source Up' Switch 8.14.1
15. Source Storage Pool 9.1
16. Safety Delay Timer Keyswitch 8.7
17. Exhaust Air Intake 8.21.2
18. Personnel and Product Entry/Exit Maze 8.6 & 8.11
19. Radiation Warning Light 8.14.1
20. 'Source Moving' Light 8.14.1
21. Product Entry/Exit Barrier Doors 8.11
22. Product Entry/Exit Maze 8.11
23. Product Exit Monitor 8.12
24. Source Hoist Power Disconnect 8.22
25. Chec Source Location 8.3
26. Personnel Access Door With Interlocks 8.6
27. Radiation Room Monitor with Alarms 8.4
28. Seismic Detector 8.25.3
29. Master Key Attached to Portable Survey Meter 8.2 & 8.3
30. Control Console 11.1
31. Water Conditioner 10.3



NOTES
1 - ALL REQUIRED SAFETY FEATURES ARE DESCRIBED IN DETAIL IN PART 8 OF THIS STANDARD.
2 - FOR EASE IN PRESENTATION, CERTAIN IRRADIATOR COMPONENTS AND SAFETY FEATURES HAVE BEEN OMITTED FROM THIS ILLUSTRATION e.g. PRODUCT PASS MECHANISM AND RADIATION SOURCE.

Figure 2 Safety features (typical) for Category IV irradiators

multi-purpose key attached shall be carried by the operator when entering the radiation room. A check source shall be used to verify that the meter or audible warning device is operating before each room entry is made.

8.4 Radiation Monitor With Alarms

A monitor shall be provided to detect the radiation level in the radiation room when the source is indicated to be in the fully shielded condition.

The monitor shall be integrated with the personnel access door interlocks to prevent room access when the monitor:

a. detects a radiation level in excess of that specified in Part 7.3.2, or
b. malfunctions, or
c. is turned off.

The monitor shall generate visible and audible alarm signals if the radiation level exceeds that specified in Part 7.3.2 when the source is indicated to be in the fully shielded condition.

The monitor (detector and electronics) shall be tested to assure proper functioning before access to the radiation room can be attained.

8.5 Irradiation Device Warning Sign

There shall be a clearly visible sign at the personnel access door to the radiation room bearing the radiation symbol and the words:

CAUTION RADIOACTIVE MATERIAL
or
DANGER RADIOACTIVE MATERIAL

8.6 Personnel Access Door Interlocks

Means shall be provided such that the radiation room personnel access door shall be closed and secured before the source can be moved from its fully shielded condition.

The door interlocks shall be integrated with the master control system such that violation of the interlock system or use of the door shall cause the source to automatically become fully shielded. Opening of the door with the source not in its fully shielded condition, through malfunction or violation of any interlock, shall generate visible and audible alarm signals to make an individual attempting to enter the radiation room aware of the hazard.

8.7 Safety Delay Timer With Alarms

The radiation room shall be equipped with a key-operated safety timer that will automatically generate visible and audible warning signals to alert personnel in the area that the source exposure sequence has begun and provide sufficient time for any individual in the room to leave the area or operate a clearly identified emergency stop device which will abort the source exposure sequence.

The safety timer shall be integrated with the master control system such that the source cannot be exposed unless the source exposure sequence is complete and the control console indicates that it is safe to expose the source.

8.8 Emergency Egress Capability

Means shall be provided to ensure that personnel may leave the radiation room at any time.

8.9 Emergency Stop Device—Radiation Room

Means shall be provided within the radiation room to prevent, quickly interrupt, or abort irradiator operations and return the radiation source to the fully shielded condition at any time. The device shall be clearly labeled and readily accessible to personnel in the radiation room.

8.10 Emergency Stop Device—Control Console

Means shall be provided at the control console to prevent, quickly interrupt, or abort irradiator operations and return the radiation source to the fully shielded condition at any time. This emergency stop device shall be clearly labeled and provided in addition to any other means normally provided at the control console to shut down the irradiator.

8.11 Product Entry/Exit Port Interlocks

Physical means shall be provided on product entry and exit ports to prevent inadvertent or accidental entry of personnel into high radiation areas.

An audible or visible alarm shall be provided to indicate that the entry/exit port control mechanism has malfunctioned.

8.12 Product Exit Monitor

A fixed radiation monitor with an audible alarm shall be located such that it shall detect radiation emitted through the product exit port. This monitor shall be interlocked with the irradiator controls such that if radiation at the exit port exceeds a predetermined level, the conveyor which carries product from the radiation room to the exit port shall stop and the source shall automatically become fully shielded.

8.13 Source Status and Exposure System Interlocks

Means shall be provided to ensure that, if a malfunction occurs in the source exposure mechanism, the radiation source shall automatically become fully shielded.

The source exposure system shall be equipped with a device whi . positively indicates at the control console when ıe source is in the fully shielded condition.

8.14 Indicators

8.14.1 Source Status Indicators. A discrete alarm, which is audible both inside the radiation room anc ıt all access ports, shall be provided to indicate v..ıen the radiation source is not fully shielded nor in the source-in-use status.

Source status indicators shall be provided at the control console to indicate:

a. When the radiation source is fully shielded,
b. when the radiation source is in the source-in-use status, and
c. when the radiation source is not fully shielded nor in the source-in-use status.

A source status indicator shall be visible at each personnel or product entry/exit port in the radiation shield to indicate when the radiation source is not fully shielded.

8.14.2 Audible Signals. Each audible signal designed into the irradiator control system shall be distinct and loud enough to gain the immediate attention of persons in the area.

8.15 Removable Radiation Room Shield Plugs

Removable radiation room shield plugs shall be interlocked with the master control system to prevent or abort irradiator operations, causing the source to automatically become fully shielded if a plug is removed.

8.16 Source Holder

Means shall be provided to position and retain the sealed source in the design position.

In the event of failure of the sealed source retainer it shall not be possible for the source to move into a position which during normal use of the irradiator may cause a radiation hazard to any individual.

8.17 Source Guard

The radiation source shall be provided with adequate mechanical protection to prevent interference from items such as product boxes or carriers. For example, this may take the form of a protective shroud, guide bars, or floor guides on the product positioning system.

Product positioning systems shall not be able to apply force directly or indirectly to the radiation source.

8.18 Product Positioning System

It is detrimental to the irradiator and product to continue operations when a malfunction of the product positioning system occurs.

The product positioning system shall be provided with controls that detect a malfunction of the system, which shall cause the source to automatically become fully shielded and the irradiator to shut down.

8.19 Pool Guard

A physical barrier, such as a railing, shall be placed around any open pool to prevent personnel from inadvertently falling into the source storage pool. This physical barrier may be removed during maintenance or service operations.

8.20 Fire Protection

8.20.1 General. During extended periods of static irradiation of combustible materials, or when a malfunction prevents the source from becoming fully shielded, heat buildup to the point of combustion may occur. Provision shall be made to protect the integrity of the source if combustion occurs.

Inherent in this requirement is the prevention of damage to the irradiator which could inhibit efforts to fully shield the source.

8.20.2 Heat and Smoke Sensors. Heat and smoke sensing devices with visible and audible alarms shall be provided to detect combustion in the radiation room. The source shall automatically become fully shielded and the product positioning and ventilation systems shall shut down if either device is actuated.

8.20.3 Fire Extinguishing System. A fire extinguishing system shall be provided in the radiation room.

Provision should be made to control the overflow of water from rooms equipped with water sprinkling systems.

If other than water sprinkling systems are used, care shall be taken to avoid the use of chemicals and corrosive substances which could adversely affect the integrity of the sealed source.

8.21 Noxious Gas Control

8.21.1 General. Ozone and other noxious gases are produced by radiolysis. (See Part 3.1.) Measures shall be taken to protect personnel against exposure to concentrations of such gases above the threshold limit values prescribed by the pertinent health authority.

8.21.2 Ozone. Ozone (O_3) is produced by the radiolysis of air in an irradiator. Care shall be taken to prevent the migration of ozone into areas which may be occupied and where the concentration could exceed 0.2 mg/m^3 (0.1 ppm) [6]. This can be achieved by using a ventilation system which creates a negative pressure in the radiation room.

Where forced air systems are utilized, the flow of air shall be continuously monitored such that failure of the system will cause the source to automatically become fully shielded and shut down the product positioning system.

Personnel shall be prevented from entering any area where it is possible for them to be exposed to more than the threshold limit value-time weighted average (TLV-TWA) [6] or threshold limit value-short term exposure limit (TLV-STEL) [6]

Ozone, being unstable, changes to the normal form of oxygen (O_2) and, when a large capacity continuously-operated ventilation system is used, the radiation room can normally be entered a few minutes after the radiation source becomes fully shielded. Another advantage of using a continuously-operated ventilation system is the significant reduction achieved in oxidation effects on radiation room components.

A method of controlling personnel access until the ozone level is at an acceptable level in the radiation room is to provide a time delay interlock mechanism which prevents personnel access doors from being opened before a preset time has elapsed after the radiation source has become fully shielded.

8.21.3 Nitrogen Oxides. Nitrogen oxides such as NO and NO_2 are also generated by the radiolysis of air. Measurements in radiation rooms associated with Category IV irradiators indicate that the levels are well below the TLV-TWA and TLV-STEL [6] limits.

8.21.4 Other Noxious Gases. Certain plastics, chemicals, and other materials produce noxious gases as a result of radiolysis. In these special instances, care shall be taken to ensure that personnel exposures do not exceed the appropriate TLV-TWA and TLV-STEL [6] limits.

8.22 Source Exposure Mechanism Disconnect for Servicing

The motive power used (e.g., electrical, pneumatic, hydraulic) to expose the source shall be provided with a disconnect mechanism to enable servicing to be carried out without the danger of the source being inadvertently exposed.

Means shall also be provided for positively securing this servicing mechanism in the disconnect position or the source exposure mechanism in a non-operative condition.

8.23 Power Failure—Electrical

8.23.1 Long-Term Power Failure. Means shall be provided to ensure that, if an electrical power failure of more than ten seconds occurs, the source shall automatically become fully shielded and the irradiator shall shut down.

8.23.2 Short-Term Power Failure. In some localities, short-term power failures of not more than ten seconds occur frequently. In these cases, it may be detrimental to product throughput if automatic shut-down of irradiator operations were to be imposed as a result of these short-term power failures. It is therefore acceptable for means to be provided to avoid unnecessary irradiator shutdowns under these short-term power failure conditions.

8.24 Power Failure—Non-Electrical

Means shall be provided to ensure that failure of non-electrical power (e.g., pneumatic or hydraulic) which is used to control or operate any irradiator safety feature or device shall cause the source to automatically become fully shielded and the irradiator to shut down.

8.25 Geologic and Seismic Site Considerations

8.25.1 Geologic Site Considerations. Geologic features which could adversely affect the integrity of the radiation shields should be evaluated, taking into account the physical properties of materials underlying the irradiator site or its environs.

Areas of potential or actual surface or subsurface subsidence, uplift, or collapse should be taken into consideration when assessing the suitability of a site for an irradiator. Other factors which need not be due to natural features and could result in soil instability should also be considered.

8.25.2 Seismic Area. For the purposes of this standard, a "seismic area" is any area where horizontal acceleration in rock of 0.3g (30% of the acceleration due to gravity)[2] may occur with a 90% probability of not being exceeded in 50 years (i.e., where there is a 10% probability that a greater horizontal acceleration would occur in 50 years), as determined by the U.S. Geological Survey [7].

8.25.3 Seismic Detector. In seismic areas, all Category IV irradiators shall be equipped with a seismic detector which causes the radiation source to automatically become fully shielded should the detector be actuated. The seismic detector may be a horizontal omniaxial or a vertical[3] uniaxial type and shall be set to actuate at 0.05g or more.

8.25.4 Design Basis Earthquake. In seismic areas, the radiation shields shall be designed to retain their integrity for the "Design Basis Earthquake" (DBE).

The DBE is that earthquake which is based upon evaluation of the maximum earthquake potential considering the regional and local geology and seismology, and specific characteristics of local subsurface material.

8.26 Irradiator Security

In addition to other security measures, all remotely located equipment, such as source hoists on radiation room roofs, which could compromise personnel safety if misused, shall be located in locked restricted areas.

9. Integrity of Radiation Shields and Barriers

9.1 Source .torage Pool

Water is normally used as the radiation shielding medium in wet source storage irradiators when the source is in its fully shielded condition. An automatic water level control shall be provided to maintain the water al ve a preset level. All components below water lev should be of material with a specific gravity of 1.000 or more. If hollow tubing is used, it shall be fully vented to allow the water to flood the tubing.

[2] Earthquakes with accelerations of 0.3g or greater are generally classed severe.

[3] It may be noted that a seismic area is defined by a *horizontal* acceleration but the seismic detector may be a *vertical* uniaxial type. All earthquakes have both a horizontal and a vertical acceleration, accordingly it is not necessary to restrict the seismic detector to a horizontal omniaxial type.

This is to eliminate the risk of a high radiation beam up the tube.

Concrete or concrete and earth fill are normally used to shield accessible basement areas adjacent to the source storage pool.

9.2 Radiation Room Shield

Concrete is normally used to construct the radiation room shield but other materials such as earth fill and steel may be used in its construction.

Where possible, all tubes, pipes, or conduits should take a curved or stepped path through the shielding material to prevent radiation leakage.

9.3 Personnel Access Door

The personnel access door shall meet the requirements for a National Fire Protection Association fire resistance rating of 20 minutes, while retaining its integrity as a personnel access barrier.

10. Source Storage Pool, Pool Components, and Controls

10.1 General

Source storage facilities generally consist of a water-filled pool located below floor level in the radiation room. Inserts, brackets, and other hardware are normally used within the pool to anchor or locate such items as the source holder guide rods or cables and various pipes for water circulation.

10.1.1 Pool Integrity. The pool shall be water-tight and designed to support radiation source transport containers used during source transfer operations without compromising the integrity of the pool.

There shall be no penetration, (e.g., pipes or plugged holes) through the bottom of the pool. There shall be no penetration through the walls of the pool more than 30 cm (12 in.) below normal water level.

10.1.2 Pool Component Material. All permanent pool components shall be made of material which will reduce the possibility of corrosion occurring and migrating to the sealed source. Where practical, stainless steel components (e.g., brackets or pulleys) should be passivated, particularly after fabrication.

10.2 Pool Water Controls

10.2.1 Water Level Control—Normal. Means shall be provided to automatically replenish water losses from the pool. Normal water losses are principally due to evaporation. The system shall be capable of maintaining the pool water at a level sufficient to provide the radiation shielding necessary to satisfy the requirements of Part 7.3.2 of this standard.

A metering device shall be installed in the make-up water supply line to indicate major changes in replenishment water requirements which may be associated with pool leakage.

Means shall be provided to prevent the migration of pool water into municipal water supply systems.

10.2.2 Water Level Control—Abnormal (Low). Means shall be provided to activate audible and visible signals in the control area if the pool water falls to a level more than 30 cm (12 in.) below the normal make-up water level.

It shall not be possible to enter the radiation room using normal entry procedures while the abnormal (low) water level condition exists.

10.3 Water Conditioning

The pool shall be equipped with a system capable of maintaining the water in a clean condition and at a level of conductance not exceeding 1000 microsiemens/m (10 microsiemens/cm). This will reduce the possibility of corrosion of the sealed source.

Extreme care shall be exercised to avoid the introduction of contaminants into the water system; e.g., deionizer regenerants, cleaning materials, corrosive fire extinguishing materials, spilled product.

All filter(s) and resin bed(s) in any water conditioning system shall be tested for radioactive contamination just prior to planned backwashing or regeneration of the system. Backwashing or regeneration shall not be started if the test reveals the presence of contamination. (See Part 16.)

10.4 Water Cooling

Because heat is produced by gamma-emitting sources, the resulting high humidity levels may damage the product and product positioning system. When such damage is likely to occur, an appropriate pool water cooling system should be provided.

Reducing evaporation loss from the pool will also facilitate maintaining the conductance of the water below 1000 microsiemens/m (10 microsiemens/cm) for a longer period of time before regeneration or replacement of deionizer resins is required.

10.5 In-Pool Piping

Since pipes are used in source storage pools for the water level and water quality systems, suitable syphon breakers shall be provided to prevent the syphoning of pool water lower than 30 cm (12 in.) below the normal make-up water level.

All pool water circulation suction pipes shall have intakes no lower than 30 cm (12 in.) below the normal make-up water level.

10.6 Cleaning Source Storage Pools

It may become necessary to clean the source storage pool to remove foreign matter which accumulates at the bottom.

Any vacuum system used for pool cleaning shall be fitted with an in-line filter. Typically, swimming pool filters are used for this purpose. The filter shall be continuously checked for the presence of radioactive material during the vacuuming operation. Should the exposure rate at the filter increase, the vacuuming operation shall be terminated. All underwater tools used for vacuuming shall satisfy the requirements of Part 13.5 of this standard.

11. Control Identification

11.1 Control Console

The control panel or console shall be easily identifiable as being part of the irradiator.

11.2 Labeling

Each control shall be clearly labeled as to its function.

11.3 Status Indicator Colors

The following colors are recommended for use when illuminated or color-coded controls are used:

Condition	*Color*
Emergency (stop buttons or lights)	Red
Warning-Hazard	International Trefoil or Red
Critical Information (source in use or malfunction)	Red
Caution (no emergency, but some function taking place to be aware of)	Yellow or Orange
Normal (source not in use or function safe)	Green
Information	Blue

12. Owner or Lessee's Responsibility

The owner or lessee responsible for possession and use of the irradiator shall obtain from the pertinent regulatory or controlling authority any licenses, permits, or authorization necessary for the possession, storage, and use of the irradiator. This person shall be responsible for the storage and operation of the irradiator in accordance with such licenses, permits, or authorizations. (See also Part 14 of this standard, "Administrative Procedures.")

The owner or lessee shall maintain the irradiator as prescribed by the manufacturer, paying particular attention to ensure that all product positioning system components, product boxes or carriers continue to meet design specifications. For example, it is important to ensure that the correct product boxes or carriers are used and that they are maintained in a condition that will not cause an irradiator malfunction.

The owner or lessee shall notify and obtain approval from the pertinent regulatory or controlling authority prior to any modifications which may cause a radiation hazard. Some examples are:

a. Modifying operating procedures.
b. Modifying the safety control system.
c. Major modifications of the irradiator.
d. Source loading, replenishment, removal or redistribution.

The owner or lessee is not required to notify the pertinent regulatory or controlling authority when performing routine maintenance procedures, including the changing of components, which will not cause a radiation hazard or compromise the safety of the irradiator, provided licensing conditions are not violated.

13. Installation and Safety Related Service

13.1 Authorized Personnel

Installation and safety related services on an irradiator containing a sealed radioactive source shall be performed only by, or under the direct supervision of, an authorized person. The authorized person shall be physically present during any operation involving source loading, replenishment, removal, or redistribution.

13.2 Qualifications

The authorized person shall have the training and experience necessary to act responsibly in the event of contingencies arising during the installation or service work.

13.3 Responsibility

An authorized person shall be responsible for the radiation safety of all associated personnel during the installation and service operations and should be accorded full cooperation by the various departments involved.

The authorized person shall possess all documentation as required by the pertinent regulatory or controlling authority.

The authorized person shall comply with all safety regulations relating to the complete operation and ensure that all personnel associated with the operation are in compliance with the pertinent regulations, e.g., the wearing of personnel dosimeters.

13.4 Records

Records of all installation and service work shall be maintained by the organization represented by the authorized person. These records shall be made available to the pertinent regulatory or controlling authority on request.

13.5 Underwater Tools and Servicing

All components used below water level which could compromise the integrity of the radiation shield during procedures such as maintenance, servicing, and source addition or removal should be of material with a specific gravity of 1.000 or more. If tubing is used in the pool, such as when the pool floor is vacuumed or hollow tool rods are used for servicing, it shall be fully vented to allow water to flood the tubing as it enters the water.

All tools, vacuum tubing, or equipment which may reduce the shielding provided by the water, shall be monitored during introduction to the storage pool.

All items removed from the storage pool shall be monitored as they are withdrawn.

Continuous monitoring of the area above the storage pool shall be carried out during any source handling or pool vacuuming operation.

14. Administrative Procedures

14.1 Written Instructions and Operational Requirements

Written administrative instructions governing the use or responsibility for use of the irradiator, and the associated radiation safety program, shall be provided to authorized personnel. These instructions shall be fully understood by the authorized personnel and shall include, as a minimum, the following:

1. A description of the safety organization including the functions, duties, and responsibilities of the:
   a. Radiation Safety Committee
   b. Radiation Safety Officer
   c. Operator
2. The method of implementing the operating instructions and assuring that the facility is being used safely on a continuing basis, which shall include:
   A description and schedule of the inspections and test procedures for ensuring that all safety interlocks, devices, and components associated with the irradiator are functioning properly. Each such safety item and the appropriate tests, checks, and inspections for each should be specified.
   The requirement that at all times when the irradiator is left unattended, the personnel access door shall be closed and secured.
   The requirement that the emergency procedures be conspicuously posted in the control area.
   The requirement that the operating procedures, instruction manual(s), and log book shall be located in the control area, along with the following information:
   Name and address of irradiator manufacturer
   Model and serial number of the irradiator
   ANSI compliance designation "N43.10-1984"
   Name and address of source manufacturer(s)
   Model and serial numbers of all sources
   Type of radionuclide involved and total activity with date of measurement
   Maximum design activity (nominal capacity) of the irradiator
3. The method of assuring that operating personnel wear proper radiation monitoring devices and that their results be assessed and recorded.
4. The method(s) of assuring that only authorized persons will use the irradiator or have access to the area. This can include controlling keys to the door into the room containing the irradiator control console, controlling operating console keys, or other positive methods of excluding access.

14.2 Log Book

A log book or file shall be maintained to record details of all important irradiator activities, including adjustments, changes or service to mechanisms and circuitry, and those functions performed under the test program. As a minimum, the log shall provide space to record time, date, operation performed, visitors' names, radiation room monitor readings (on entry), and operator performing the task. Each log entry shall be verified by the authorized operator with a signature or initials.

14.3 Malfunction Procedure

Written instructions shall be provided covering action to be taken in the event of machine malfunction and should include a general outline of the action to be taken by people who are notified of a machine malfunction, correction of which may involve the source. It s' .uld be made clear that remedial action in situatio involving work around the irradiator should be controlled by persons specially trained in radiological safety.

14.4 Emergency Procedure

Emergency procedures should be written for each type of emergency that may reasonably be encountered. These should be concise, easily followed instructions. They should describe what will be indicative of a situation requiring emergency action, specify the immediate action to be taken to minimize radiation exposure to persons in the vicinity of the irradiator, and include the name and telephone number of the person(s) to be notified to direct remedial action.

14.5 Controlled Access

The radiation rooms of all Category IV irradiators shall be designated as "Restricted Areas," and access thereto shall be strictly controlled. Initial access upon return of the radiation source to its fully shielded condition shall be made by an operator who shall use the portable monitor when entering and occupying the radiation room.

When visitors are permitted to enter the irradiator, they shall be escorted by an operator. Visitors entering the restricted area shall be issued a personal dosimeter. The visitor's name, dosimeter identification, dose received, and name of escort shall be recorded in the log book. In cases where there is a large group of visitors to the restricted area, each of their names shall be recorded in the visitors' log. However, it will suffice if at least two members of the group have a personal dosimeter, provided that the two conduct activities representative of the group at large.

15. Operator Qualifications

Each operator's qualifications shall be documented and reviewed for acceptability, and be authorized by the pertinent regulatory or controlling authority.

Each operator shall be familiar with the basic design, operation, and preventive maintenance of the irradiator; the principles and practices of radiation protection; biological effects of radiation; the written procedures for routine and emergency irradiator operation; and the regulations of the pertinent regulatory or controlling authority.

Each operator shall know the approximate location of the source and the exposure rate from leakage radiation in areas around the irradiator. Operators shall be familiar with area security safeguards such as locks, posting of signs, warning lights, audible and visible signals, and interlock systems.

Each operator shall be familiar with the radiation detection instrumentation which is used and the requirements for personnel dose monitoring as specified by the pertinent regulatory or controlling authority.

Each operator shall demonstrate competence to use the source of radiation and its related components, and to maintain the required operation logs and records. Operators shall be familiar with the overall organization structure pertaining to management of the irradiator, including specific delegations of authority and responsibility for operation of the irradiator.

16. Contamination Tests

16.1 General

The purposes of the contamination test program are to detect gross contamination and to evaluate trends so that the presence of unacceptable contamination can be foreseen.

Appendix A describes currently acceptable contamination tests required by Parts 16.4.2 and 16.5.3. The contamination test report requirements are described in Part 5.5.

16.2 Authorized Personnel

Only authorized personnel shall perform contamination tests.

16.3 Contamination Test Sensitivity

The test shall be capable of detecting the presence of 0.03 microcurie of contamination on the test sample.

16.4 Source Transport Container Tests

All empty or loaded source transport containers shall be tested to prevent the introduction of radioactive contaminants into an irradiator pool source storage system.

16.4.1 Radiation Test—External. Prior to performing the contamination tests, the authorized individual shall verify that the radiation exposure rate at one meter from the accessible surface of the transport container does not exceed 10 mR/h. If the exposure rate exceeds 10 mR/h at one meter, it shall be assumed that the integrity of the container or its contained source has been impaired and transfer of the container into the source storage pool shall not be carried out.

16.4.2 Removable Contamination Test—External. The authorized individual shall perform a wipe test on the external surface of the source transport container to test for the presence of removable contamination. If removable contamination in excess of 0.03 microcurie per 300 square centimeters of container surface is found [8, 9], it shall be assumed that the integrity of the container or its contained source has been impaired and transfer of the container into the source storage pool shall not be carried out.

16.4.3 Removable Contamination Test—Internal. The authorized individual shall test the inside of the source transport container for the presence of removable contamination. If removable contamination in excess of 0.05 microcurie is found on a test sample, it shall be assumed that the integrity of the container or its contained source has been impaired and transfer of the container into the source storage pool shall not be carried out.

16.5 Acceptable Test Program

For tests where the results are going to be recorded and compared to previous or future test results, there must be consistency in the test procedure. It is useful to plot the test results in order to have a simple illustration of trends.

Any apparent change in radioactive contamination levels which cannot be attributed to known causes requires that further action be taken to determine the cause. Such further action may include:

a. Verifying that the test instrumentation is functioning properly.
b. Repeating the tests to verify the apparent change in radioactive contamination levels.
c. Performing more frequent source wipe tests to verify source integrity.
d. Consulting with the source supplier.

While each radiation safety officer is responsible for developing his own specific program, the following tests shall be included as a portion of the total program.

16.5.1 Weekly Test

16.5.1.1 Water Conditioning System. Check each filter bed with a portable survey meter and record results. An accumulation of radioactivity in the filter or resin beds will most likely be the first evidence of source leakage.

In addition to the contamination check of the water conditioning system, the system may be equipped with a continuous radiation monitoring device with alarm which will stop all pool water recirculation should the radiation reach the preset alarm level.

16.5.2 Monthly Test

16.5.2.1 Irradiator Wipe Test. Select the surfaces inside the radiation room on which one would expect contamination to accumulate if there were to be leakage of radioactive material. Perform wipe tests on the selected surfaces. Evaluate the wipes and record the results.

Typical areas where contamination may accumulate are ventilation ducts, floor surfaces between the ventilation ducts and the radiation source, and parts of mechanisms that are adjacent to the radiation source when it is in its source-in-use status.

16.5.3 Semi-Annual Test. On a semi-annual schedule, perform a contamination test on the radiation sources. Particular attention should be given to source surfaces in the immediate vicinity of encapsulation welds and submerged surfaces of the pool and its components on which one would expect contamination to accumulate if there were to be leakage. Examples of the latter would be the floor of the pool, the source holder, and source guides.

If the test indicates the presence of contamination in excess of that specified in Part 16.5.4, then discrete tests shall be performed on individual source elements to establish the origin of the contamination.

16.5.4 Detection of Removable Contamination. The test results are considered negative if less than 0.05 microcurie of removed radioactive material is detected on the test sample. When the test results are negative, no action other than record-keeping is required.

Tests which reveal the presence of 0.05 microcurie or more of total removed radioactive material on the test sample shall be considered as evidence that the sealed source is leaking. In this event, the irradiator shall be immediately withdrawn from service and appropriate action taken to prevent exposure of personnel and further dispersal of radioactive material. The responsible user shall immediately notify the pertinent regulatory or controlling authority and should notify the manufacturer or supplier of the equipment that an incident has occurred which might have caused or threatens to cause a radiation hazard. Under no circumstances shall unauthorized or untrained persons attempt to examine or decontaminate the irradiator.

17. Safety Tests and Checks

17.1 At Time of Irradiator Installation

17.1.1 Contamination Test. After installation of the sealed source, a contamination test shall be performed to confirm compliance with Part 16 of this standard before the start of routine operations.

17.1.2 Radiation Survey. Immediately after installation of the source, a radiation survey of the irradiator shall be conducted in accordance with Part 5 to confirm compliance with Part 7.3. The survey shall be performed with the irradiator free of materials or objects for irradiation.

17.2 Routine Checks and Tests

17.2.1 Interlock Testing. To assure that all interlocks and critical components remain operable, and continue to provide the personnel safety for which they were intended, periodic (or systematic) testing shall be performed using a formal checklist. If the interlocks do not function properly, the irradiator shall not be used until repairs are accomplished. As a minimum, the checks and tests shall include the following:

17.2.1.1 Indicator and System Checks. Verification of visual indicators and general system operation prior to each radiation room entry.

17.2.1.2 Weekly Tests. Critical systems such as the emergency stop button on the control console, emergency stop device inside the radiation room, door interlock, water level control, low pool water interlock, and water treatment system shall be tested. Attempts should also be made to operate the irradiator after deliberately violating the approved start-up procedure to ensure that the interlocks and sequential controls are functioning correctly.

17.2.1.3 Monthly Tests. Test that the radiation room monitor is functioning properly by exposing the monitor probe to a check source until the alarm sounds. With the monitor alarming, check that the personnel access door cannot be opened.

With the irradiator operating, test that the product exit monitor is functioning properly by exposing the monitor probe to a check source until the alarm sounds. The exit product conveyor shall stop and the source shall automatically become fully shielded.

Tests and checks of less critical but important items such as the source exposure mechanism, the ventilation system, and similar hardware which contribute to the safe operation of the irradiator and its related product positioning mechanism.

17.2.1.4 Semi-Annual Test. Irradiator sources shall be tested for contamination at intervals not to exceed six months. (See Part 16.)

17.3 Additional Contamination Tests

Tests shall also be performed when sealed sources have been loaded, replenished, removed, or redistributed in an irradiator, or when contamination is suspected, before the irradiator is returned to routine operation.

17.4 Additional Radiation Surveys

A physical radiation survey shall be performed to confirm continued compliance with Part 7 when changes to the irradiator have been made such as an increase in the amount of activity above the previous maximum, sealed source rearrangement, a decrease in shielding, or any other change which may have increased the leakage radiation levels. If the survey indicates the need for corrective action, another survey shall be performed after appropriate modifications have been made.

The survey shall be performed with the irradiator free of materials or objects for irradiation if it is calculated that in this condition the leakage radiation levels may exceed those specified in Part 7.3.

18. Removal, Transfer, or Disposal of Sources and Radioactively Contaminated Material

18.1 Removal of Sealed Sources

Removal, transfer, or disposal of the sealed source may become necessary or desirable. These procedures shall only be performed by, or under the supervision and in the physical presence of, an authorized person.

18.2 Removal of Damaged or Leaking Source

The appropriate method of removal, transfer, or disposal of a damaged or leaking source will be dictated by circumstance, but the following procedure is generally applicable:

If an actual or suspected source leak has occurred, terminate use of the irradiator and close down its water circulation and air ventilation systems to prevent the spread of contamination and exposure of personnel. Isolate the area and contact the following for assistance:

a. The pertinent regulatory or controlling authority.
b. The manufacturer of the device.
c. The supplier and the installer of the source (if different from the manufacturer of the device).
d. A person authorized to remove the defective source. Special permission to remove and transport the source shall be obtained from the pertinent regulatory or controlling authority.

Removal of the defective source should be prompt once the decision is made and shall be performed by, or under the supervision and in the physical presence of, an authorized person.

18.3 Removal of Contaminated Material

Contaminated material generally results from a leaking source. Under no circumstances shall any contaminated material such as water, filter medium, resin, or components be removed, transferred, or disposed of without the express permission of the pertinent regulatory or controlling authority. Disposal of contaminated material shall be performed by, or under the supervision and in the physical presence of, an authorized person

19. Revision of American National Standards Referred To in This Document

When the following American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply:

N43.6–1977, Sealed Radioactive Sources, Classification.

References

[1] Basic Radiation Protection Criteria, NCRP Report No. 39, National Council on Radiation Protection and Measurements, Washington, DC (1971).
[2] Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, International Commission on Radiological Protection, published by Pergamon Press, New York, NY (1977).
[3] United States Nuclear Regulatory Commission, Rules and Regulations, Code of Federal Regulations, Title 10—Energy, Chapter I, Part 20. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
[4] Occupational Safety and Health Administration, Department of Labor, Rules and Regulations, Code of Federal Regulations, Title 29, Chapter 17, Labor, Part 1910, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
[5] American National Standard N43.6, Sealed Radioactive Sources, Classification American National Standards Institute, New York, NY 10018.
[6] Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH. American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, OH 45201. Note: The TLVs are reassessed and republished annually for ACGIH and the most recent edition of these values should be used.
[7] S. I. Algermissen and David M. Perkins, A Probabilistic Estimate of Maximum Acceleration in Rock in the Contiguous United States, Geological Survey Open File Report 76-416, U.S. Department of the Interior, (1976).
[8] United States Department of Transportation, Rules and Regulations, Code of Federal Regulations, Title 49—Transportation, Chapter I, Part 173.397, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
[9] IAEA Safety Standards, Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials 1973 Revised Edition (As Amended), Part 502 and Table XI. International Atomic Energy Agency, Vienna (1979).

Appendix A
Radiation Measurements

(This appendix is not a part of American National Standard N43.10, Safe Design and Use of Panoramic, Wet Source Storage Gamma Irradiators)

For the purpose of this standard, the objective of radiation measurements is to provide adequate information for protection of personnel.

When making a survey of exposure rates through the radiation shields of an irradiator, the instrument should be properly calibrated. This becomes particularly important as radiation levels approach the limits specified in Part 7. The measured levels will determine what action is necessary.

In many cases, the detection of radiation above the normally expected levels may be as important as accurately determining the amount of radiation present. This is illustrated by the following examples. When entering the radiation room with a survey meter, a reading which increases steadily above the expected background level should be taken as an indication that a problem exists and additional investigative action should be taken before further entry is made. In the second example, if the reading on material used in a wipe test on the sources in the pool is significantly greater than previous measurements made under similar conditions, it should be taken as an indication of potential contamination and more accurate measurements should be made to determine the extent of the problem. These examples illustrate the two most common types of radiation measurements performed at irradiators: exposure rate (or dose rate) and activity.

Instrument Selection

In all cases an instrument should be selected which will measure the radiation quantity under consideration to the required accuracy. Exposure measurements are usually performed with survey meters whereas more accurate measurement of a particular radiation quantity may have to be made using sophisticated instruments or laboratory equipment. This appendix only addresses selection criteria for survey instruments. Additional information can be found in ANSI N323-1978, Radiation Protection Instrument Test and Calibration [1]. Some of the most important considerations in the selection and use of survey instruments include:

Energy Dependence. Energy dependence of an instrument is its observed response as a function of radiation energy when placed in a field of known exposure (or exposure rate). The response should be known at several energies over the operating energy range of the instrument so that appropriate correction factors may be applied. The instrument selected should have the smallest practical energy dependence for the radiation being measured.

Sensitivity. The instrument should have the capability to respond to all levels of radiation expected during the survey, and should have the capability to respond to minimum changes of 10% of radiation levels being measured.

Response Time. Survey instruments do not respond instantly to changes in radiation levels but have a finite response time. The response time is the time required for the instrument to reach 90% of its final reading when the radiation sensitive volume of the instrument system is exposed to a step change in radiation level. Response time may be different for the various ranges covered by a given instrument.

Directional Response. The response of the instrument may depend on the orientation of the detector chamber with respect to the incident radiation. Readings should be taken in the orientation in which the instrument has been calibrated.

Environmental Effects. Temperature and pressure can have a significant effect on the indicated radiation levels. Correction factors should be applied to indicated readings to establish the actual radiation levels.

Calibration

The procedure used to calibrate the survey instrument will depend on the radiation quantity being measured. The considerations addressed here are for exposure rate and activity measurements made with survey instruments.

Exposure Rate. An acceptable procedure for calibrating survey instruments for exposure rate measurements is to use a 'point' source of radiation whose exposure rate at a given distance is known, and to compare the observed instrument response in a particular geometry with the expected response using appropriate correction and conversion factors. The instrument should be calibrated at two points on each scale with the two points separated by at least 50% of the scale. For a properly calibrated instrument, the readings are within ±10% of the known or calculated values for each point, or the readings are within ±20% if a calibration chart or graph is prepared and provided with the instrument. The survey instrument should be calibrated in a known radiation field which is traceable to a National Standard.

Activity. The instrument used for measuring activity should be calibrated with a radioactive source having a known amount of activity on material of the same type used in the contamination test. All measurements should be performed using the same source-instrument geometry which was used for the calibration. All conversion and correction factors used in the measurement process should be recorded. If the survey instrument has suitable sensitivity, it is acceptable to use the same instrument for both activity measurements and exposure rate measurements required by this standard. In this case, the recommended calibration procedure is:

a. Calibrate the instrument for exposure rate measurements.
b. Determine the activity on the contamination test sample using appropriate conversion factors.

Contamination Tests

Several subsections of Part 16 specify tests to be performed to detect contamination.

Source Transport Container—Internal

An acceptable test method for transport containers fitted with vent holes and drain lines: Fit a 10-micron-pore filter on both the container vent and drain lines to prevent the release of any unfiltered steam/water into the atmosphere during the test. Using a radiation survey instrument, continuously monitor the vent-line filter while filling the source storage cavity with clean water; the water is fed by gravity through the drain line from an elevated water container. Lower the water container to ground level and continuously monitor the drain line filter while all the water from the cavity is flowing back into the water container. During the draining process, the radiation exposure rate at the drain line filter may increase due to displacement of water in the source storage cavity. Both filters and the water shall be taken to a low radiation (background) area and monitored for contamination.

During the test, should the exposure rate at either filter increase beyond the level directly attributable to the displacement of the water shielding, it shall be assumed that the integrity of the contained sources has been impaired and the test shall be terminated. If the measured contamination is below the allowable limit, the contamination test may be resumed.

Radiation Sources

An acceptable contamination test on the radiation sources is to perform a gross wipe test using a foamed plastic wipe sample not exceeding 100 cm² in area. Attach the wipe to a rod or tube for wiping the suspect surfaces under water. Care should be taken to ensure that the tubing used as the sampler holder is fully vented to allow water to flood the tubing and avoid the risk of a direct unattenuated beam to personnel during the test.

Measure the test sample in a low radiation (background) area with a suitable instrument and record the result.

Reference

[1] ANSI N323-1978, Radiation Protection Instrument Test and Calibration. American National Standards Institute, New York, NY 10018.

PUBLICATIONS BY COMMITTEE N43

AMERICAN NATIONAL STANDARD N43.1; RADIOLOGICAL SAFETY IN THE DESIGN AND OPERATION OF PARTICLE ACCELERATORS. NBS Handbook 107, Revised 1978.

AMERICAN NATIONAL STANDARD N43.2; RADIATION SAFETY FOR X-RAY DIFFRACTION AND FLUORESCENCE ANALYSIS EQUIPMENT. NBS Handbook 111, Revised 1977.

AMERICAN NATIONAL STANDARD N543; GENERAL SAFETY STANDARD FOR INSTALLATIONS USING NON-MEDICAL X-RAY AND SEALED GAMMA-RAY SOURCES, ENERGIES UP TO 10 MEV. NBS Handbook 114.

AMERICAN NATIONAL STANDARD N540; CLASSIFICATION OF RADIOACTIVE SELF-LUMINOUS LIGHT SOURCES. NBS Handbook 116.

AMERICAN NATIONAL STANDARD N537; RADIOLOGICAL SAFETY STANDARD FOR THE DESIGN OF RADIOGRAPHIC AND FLUOROSCOPIC INDUSTRIAL X-RAY EQUIPMENT. NBS Handbook 123.

AMERICAN NATIONAL STANDARD N542; SEALED RADIOACTIVE SOURCES, CLASSIFICATION. NBS Handbook 126.

AMERICAN NATIONAL STANDARD N433.1; SAFE DESIGN AND USE OF SELF-CONTAINED, DRY SOURCE STORAGE GAMMA IRRADIATORS (Category I). NBS Handbook 127.

AMERICAN NATIONAL STANDARD N538; CLASSIFICATION OF INDUSTRIAL IONIZING RADIATION GAUGING DEVICES NBS Handbook 129.

AMERICAN NATIONAL STANDARD N432; RADIOLOGICAL SAFETY FOR THE DESIGN AND CONSTRUCTION OF APPARATUS FOR GAMMA RADIOGRAPHY. NBS Handbook 136.

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This standard applies to panoramic, wet source storage irradiators (Category IV) that contain sealed gamma emitting sources for the irr. iation of objects or materials. It establishes the criteria to be used in ...e proper design, fabrication, installation, use, and maintenance of these irradiators which will ensure a high degree of radiation safety at all times. The requirements of the standard are grouped as 1) general considerations, 2) manufacturer's responsibility, and 3) owner's responsibility. Included in the first group are general radiation protection criteria, sealed source performance requirements, and radiation survey needs. Among the manufacturer's responsibilities are criter a for maximum external radiation levels, integrity of shielding, and controls and ind.cators. The requirements for users include safety-related servicing, administrative procedures, operator qualifications, and routine safety tests.

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APPENDIX I

MARKETABILITY STUDY:

MARKETABILITY OF IRRADIATED MANGOES, PAPAYAS, AND LYCHEES

BY: DR. HOWARD G. SCHUTZ

MARKETABILITY OF IRRADIATED MANGOES, PAPAYAS AND LICHEES

Issues

The successful marketing of any irradiated food product including mangoes, papayas and lichees depends on the complex interaction of many sectors of the food chain. This includes willingness to invest in the facilities for the production of irradiated food products which in turn involves the community acceptance of the citing of such a facility; acceptance and willingness of the food retailers to buy and sell such products; and last but not least, the willingness of the consumer to purchase such products if they were available in the marketplace. All of these sectors are influenced by organized anti-irradiation groups who for a variety of reasons view irradiated food products as either unsafe in their production or consumption or at best uneconomical.

In this section of the report we will review the major research activities which relate to the above concerns with the aim of determining the likelihood of success of irradiated foods in the marketplace and give some recommendations as to how the barriers to such success might be overcome.

In the consideration of the research results to be covered, it is important to keep in mind that in almost all cases we are discussing the evaluation of a concept rather than experience with a particular product. Very few people have actually eaten irradiated food. In addition, this concept is one which is quite ambiguous in the minds of the individuals who are queried concerning their attitudes about irradiated foods. Also, most of the information, other than what is presented in the individual questionnaires or discussions, is derived from the media. For the most part the media presentation of information on irradiation of foods, as might be expected, presents what at best can be considered unbalanced reports with regard to its safety and efficacy and at worst, highly inflammatory and biased information. It is not surprising that the media presents information which they believe will attract readership and in most instances this would lead to the presentation of negative information about irradiation.

Rather than discuss the individual studies which cover a variety of topics, we will present the material by topics, bringing to bear the information as available from each study to present on that topic. The topics to be covered are awareness, general consumer reactions, levels of consumer concern, willingness to buy, trade attitudes, influence of information/education, label and positioning results, and marketing efforts.

Awareness

From examination of Table 1, which gives the awareness levels of irradiation for five research studies, it can be seen that awareness ranges from 23 to 66%. Up to the Harrison study in 1987, it appeared as if awareness levels were increasing over time, whereas in the Harrison results awareness dropped to a level of 31%. This anomaly could in fact be due in part to the methodology of the study. The other studies mentioned were random sample studies whereas the Harrison study was a study conducted where people were stopped outside of supermarkets. From the results on awareness it is clear

Table 1

Awareness of Food Irradiation

Wiese, 1984	National study	23%
Harris, 1985	National study	29%
Bruhn et al., 1986	Sacramento, CA	45%
Brand Group, 1986	National study	66%
E. B. Harrison, 1987	National study	31%

that a high proportion of the population is as yet unaware of the food irradiation process. In addition, in several of the studies when respondents were asked their degree of fami...arity, awareness dropped to very low levels (3-4%). It would be accurate to conclude that the degree of sophistication with regard to the food irradiation process among United States consumers is quite low. This result in some way colors all of the subsequent information that is obtained concerning other judgments about irradiation since the majority of respondents are operating on the basis of either no information at all or just the information that is presented to them in the particular study involved. From the standpoint of potential marketability, this is both an advantage and a disadvantage. The advantage is that a great deal of the attitudes toward food irradiation could be formed on the basis of the way in which people first become aware of the process. The disadvantage is that there is a great deal of education, promotion, and advertising that would be necessary in order to inform people about this process.

General Consumer Comments

Several of the studies elicited general comments from consumers rather than, or in addition to asking for specific concerns or willingness to purchase.

In the Bruhn et al. 1986 study, discussion groups were hold concerning irradiation. Some of the major comments were: concern regarding the creditability of toxicity studies; concern for the level of nutritive losses; all felt the products should be labeled so the consumer could choose since not having a label implies something worth hiding and/or obscures the product advantages; many felt the name irradiation was fear arousing. In the Wiese 1984 study, the top four volunteured advantages perceived for the concept

were: less danger of disease or sickness from food; eliminating/reduce chemicals; longer shelf life; safer in general. In a focus group study conducted in The Netherlands reported in Marketing and Consumer Acceptance of Irradiated Foods, 1983, positive consumer reaction included: interest in fresh and safe foods; interest in consuming much loved foods that are known to be dangerous; interest in durable and fresh and safe and new foods; no chemicals; confidence in recommendations and guarantees from officials and government authorities. Negative consumer reactions were: consumer wanted to avoid being confused and alarmed; association with death and disease; fear of radioactive residues; devitalization of foods; fear of controls at point of irradiation being insufficient; fear that waste disposal methods were unsafe.

Many of these concerns are obviously derived with the association of irradiation with radioactivity, nuclear power plants, and atomic power. It is not surprising considering the lack of true awareness of the irradiation process as well as the type of information that is promulgated in the media that the consumer's general reactions would be characterized by these types of negative responses. It is clear that the process of educating and informing the consumer is going to be overlayed on some serious general negative reactions to the irradiation concept.

Since much of the media information is derived in part from the issues raised by organized opponents to irradiation, it would be of value to cover their major concerns. These concerns are covered in the media which becomes the main source of information for the consumer. This discussion is in no way a complete representation of opposition points of view but rather is illustrative of the type of concerns which they have. There are seven general areas of concern as expressed by the opponent groups. They are (1) unproved safety of food: feeding studies are inconclusive and a concern for the noncompetitive growth of harmful organisms once irradiation has destroyed selective organisms; (2) nutrient losses: there is a concern that certain nutrients are lost in the irradiation process which would lead to lower quality food; (3) there is a strong belief that the Department of Energy is using food irradiation as a way of disposing of Cesium 137 waste from nuclear power plants; (4) there is a concern for safety of the workers in plants and in the safety of transport of materials to and from plants; (5) there has been a concern that the change in th labeling requirements which would have taken place in April of 1988 would no longer require associating the Radura symbol with the statement "treated by irradiation." This they felt, would then leave the consumer without clear cut information as to the meaning of the Radura label. However, this labeling requirement has recently been extended by the Food and Drug Administration for another two years; (6) there is some confusion as to how much of an irradiated ingredient must be in a product before the product must be labeled irradiated. Clearly, minor ingredients such as spices are not labeled as irradiated; (7) economics: there have been general and some specific comments made that the radiation process would result in additional cost to the consumer.

Although it is not the purpose of this discussion to argue the value or lack thereof of the concerns stated above, but rather to indicate that these types of concerns would be ones that have to be dealt with in any successful marketing program for irradiated food.

Levels of Consumer Concern

Table 2 summarizes the results from the Wiese 1984 study on major concerns for food safety areas. These results make it quite clear that irradiation as

a major concern has the lowest concern level among the areas investigated.

Table 2

Major Concern for Food Safety Areas

Chemical Sprays	55%
Disease	50%
Preservatives	42%
Waste	45%
Irradiation	38%

It should be noted that this is a result of people who had both heard and not heard of irradiation and that these levels of concern could change in an upward as well as downward direction with additional information. As a matter of fact, in this particular study when additional information was provided to respondents, there was a slight increase in concern for some of the respondents. A study conducted for Good Housekeeping (McNutt, 1985) as shown in Table 3 investigated concerns for a variety of food preparation techniques. Here again food irradiation appears to have a lower level of concern than chemical sprays or preservatives. In addition, it is interesting to note

Table 3

Women's Concern about Ten Types of Food Products

	Major Concern	Small Concern	Little or No Concern	Don't Know
Freeze-dried or dehydrated foods	8	20	53	19
Commercially canned food	8	25	67	0
Home canned food	15	31	52	2

Commercially frozen food	4	23	73	0
Home frozen food	9	24	65	2
Foods cooked by microwave	9	22	61	2
Foods grown using chemical spray	80	16	4	0
Foods with chemical preservatives	75	18	7	0
Foods treated with electro-magnetic energy/iodized	41	21	6	32
Food irradiated to prevent spoilage	19	31	26	24

the change in level of concern when the statement is changed from one simply involving the nature of the process "foods treated with electro-magnetic energy/iodize, to a reason for irradiation," i.e, food irradiated to prevent spoilage." This emphasizes the importance of giving meaningful reasons to the consumer for use rather than just indicating that the food irradiation process was utilized. In a Foo‿ Marketing Institute study conducted by Harris in 1985, there was an opportunity to directly compare whether consumers would prefer as a method for sterilizing foods, either chemical preservatives or irradiation. In Table 4 one can see that for the total sample there was no difference in preference, whereas for those who had heard of irradiation there was a higher level of preference for irradiation than chemical preservatives.

Table 4

In general, which would you prefer as a method for sterilizing foods?

	Total Sample	Heard of Irradiation	Not heard of Irradiation
Chemical preservatives	27%	24%	28%
Irradiation	27	39	22

Neither	11	14	10
Not sure	33	22	37

This would appear to offer some hope that information about irradiation would improve acceptance, but I would caution there is also the likelihood that additional information could lead to lower levels of acceptability for some groups in the population. In another Good Housekeeping study (McNutt, 1985), the question was asked with regard to preference for irradiation or preservatives where there was a 23 to 3% preference for irradiation over preservatives, but clearly the majority indicated they don't know enough to

Table 5

Preference for Irradiated Foods or Foods Containing Preservatives

Good Housekeeping Readers

I don't know enough to judge	44%
I don't want either irradiation or preservatives	27%
I would prefer irradiation to preservatives	23%
I would prefer preservatives to irradiation	3%

judge or they don't want either. This points out dramatically the need for additional information in order for consumers to make intelligent decisions regarding the food irradiation process.

In an in press study by Bruhn et al. in which concern for food irradiation was related to demographic characteristics, it was found that those consumers with higher concern were more likely to be female, younger, concerned about sprays, as well as an ecologically balanced world, and seemed to value fun or enjoyment in life.

In the E. B. Harrison, 1987 study questions on concern were not directly asked, instead a rating scale on degree of opposition was utilized. For this type of analysis 42% were considered to generally favor the idea, 33% taking a middle position, and 25% indicating opposition. Since the question is asked in a different manner, it is hard to relate it directly to the concern results reported earlier. Another factor to consider in this study is that before the individuals rated their degree of opposition to food irradiation, they were read a concept statement which would most likely yield a positive bias. On the other hand, this would give some evidence that presenting positive information with regard to the process could potentially increase acceptance of the concept.

Willingness to Buy Irradiated Food

Table 6 summarizes the results of six studies in which willingness to buy irradiated food was asked in one way or another. In examining these results it should be born in mind that the type of information the respondent had previous to answering this question varied considerably, therefore one would expect different results for this reason alone. In addition, they were conducted at different points in time so that additional information available to consumers might possibly influence the results as well. And lastly, the products investigated and discu sed differed from study to study. In the Bruhn et al. study, the strawberries and pork likelihood did not differ significantly, although there was a higher level of acceptance of willingness to purchase for strawberries. The Gallup Canadian study was primarily interested in fish as was the Brand Group. Both of these indicate fairly high levels of willingness to purchase, although it should be mentioned that in the Canadian study the process was not described as

Table 6

Willingness to Buy Irradiated Food

	Item	Likely	?	Unlikely
Bruhn et al. (in press)	Strawberries	40%	29%	31%
	Pork	32%	33%	35%
Gallup Canada, 1984	3 to 1 positive intent to purchase (non-irradiation name)			
Brand Group, 1986	2/3 would personally try and serve irradiated food to their family			
Packer Fresh Trends Waterfield, 1987	54% said they would not buy an irradiated item until they knew more about the process of food irradiation			
Terry and Tabor, 1988	ca 50% of consumers would buy irradiated produce if prices were competitive and if given information explaining food irradiation			
E. B. Harrison, 1987	69% likely to buy mangoes, papayas, lichee nut, avocados or pineapple			

irradiation and this could contribute to higher levels of willingness to purchase. The Terry and Tabor study was one of the few that has specifically investigated the influence of price on willingness to purchase irradiated produce and here there was an indication that prices that were competitive and information about food irradiation resulted about a 50% interest in purchase. This certainly could be considered very encouraging for the marketability of the products. The Harrison study was the only one specifically investigating interest in purchase of mangoes, papayas and lichee nuts, and here the 69% "likely to buy" is an encouraging results. However, it should be noted that this is the study in which before answering the purchase question there was a concept statement read which was highly positive about the food irradiation process.

In considering this willingness to buy data as well as the concern data given in the previous section, it is important to note that although there are many food treatment techniques which receive higher levels of concern than irradiated foods, products with such treatments nevertheless are purchased in the marketplace. In part this is due to because of lack of awareness (due to lack of labeling in most cases) and in part because of lack of alternatives.

An interesting set of events in California markets which is relevant is the recent campaign by one market to advertise and label their produce as chemical free as demonstrated by independent testing. This has resulted in strong defensive responses from other markets but has apparently increased produce sales for the market in question. One might assume that if there were no other alternatives to certain irradiated food products, that consumers would purchase them in the same way as they purchase products with preservatives and those treated with insecticides. Again as noted earlier, these are strictly hypothetical questions; the U.S. consumer has not actually been faced with decision to make an irradiated food purchase in the marketplace. Also as indicated earlier, there is some evidence that when given a particular reason for irradiation that purchase interest increases.

Trade Reactions

We could find only two North American studies involving the reaction of the retail trade to the concept of irradiated food products. The first one was the Canadian study conducted by the Brand Group, 1986, in which responses from the retail trade was elicited concerning seafood products that would be irradiated. The general respor e was negative with concerns that fresh fish equals quality; consumers currently pay a premium for fresh fish; the

elimination of waste is not perceived as a benefit as waste is controlled by tight control over orders; that fresh fish is a small part of a grocer's business, so there isn't really a great interest; traders are concerned about consumer acceptance.

The second study specifically concerned mangoes, papayas, and lichee nuts, conducted by E. Harrison, 1987. Here again there was reservations about consumer acceptance and that industry would need to answer these concerns and promote the process before Americans would accept the technology. Many expressed the willingness to sell irradiated produce if they felt they knew enough about the process to answer any questions that their customers might have.

Illustrative of the sensitivity of producers to public opinion concerning labeling and irradiation was the recent withdrawal from the marketplace of a rice mixture which contained a minor unlabeled irradiated mushroom. This was made public, not surprisingly, by an anti-irradiation group.

Influence of Information/Education on Food Irradiation Attitudes

Based on their research, the Brand Group, 1986, concluded with regard to educational efficacy that there were three groups of consumers, "rejecters," estimated at 5 to 10% of the population, who reject on the basis of conflicting values, and education will have no effect on their attitudes. Secondly an "undecided" group of 55 to 65% who were confused by the technology, have concerns, and education and promotion are quite important. And lastly, "acceptors," representing 25 to 30% who believe they understand the technology, have positive attitudes which could be shaken by exposure to others concern and therefore education is important. Wiese, 1984 research concluded the most important facts to reduce or eliminate concern was that there was no chemical residue in the food nor radiation in the food. Secondarily, that irradiated food was consumed by critical immunity patients, used to sterilize medical equipment, and that it had FDA approval. Brand, 1986 indicated that in utilizing information and education it would be necessary to emphasize the product benefits, give instructions for proper care, have endorsements, give laymans' descriptions of irradiation, and have technical information on demand. In the Brand Group study, an attempt was made to influence willingness to purchase product utilizing a series of promotional and advertising statements emphasizing extended freshness without chemicals, increased availability of fresh seafood, and elimination of the risk of food poisoning. They found no difference among the various promotional material and willingness to purchase irradiated seafood product, and in fact, there was very little difference among any of the concepts purchase levels and the consumers' willingness to purchase without any promotional statement.

Bruhn et al., 1986ab conducted a series of studies utilizing a variety of populations and methodologies which attempted to measure changes in concern and willingness to purchase after the presentation of information about the food irradiation process. This included information about sources of radiation, safety of the food, quality of the food, effect on nutrient content, and the relationship to other types of food treatment and processing. The methodology utilized discussion groups with conventional and alternative consumers (food co-op members) as well as master gardeners, UC Davis Open House and Whole Earth Day participants.

In general, one could summarize all these studies with the conclusion that concerns either stayed about the same or dropped slightly for all groups

except for the "alternative group" where there was an increase in concern. For willingness to buy irradiated food there was an increase in willingness to buy for all groups but the alternative group where it declined slightly. These results support some of the earlier findings reported in which concern levels do not change greatly with information, but that in spite of concern for irradiation as well as other treatments for food, individuals still obviously make purchases. It seems that when one presents information about irradiated food that the influence on concerns is slight, but the willingness to take the risk of purchase is improved. This would seem to illustrate the importance of information in producing, if not a change in concern level, (with the caveat of the way information has been presented to date), an increase in willingness to try irradiated food products. The fact that those in the alternative group whose values are inconsistent with irradiation supports the Brand Group, 1986, "rejecter group" for whom education would not provide any additional benefit.

Label and Positioning Influences on Food Irradiation Attitudes

Table 7 summarizes research studies that involved label and positioning variables. From examination of these results, we see that consumers want irradiated food products labeled, that irradiation as a name for the product fares poorly relative to alternative names, that the symbol chosen for irradiation, i.e., Radura, did not do as well as others, and as indicated in an earlier section, that label statements which promoted specific aspects of irradiation did not produce increased willingness to purchase.

The one major study on mangoes, papayas, and lichee nuts by E. B. Harrison, 1987, did not inquire as to the value of labeling so we don't have any specific information with regard to the impact of such labeling on consumer interest in these products.

Table 7

Label and Positioning Results

Gallup Canada, 1984	6 labels presented; best: Ionized fresh poorest: Irradiated
	3 symbols
	Best: Sun Poorest: Radura
	80% wanted both label and symbol
Brand Group, 1986	72% want identification
	Of 10 position statements based on freshness without chemicals; increased availability; elimination of food poisoning. All produced 70% willingness to buy.
Wiese, 1984	6 labels presented
	Lowest concern for ionization and electromagnetic energy labels
	Highest concern for irradiation and transirradiation labels
	Concern reduced most by assurance no chemical residue and no radiation in food
Bruhn et al., 1986a	All felt product should be labeled Many felt irradiation name was fear arousing

<u>Marketing Efforts</u>

There have been three marketing efforts in the area of irradiated food, only one of which is truly a long-term marketing activity, whereas the other two would fall under the general description of marketing demonstrations. The true marketing study was in South Africa where potatoes, mangoes, papayas and

strawberries were marketed in Pretoria and Johanesburg with special promotional activity over an eight month period in 1978 (Webb, 1983, in Marketing and Consumer Acceptance of Irradiated Foods). In this study leaflets, TV, newspapers, radio and an in-store advice was utilized as well as eliciting the aid of consumer organizations. The Radura emblem was utilized in-store along with other labeling. It was reported that there was 90% consumer acceptance as well as general retailer satisfaction. This study demonstrated clearly that a major promotion and advertising effort involving many aspects of the community, including the media can produce a successful result in the marketing of an irradiated product. Certainly it is difficult to generalize from the South African market to the United States market since the nature of the product that was previously available before irradiation might not be as high a quality as was available in this country, as well as the fact that the organized opposition to irradiation apparently did not exist to the same degree as in the United States.

In the United States in 1986 the Lorenzo market in Florida sold Puerto Rican mangoes for a short while that were irradiated in the United States. This study was never reported in the professional literature but newspaper reports indicated that it was a highly successful operation. However the nature of the study and the length of time that it was available would not allow generalizability to the success of such an effort on a long-term basis or in other areas of the country.

In Southern California in 1987 a much more carefully conducted study of the marketing of papaya was conducted in two Orange county, upper middle-class supermarkets. Here both double dip papaya as well as irradiated product from Hawaii (irradiated in the U.S.) was marketed with in-store promotion, which included taste tests with volunteer consumers (Bruhn and Noell, 1987). Significantly more of the irradia ed papaya was sold compared to the double dip papaya and consumers who voluntarily tasted the product preferred it for appearance and taste over the double dip product. Willingness to make future purchase was also at a quite high level. There was a definite indication of the lack of awareness of the details of how papaya are treated. When considering the generalizability of this marketing demonstration, it should be remembered that this was a Southern California upscale market where papaya is a more commonly purchased product, that the responses were obtained from volunteers, and therefore do not represent a generalizable sample to the population, and that the appearance of the double dip product was not as good as for the irradiated product even though an attempt was made to have equality in appearance.

Although this particular study was a demonstration and had some of the qualifying considerations mentioned above, it represents support that papaya and other tropical fruit products would not be automatically rejected, at least by portions of the consuming population.

Overcoming Barriers to the Marketing of Tropical Produce

It is clear from the evaluation of the material presented in the previous sections that the successful marketing of tropical produce is dependent on a many faceted set of activities. Naturally the product must be produced, and in doing that, the problems of consumer resistance to siting of radiation facilities must be overcome. The level of awareness and concern about irradiated products including produce leads one to the conclusion that a major effort must be undertaken to educate consumers as to the advantages of irradiated food products as well as to dispel inappropriate beliefs about the

safety of its production and the product itself. This type of education must take place not only through government information and reassurance from government regulatory agencies, but also through the more standard use of the media, radio and TV.

It is also essential that a product that is marketed as irradiated must be of the highest quality possible so that the consumer does not attribute poor quality due to other factors to the irradiation process itself. Extra care must be taken at every stage of the production and distribution of an irradiated product to insure that when it reaches the consumer, it is of the highest quality.

In addition, the research on the retail trade would lead one to the obvious conclusion that they will as well require a major education effort. Materials must be developed, workshops organized, which present the irradiation story in as clear cut and meaningful fashion to their interests.

Where possible we believe that sharing plans and information with groups of consumers that are organized opponents to irradiation is a wiser choice than trying to go around them thus giving the impression that their interests are without any value whatsoever. Consumer groups which have not taken strong anti-irradiation positions should become a part of an informed group that can act as a counterweight to the less amenable anti-irradiation organizations.

As with all consumer food products, it is not necessary for success to mean that all consumers are purchasers of an item. Many food products have been quite successful appealing to a small accepting segment of the population that is quite loyal and willing to pay an appropriate price for the product. It seems that in the case of tropical fruits such as mangoes and papayas that those people who are present purchasers of such products if offered the alternative between no product and an irradiated product, would probably result in 70-80% willingness to purchase an irradiated product. This naturally assumes the appropriate education and information activities mentioned earlier are undertaken. If there were an alternative tropical produce product available that did not involve irradiation, I believe the degree of share of market for the irradiated product would drop significantly (to 50 to 70%) even though there might be an obvious appearance difference between the two types of treated products. This would be an estimate of the initial reaction which could change over time. I believe there could be a definite diffusion of this type of innovation over time as individuals who use the product make their satisfaction known to their friends and to the retailers. In fact, the success of the irradiated tropical produce could lead to greater consumer acceptance of other irradiated food products such as other produce as well as pork and chicken and seafood products.

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APPENDIX J

ALTERNATIVE METHODS DESCRIPTIVE INFORMATION

APPENDIX J
RELEVANT REGULATIONS AND GOVERNMENT DOCUMENTS

Following is some miscellaneous information regarding some alternative treatment technologies.

LAWRENCE LIVERMORE LABORATORY

January 25, 1988

Mr. T. Yoshihara
Energy Program Administrator
335 Merchant St., Room 108
Honolulu, Hawaii 96813

Dear Mr. Yoshihara:

Enclosed please find a copy of the economic analysis study comparing machine and isotope sources of radiation for food processing.

A very preliminary calculation indicates that the papaya industry will require a 5 MeV electron accelerator with an average beam power of approximately 40-50 kilowatts to produce the equivalent processing throughput of 250 kCi cobalt-60. I do not know where one might purchase such an accelerator.

This laboratory has agreed to provide accelerator parts and technical assistance to the University of California at Davis in conjunction with their National Science Foundation proposal to build a high intensity x-ray food irradiation facility. The machine that would result from this assistance would be a 5 MeV electron accelerator with an average beam power of 125 kW, and an upgrade capacity to 250 kW. The accelerator would be a duplicate of existing hardware at this laboratory. The cost of the accelerator would be $5 million and would include neither the 1 MW power substation nor the building to house the hardware.

Unfortunately, the machine design is not cost effective at lower power. A 50 kW design to match the papaya industry requirements would not be less expensive than the Davis machine. It is possible that these accelerators will be significantly less costly if manufactured in quantity.

Based on these facts I would advise the papaya industry to go ahead with a cobalt source initially, but design the facility to be convertible to an x-ray source in the future.

Sincerely,

Stephen M. Matthews
Senior Physicist

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT
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00941

March 23, 1988

The Honorable Andrew Levin
House of Representatives
The Fourteenth Legislature
State Capitol, Room 432
Honolulu, Hawaii 96813

Dear Representative Levin:

Subject: Use of Linear Accelerator Technology for the Hawaii Commodities Irradiator

Thank for your letter of March 10, 1988 suggesting that the State consider developing the Hawaii irradiator utilizing a machine generated source.

The Department of Business and Economic Development has looked very seriously at employing machine technology given concerns that have been expressed over the use of an isotope source. Based on our findings to date, we still believe that it is more desirable to pursue the construction of an irradiator with a cobalt-60 source for the following reasons:

1. An irradiation facility with a machine source would cost on the order of $2 million to $3 million more than a comparable isotope facility. Also because of the high power costs required for a machine, the operating cost will be more.

2. With the exception of one company in France, there are no commercially available machine sources suitable for the Hawaii application. Thus a prototype would have to be developed, requiring considerable investment in time and dollars. We estimate that prototype development and testing would delay any commercial scale demonstration program by one to two ye s. By comparison, an isotope irradiator is a mature technol y that can be operated in the demonstration mode immediately upon construction. Because the commercial scale demonstration of irradiation treatment of papaya is a significant and urgent goal of Hawaii, any such delay is undesirable.

3. The complexity of a linear accelerator mandates that a qualified service technician be available for servicing and repairs. Because there is a scarcity of these machine irradiators, obtaining timely and competent repair and servicing support would be difficult.

4. The linear accelerator designs for the University of California and Florida will differ from the design for Hawaii, depending on the specific application, so there may not be a significant potential cost savings.

The Department is also aware that there is serious private interest in constructing, operating, and investing in an isotope irradiator in Hawaii, principally because of the availability of a primary commodity, papaya, that is in need of a superior long-term treatment method. There may not be this interest if we were to switch to the higher cost machine concept.

Therefore, while the idea of joining with the University of California, Davis, and other states to save money in a joint purchase agreement for a linear accelerator is meritorious, we believe that Hawaii's best interest would be served by continuing to pursue the proven alternative of an isotope irradiator.

Very truly yours,

Roger A. Ulveling

RAU/MHK:go

Lawrence Livermore National Laboratory

April 7, 1988

Gerald O. Lesperance
Department of Business
and Economic Development
335 Merchant St., Room 110
P.O. Box 2359
Honolulu, Hawaii 96804

Dear Gerald,

Enclosed please find copies of the viewgraphs that I presented during our meeting at the state Capitol on March 30. I have also enclosed two additional articles for your information. One of these is a set of unpublished notes that I wrote several years ago comparing isotope and electric sources for food irradiation. The other is an economic analysis comparing isotope and electric food processing facilities. This analysis was presented at the 5th International Meeting on Radiation Processing held in San Diego in October 1984 and may prove useful regarding your design of a facility that could accept either an isotope or electric source.

The economic analysis assumes that a 1 MW, 5 MeV electron accelerator is available for $900,000. Unfortunately, no such machine is available at that price today. The 5 MeV accelerators that are presently commercially available cost about $3 million and provide considerably less power. The ETA-II accelerator at this laboratory could be upgraded to the 1 MW power level however it is not a commercial machine. This accelerator would cost $5-6 million to replicate in spite of the fact that it has many advanced features that are unnecessary for food irradiation. A downgraded, commercial variant of this technology is expected to be significantly less expensive.

I am intrigued by the challenge of producing a facility design that could accept either a cobalt or electric source and I have given the idea a little thought. The conveyor system and radiation shielding for an electric source need not be as complex as with an isotope source because the x-rays are not scattered isotropically. Therefore, I believe that a common facility design should certainly be possible. The big question is whether it can be done economically. The specifics of any particular design would be dependent upon the accelerator geometry and the x-ray convertor. The first task would be to produce conceptual facility layouts assuming the use of specific machine sources.

Please keep in touch because I am interested in watching this problem unfold. If there is anything further that I can do for you please don't hesitate to ask.

Sincerely,

Steve

Stephen H. Matthews
Senior Physicist

HIGH-TEMPERATURE FORCED-AIR QUARANTINE TREATMENT FOR PAPAYA

A Report to the Hawaii State Legislature
House and Senate Economic Development Committees'
Joint Hearing on the Issue of Food Irradiation

Submitted by:

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Tropical Fruit and Vegetable Research Laboratory
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FOR INFORMATION ONLY:

This report is submitted to the Hawaii State Legislature House and Senate Economic Development Committees' joint hearing on the issue of food irradiation, held on February 3, 1988. It was prepared at the request of the Honorable Andrew Levin, State Representative, First District of Hawaii. The purpose of this report is to inform the House and Senate Economic Development Committees about the recently developed high-temperature forced-air quarantine treatment for Hawaii-grown papaya. This laboratory represents the USDA-ARS and it is neither a proponent nor an opponent of food irradiation.

BACKGROUND:

Before shipment to the mainland United States, papayas grown in Hawaii require a postharvest quarantine treatment for disinfestation of Mediterranean fruit fly, melon fly and oriental fruit fly. In September, 1984, the Environmental Protection Agency discontinued the registration for the use of ethylene dibromide (EDB) for postharvest treatment in the U.S. Previously, the standard treatment consisted of a hot-water immersion for decay control, followed by fumigation with EDB. After the discontinuation of EDB fumigation for papayas, two high-temperature quarantine treatments were utilized to disinfest fruit flies from papayas. One was a vapor heat treatment utilizing forced high-temperature air saturated with water vapor. The other was a quarantine system using fruit selection based on ripeness to ensure that any infestation would consist only of fruit fly eggs, not fruit fly larvae; the selected fruit were processed through a two-stage hot-water immersion (hereafter referred to as the double-dip treatment). Both treatments raise the fruit temperature above the thermal deathpoint of the fruit flies. Both treatments, until early 1987 for the double-dip treatment, adequately disinfested papayas although both were capable of causing damage to the fruit. In early 1987, a blossom-end defect, possibly of genetic origin, was found occurring in papaya. This defect allowed fruit fly larvae to hatch and survive in papaya that was within the allowable color standard required by fruit selection for the double-dip treatment. Consequently, the double-dip quarantine system, which was designed to disinfest only fruit fly eggs from papaya, was breached in March, 1987, resulting in infested papayas being discovered in California. The immediate research, development and emplacement of a culling system to remove all blossom-end defective fruit from the packouts of packinghouses using the double-dip quarantine system maintained the integrity of that quarantine procedure and allowed the continued export of papaya to the mainland.

THE HIGH-TEMPERATURE FORCED-AIR QUARANTINE TREATMENT FOR PAPAYA:

In October, 1986, our laboratory initiated research to determine the cause of, and attempt to alleviate damage from the vapor heat treatment. Information from commodity treatment literature, USDA and University of Hawaii researchers, and personal communication from members of the papaya industry indicated that heating papaya with high-temperature air ("dry heat") prior to vapor heat treatment would "precondition" the fruit to the higher temperatures, thus avoiding damage. The original research goal was to determine the maximum temperature papaya would tolerate from dry heat before injury occurred, then to follow the dry-heat preconditioning with a vapor heat treatment. The results, contrary to previous assumptions, showed that papaya would tolerate temperatures sufficiently high to preclude the need for a vapor heat treatment, i.e., papaya could be heated beyond the thermal deathpoint of the fruit flies using dry heat alone. These research results were sufficiently unusual that we withheld the results from the papaya industry for nearly one year while we continued research toward the development of the high-temperature forced-air quarantine treatment (hereafter referred to as the dry-heat treatment).

In November, 1987, we informed the papaya industry about the dry-heat treatment. Since then, the research has been completed. All information and data showing that this treatment is an efficacious quarantine treatment was submitted to the USDA-ARS National Programs Staff (NPS) for evaluation and approval. Following NPS approval, the information and data was submitted to the USDA-Animal and Plant Health Inspection Service (APHIS) for final approval and development of regulatory protocols. At this date, NPS has informed us that final approval by APHIS is imminent.

The dry-heat treatment represents a major breakthrough in quarantine treatment technology. A USDA patent on the treatment is pending. Our data indicate that the dry-heat treatment is superior to both the double-dip and vapor heat treatments, and that it will allow the Hawaii papaya industry to market a better product. Fruit, up to one-half ripe, can be treated, which is much riper fruit than allowed for the double-dip treatment. Blossom-end defective fruits are not a problem because both egg and larval stages are killed by the dry-heat treatment. The dry-heat treatment does not damage the papaya as can both the double-dip and the vapor heat treatments. Because the dry-heat treatment is essentially a vapor heat treatment without the vapor, there is no reason for Japan not to follow the USDA-APHIS approval and accept the dry-heat treatment.

The dry-heat treatment offers this laboratory and its cooperators many new challenges starting immediately. Preliminary data from our tests and other information sources indicate that the dry-heat treatment for papaya, or modifications thereof, will be applicable to atemoya, avocado, some cultivars of beans, cucumber, litchi, longan, mango (including treatment for mango weevil), various cultivars of peppers, rambutan, tomato, zucchini and other squashes, and other fruits that will help to diversify and expand the agricultural export potential of Hawaii.

PART III
TRI-FLY CONTROL TACTICS AND ERADICATION PROGRAM FACTORS

PART III reviews presently available and potential tactics for suppression of one or more species of tri-flies in eradication programs. For each tactic, there is a review of the application, effectiveness, and field experience, and negative consequences and conflicts. (The negative consequences and conflicts are treated more thoroughly in PART VII.) In addition, PART III reviews those factors that may affect the formulation and execution of a tri-fly eradication effort in the Hawaiian Islands - including sequence and timing of tactics, sequence in which individual islands receive the eradication effort, and quarantine, education, and monitoring requirements.

A. Malathion Bait Sprays

J-5

a. Description and Application

Malathion bait sprays contain a combination of bait - protein hydrolysate, a feeding stimulant that furnishes nutrients necessary for sexual maturation (Hagen 1953) - and toxicant, malathion. When applied to tri-fly habitats, the bait sprays attract and destroy both males and females of all tri-fly species.

Malathion bait sprays are applied using either ground or aerial application techniques. Ground applications (made by backpack sprayers or mist blowers) use a mixture of one pound of malathion (50% WP), 2.5 gallons of protein hydrolysate (Staley's PIB-7 or Nu-lure), and approximately 25 gallons of water (depending on application equipment) per acre. The host plants and border vegetation (a minimum of 6,000 hosts or stations per square mile) that may be treated are fully wetted with the spray mixture (12-15 milliliters, or about 0.5 ounce, bait spray per host or station). The bait sprays are applied by powered or backpack sprayers or other hand-held equipment. Complete coverage is not required. Large bait spray droplets are more effective. Mist blowers may be used if the terrain permits. Treatments should be applied every 7-10 days until the tri-flies have been reduced to the desired level (USDA/APHIS Action Plan for oriental fruit fly).

The aerial application technique uses an aircraft to apply a bait spray - a mixture of 2.4 ounces of ULV malathion (91% technical material) and 9.6 ounces of Staley's PIB-7 protein hydrolysate for each designated acre (from USDA/APHIS Action Plans for melon fly and oriental fruit fly). Treatments should be made every 7-10 days until the desired results have been achieved.

The bait spray is applied in relatively large droplets (500-1,000 microns). The large droplets tend to adhere to the upper surfaces of the leaves at the top of the plants. It is not always desirable to cover entire islands or large geographic areas with aerial sprays. The aerial applications may be restricted to areas where fruit fly densities are high, such as concentrated agricultural areas where the host plants are plentiful, and/or areas inaccessible to ground applicators (R. Cunningham, personal communication 1983).

b. Effectiveness and Field Experience

Steiner (1952;1955;1957) conducted field tests, during the period 1950-55, to determine the effectiveness of various insecticides for control of the oriental fruit fly in mangoes, bananas, guavas, passion fruit, and papayas. Malathion bait sprays, applied at 0.5 - 1.0 pound of active ingredient per acre, reduced field populations 65-96%. The bait sprays have given comparable results when used against field populations of melon flies (Steiner 1954) and Mediterranean fruit flies in the 1980-82 California eradication program (Brazzel 1983).

Malathion bait sprays were used extensively in the successful California medfly eradication campaign in 1980-82. Aerial spraying was carried out during 13 of the 27 months of the program. The aerially treated area encompassed eight counties, 44 cities, and approximately 2 million homes. During peak spray periods, over 1,300 square miles were sprayed weekly by a fleet of twelve helicopters and eight fixed-wing aircraft (four DC-4's, and four PV-2's). The overall aerial operation (counting multiple applications) amounted to treatment to more than 10 million

From: Eradication of the Tri-fly Complex from the State of Hawaii DEIS, USDA 1985.

acres of land at a cost of more than $21 million. In addition, counting multiple applications, there were more than 0.5 million ground applications of malathion bait sprays (CDFA/CDF 1982).

c. <u>Negative Consequences and Conflicts</u>

There are potential adverse impacts associated with malathion bait sprays applied over large geographic areas, including:

* contamination of aquatic systems (natural and artificial), directly from application or indirectly from leaching and runoff,
* deposition of residues in soil or foliage,
* damage to automobile surfaces,
* atmospheric contamination,
* hazard to applicators, field workers, and others who may be exposed to the sprays,
* destruction of parasites, predators, pollinators, threatened and endangered endemic species, and other nontarget organisms,
* ecological upsets and secondary pest outbreaks, and
* development of insecticide resistance in the target fruit fly populations.

PART VII reviews these impacts and also the measures for mitigating them.

Further, conflicts with federal, state, and local objectives may arise over the use of malathion in the Hawaiian Islands, especially in situations involving spraying in protected habitat areas. Part VII discusses these potential conflicts.

B. Male Annihilation Technique

a. <u>Description and Application</u>

The male annihilation technique combines a synthetic lure, primarily attractive to male fruit flies, with either a toxicant (usually naled or malathion) or a nonpesticidal sticky surface. This tactic reduces the population directly by killing flies attracted to the lure. In addition, as the male population decreases, virgin female flies are less apt to find mates; overall reproduction in the wild population declines proportionally.

The lure and toxicant can be combined in a number of different formulations and on different carriers. They can be mixed with a thixotropic gel for aerial application or ground application to tree trunks, fences, utility poles, etc., or they can be impregnated into solid carriers such as cigarette filter tips, dental wicks, or fiberboard (canec blocks) for either ground or aerial application. The synthetic lure is methyl eugenol for oriental fruit fly, cuelure for melon fly, and trimedlure for Mediterranean fruit fly.

Some specific male annihilation methods include:

<u>Oriental Fruit Fly</u> (USDA/APHIS oriental fruit fly Action Plan)

1. <u>Spot treatment.</u> 10% by weight of Dibrom 14 (Dibrom is a trade name for naled) combined with 23% Minu-gel 400 and 67% methyl eugenol and applied every 2 weeks to tree trunks, fences, utility poles, etc. (out of the reach of children) at the rate of 3-5 milliliters per station with 600 stations per square mile.

2. <u>Filter tips.</u> 2 grams of technical grade malathion (91%) and 6 grams of methyl eugenol per transport filter applied by aerial drop at 600 filters per square

mile.

3. Traps. Jackson traps with dental wicks baited with methyl eugenol and 1% Dibrom at 6 milliliters per trap and changed every 8 weeks depending upon lure evaporation under existing weather conditions.

Koyama et al. 1984 used the following technique recently in a successful eradication effort against oriental fruit fly in Okinawa:

Ground Treatment. From 3.5 to 5% by weight of naled and 67-80% methyl eugenol, plus solvent, are applied in 10 gram doses to fiberboard squares measuring 4.5 centimeters x 4.5 centimeters x 0.9 centimeters. The squares are hung from tree trunks, fences, utility poles, etc. - out of the reach of children - in urban and residential areas at the rate of 600 stations per square mile, up to a total dose of 5,200 grams of formulation per square mile. The squares are replaced monthly for 6 months.

Aerial Application. Fiberboard squares at the same dose and rate as above are applied by aircraft in forested and cultivated areas.

Mediterranean Fruit Fly

To date, male annihilation has not been effectively utilized against the medfly. However, in monitoring a medfly eradication program, the standard procedure is to use a Jackson trap contai ing a 0.75 x 1.5 inch dental roll baited with 2 milliliters of trimedlure. No toxicant is used; the flies are captured on the sticky surface of the trap. In Hawaii, some formulations of trimedlure are effective for up to 3 months (Nakagawa et al. 1981).

Melon Fly (USDA/APHIS melon fly Action Plan)

The male annihilation technique against the melon fly has

not been demonstrated on a large scale.

1. Spot treatment. 30% Dibrom 14 combined with 23% Minu-gel and 47% cuelure applied as for oriental fruit fly but at 3-5 milliliters per station, 6,000 stations per square mile and applied every 1-2 weeks.

2. Cordelitos (dental wicks). 0.6 gram of naled and 2 grams of cuelure per 30 millimeters of 6-ply cotton dental wicks placed on vegetation.

3. Bait traps. Jackson traps initially baited with 6 milliliters of cuelure and Dibrom 14 (1% by volume) in dental wicks (0.75 x 1.5 inch) and serviced every 16 weeks, depending upon lure evaporation under existing weather conditions.

b. Effectiveness and Field Experience

Malathion can be satisfactorily substituted for naled in any of the above listed methods. However, malathion's killing action is slower than naled's (R. Cunningham, personal communication 1983).

For both medfly and melon fly, male annihilation must be considered an unproven method of control. However, limited field experiments have been conducted, and some spot treatments were used in medfly eradication programs in California and Florida. The technique, using cuelure as an attractant, is currently being tested against melon fly in large-scale field trials in Rota (T. Wong, personal communications).

The effectiveness of the male annihilation technique against oriental fruit fly was clearly demonstrated in eradication programs in the Amami Islands, Japan in 1979 (Ushio et al. 1982), Mariana Islands in 1964 (Steiner et al. 1965a and 1970), and Okinawa in 1983 (Koyama et al. 1984). Incipient infestations in the U.S. mainland were eradicated with the male annihilation tactic several times, including a 1976-1977 infestation in the Los Angeles, California area

(Appendix C).

c. Negative Consequences and Conflicts.

The report of APHIS (Ketron) 1980b discussed concerns over the male annihilation technique's direct and indirect effects, including effects on insect pollinators and the plants pollinated by these insects; insects that are components in the diet of certain nestling and fledgling birds; and the birds themselves. A review of the overall negative consequences associated with naled and measures for mitigating them appears in PART VII.

C. Sterile Insect Release Method

a. Description and Application

SIRM, or the sterile insect release method, consists of rearing and then sterilizing large numbers of fruit flies with gamma rays (10-18 Krad, depending on the species) from a cobalt-60 or other irradiation source in a nitrogen atmosphere (Ohinata et al. 1978). The sterile flies are released into infested areas where they will mate with wild flies. No offspring will result from these matings.

If the infested area is flooded with large numbers of sterile flies, the likelihood of a fertile mating is greatly reduced. Consequently, the pest population should rapidly decline and, as it does, the relative effect of each new release of sterile flies will be progressively greater. If the sterile flies are released often enough, the wild population will ultimately fall to such a low level that it does not recover (Knipling 1979).

Release of the sterile flies can be facilitated in a number of ways. The static release involves use of buckets containing pupae placed at specific sites in the release area; adult flies emerging from the pupal cases escape from exit holes in the buckets' lids. Alternatively, adults three days old can be liberated from a motor vehicle

driven through the release area (roving release) or from aircraft (aerial release) (APHIS/CDFA 1981).

b. Effectiveness and Field Experience

Several factors affect the success of any SIRM program aimed at wild populations (Flint and van den Bosch 1981): (1) females should mate only a few times, (2) the release site must be isolated sufficiently to prevent immigration of pests from untreated areas into treated areas, (3) there must be a practical system for mass rearing and sterilizing the insects, (4) the sterilized males must be sexually competitive with wild males (Knipling 1979), and (5) the sterilized insects released into the wild must greatly outnumber the naturally occurring ones.

SIRM is most useful against low level populations of the pest where high overflooding ratios are easier to sustain. For this reason, unless the fruit fly populations are naturally low, SIRM is generally used in combination with one or more of the other pest control tactics which first reduce the wild population to a manageable level. This level will vary depending on the number of sterile flies that can be successfully reared, their competitiveness, the degree of site isolation, and the rate of increase in wild fly populations. These factors will determine how long it will take to eradicate a fly pest species from a particular area (Knipling 1979).

SIRM has been used many times in programs aimed at eradicating or suppressing one or more of the tri-fly species. The melon fly was successfully eradicated from the island of Rota (33 square miles) in the Mariana Islands in 1962-63 (Steiner et al. 1965b) following the release of approximately 257 million sterile flies (up to 11 million weekly). Release of the sterile insects was preceded by ground applications of malathion bait sprays. Melon fly was suppressed on Kudack Island with SIRM (Iwahashi 1976).

An attempt to eradicate the oriental fruit fly from Rota (1960-62) using SIRM alone was unsuccessful because too few flies were released. Eradication of oriental fruit flies with SIRM was also unsuccessful on Saipan, Tinian, and Agiguan during 1964, despite the sustained release of 2.5-4.0 million sterile flies per week in Saipan and 1 million sterile flies per week in Tinian and Agiguan, over a period of one year. However, the oriental fruit fly was eventually eradicated from these islands using a multitactical eradication program (Steiner et al. 1970; APHIS (Ketron) 1980a).

A number of programs involving the use of SIRM have been aimed at the medfly. A pilot test begun in 1959 in an isolated 12 square mile area in Hawaii (altitude 3,900-6,000 feet) involved the release of 18.7 million sterile flies; by June 1960, the field populations had been reduced by about 90% (Steiner et al. 1962). However, medflies from nearby untreated (windward) areas invaded the treated area, and the populations in the treated area quickly returned to previous levels.

An attempt in 1967 to eradicate the medfly from a 120 square kilometer area of Nicaragua (Rhode et al. 1971) failed, probably because of lack of knowledge of the basic population ecology of the flies, high fly densities, lack of isolation, and the short life span of the sterile flies. Following this, eradication was attempted in a smaller area (48 square kilometers), planted in coffee and citrus. This program integrated aerial bait spraying (applied as a border treatment two kilometers wide) and SIRM; 40 million sterile flies were released aerially each week. The combined treatments reduced the viable medfly eggs and larval infestation by 90%. A program in Tunisia in 1971-72 failed to eradicate the medfly from 600 hectares near Porto-Farina, probably because of inadequate isolation and poor sterile fly distribution (Cheikh et al. 1975). Successful eradication of medfly using SIRM in Los Angeles in 1975 was reported by Cunningham et al. (1980).

SIRM was one method in the successful multitactical California medfly eradication program in 1980-82; over 4 billion sterile medflies were released during the period July 11, 1980 to July 6, 1981.

Sterile fly requirements for tri-fly eradication in the Hawaiian Islands would depend on a number of factors: (1) whether eradication is attempted on all islands simultaneously or sequentially across islands, (2) sequence in which the islands are approached, (3) whether eradication is attempted separately for each of the three fly species or simultaneously, (4) competitiveness of sterile insects, and (5) success of other control tactics that precede deployment of SIRM.

In a tri-fly eradication program in Hawaii, the sterile insect release method would be used primarily against the medfly. According to the Agricultural Research Service of USDA, the rearing facility at Metapa, Chiapas, Mexico has the capability of rearing 250-650 (average = 460) million sterile medflies weekly (L. Williamson, personal communication 1983). It is unclear whether the rearing facility being built on Oahu can meet requirements of a SIRM program aimed exclusively at the Mediterranean fruit fly. The Environmental Assessment for the rearing facility (1983) mentions a standby capacity of 100 million fly pupae per week, but gives no figures for expanded operations. Also, the facility will not be able to produce sterile flies for concurrent programs against the oriental fruit fly and/or melon fly.

c. Negative Consequences and Conflicts

SIRM is species specific, acting only against the target pest at which it is directed (Knipling 1979). It therefore offers an ideal means for achieving ecological selectivity in a control tactic. Yet, there are potentially adverse impacts connected with use of SIRM in the Hawaiian Islands. These and measures for mitigating them are discussed in PART VII.

D. Chemical Soil Treatments

a. Description and Application

Chemical soil treatment is a supplemental measure that involves treatment of the soil around tri-fly host plants with an approved insecticide. The insecticide kills fruit fly larvae (as they crawl on the soil surface or burrow in the soil to pupate) and adults emerging from the soil after pupation. The insecticide of choice is Diazinon AG-4, mixed at 3.54 ounces per 20 gallons of water and applied out to the dripline of the plant until the ground is wet. The treatments are applied at 14-day intervals (USDA/APHIS melon fly Action Plan).

b. Effectiveness and Field Experience

Laboratory and field trials in Kula, Hawaii evaluated a number of soil chemical treatments against the Mediterranean fruit fly. When tested in a peach orchard, Diazinon reduced the populations from 90 to 99%, depending on the dose and timing (Saul et al. 1983).

Soil treatments were used during the 1980-82 medfly eradication program in California. Fenthion was used initially, then replaced by Diazinon. In 1981, counting the multiple treatments, a total of 69,109 applications of Diazinon were made. More than 22 thousand properties were treated three times (CDFA/CDF 1982).

c. Negative Consequences and Conflicts

Diazinon is an organophosphorus insecticide of intermediate toxicity to humans and warm-blooded animals. It may be absorbed through the skin as well as by the respiratory and gastrointestinal routes. Chronic poisoning does not occur; after absorption and metabolism of nontoxic doses, the cholinesterase level returns to normal (APHIS/CDFA, Addendum 1981).

As a broad spectrum organophosphate, Diazinon may affect nontarget organisms, including beneficial insects, spiders, and related arthropods. Although specific tests of the toxicity of Diazinon to endemic snails have not been

performed, Diazinon exhibited low toxicity to the giant African snail (family Achatinidae) (Olson 1973).

A more complete review of potentially negative consequences and conflicts and measures for mitigating them appears in PART VII.

E. General Suppressive Measures

The key control tactics were just reviewed, but the following general suppressive measures may be important in a tri-fly eradication program:

a. Fruit Picking or Stripping

Hand picking or stripping (or removal using commercial hormonal treatments) and destruction of tri-fly infested fruit from trees can reduce tri-fly populations. These measures are especially important during quarantine periods when spot infestations are detected. One way to use these measures in quarantine areas is to strip and dispose of host fruit within 200 meters of a confirmed infestation of tri-fly larvae (USDA/APHIS oriental fruit fly Action Plan).

b. Cultural Controls

A number of cultural controls are effective against fruit flies. For example, when melon fly infested fruit is left in the field, populations can develop quickly. Careful harvesting, combined with destruction of infested and unmarketable crops, effectively limits this development (Nishida and Bess 1957). Field sanitation (destruction of postharvest fruit residues, destruction of injured fruits, etc.) can have a strong suppressive effect on the medfly. Removal of Kona coffee beans that remain on the plants in January and February, after the principal harvest period in November, will help prevent medfly population increase (C.J. Davis, personal communication 1983).

Commercial growers and home gardeners may use additional cultural practices to reduce the fruit fly populations:

* scheduling plantings of short season fruit and vegetable crops, when possible, such that ripening of the fruit does not coincide with peak fruit fly activity,
* harvesting the fruit before it reaches a stage of ripeness highly susceptible to fruit fly attack as now commonly practiced by commercial banana, papaya, and avocado growers,
* using insecticide treated trap crops - corn, for example, around melon or squash fields (the corn plants attract large numbers of melon flies; treatment of the corn "trap" plants kills those flies), and
* selecting, when available, crop varieties that are partially resistant to the tri-fly species.

c. Host elimination

Host elimination involves destruction of wild guava and other wild hosts (not cultivated plants) of the tri-flies. The technique is not used in the State of Hawaii because of the difficulty in accessing and removing the wild hosts which are often in rugged terrain (Takara et al. 1983).

The main wild hosts of oriental fruit fly are common guava (Psidium guajava L.) and strawberry guava (P. cattleianum Sabine). Large populations of guava can be found in gulches and other uncultivated lands in areas of high rainfall (e.g., Hamakua coast of Hawaii, Hana coast of Maui, and windward Oahu). Individual trees and small stands occur from sea level up to 1,100 meters or more in some localities, but not in nonirrigated dry habitats. The main wild host of the medfly is feral coffee (Coffea arabica L.). In Kauai, feral coffee is widely scattered under the forest canopy (Takara et al. 1983). Medfly also commonly attacks guava. The melon fly's primary wild host is bittermelon (Momordica balsamina L.) that occurs in the lowlands (Takara

and Harris, unpublished).

F. Potential Tactics

In addition, there are a number of control tactics that have shown promise against one or more of the tri-fly species in experimental studies or in limited field trials. Although promising, none of the following is presently ready for adoption in operational eradication programs.

a. Genetic Manipulation

Like the sterile insect release method, genetic manipulation involves release of reared insects for mating with wild populations. However, whereas sterile males produce inactive or nonviable sperm, genetic manipulation involves genetically altered insects whose sperm is active, carrying genes that make the wild populations less vigorous, less prolific, or genetically sterile as a consequence of hybridization. Genetic research on tri-flies has centered on sex ratio distortions, translocation homozygotes, conditional lethal genes, and isochromosomes. None has yet reached the stage of practical implementation, and most are in an early stage of research.

b. Control by Natural Enemies

A variety of predators and parasites operate against the tri-flies. These "biological control" agents may be important natural constraints of the pests.

Parasite-inflicted mortality is thought to be the most important form of naturally occurring biological control affecting the tri-fly species. A complex of parasites attacks eggs, larvae, and pupae of the tri-flies. One parasite especially, a braconid (wasp), Biosteres oophilus, has been responsible for a large portion of the parasitism (65-70%) recorded in populations of the oriental fruit fly in the Hawaiian Islands (Haramoto and Bess 1970).

Naturally occurring parasitism in the various tri-flies is usually fairly high. Overall parasitism of immature forms of the medfly collected from all hosts at Kula was 40%; the rate was highest in peaches (60%). Of all parasites recovered from the medfly, 80% were Biosteres oophilus (Wong et al. 1984).

Nishida (1955) found that predaceous spiders, ants, and reduviid bugs had only minor effects on the melon fly. But the real value of these or other predators in controlling the melon fly or the other tri-fly species has not been determined for a large variety of ecological situations.

Insect-specific parasitic nematodes (roundworms) applied to the soil in tri-fly habitats, infect and kill tri-fly larvae, and to a lesser degree pupae. Preliminary test results indicate that the nematodes may be most effective against the medfly (J. Lindegren, personal communication 1983). There is no evidence of adverse effects of parasitic nematodes on native soil inhabitants.

The models of Knipling (1979) suggest that inundative releases of parasites, involving the colonization and liberation of large numbers of these beneficial organisms against the pest populations, may have promise. Parasites would be mass reared and released when host populations were declining, usually in the latter part of the year. As yet, the technology for mass rearing of the tri-fly parasites has not been perfected, and the inundative release method has not been tested in the field.

G. Eradication Program Factors

a. Sequence and Timing of Tactics

Choice of sequence in application of the control tactics against the individual fly species, as well as the tri-fly complex as a whole, must be carefully considered.

The sterile insect release method is most useful against low level populations whereas insecticidal treatments are effective at all density levels (Knipling 1979). If the pest populations occur naturally at high levels, or if the rearing capacity for sterile insects is insufficient to achieve the desired 100 to 1 overflooding ratio of sterile: wild flies (USDA/APHIS Mediterranean fruit fly Action Plan), then the populations must be reduced by applying malathion bait sprays, or by other means, before SIRM can be employed with confidence of success. If the populations occur naturally at sufficiently low levels, or if application of the SIRM coincides with the season when the infestation is low, SIRM alone may eradicate the flies.

Whether eradication is attempted simultaneously for all three fruit fly species or sequentially for individual species is another consideration. And if eradication is conducted sequentially, which species should be attacked first?

It is generally agreed that the oriental fruit fly has replaced the medfly in many areas in Hawaii. If the oriental fruit fly were eradicated and the medfly remained, would the latter species reinvade its old territories? Some researchers believe that it would (Keiser et al. 1974).

b. Island-by-Island Sequence

Success in achieving tri-fly eradication in the Hawaiian Islands may be affected by the sequence in which the islands receive the eradication effort. Choice of island sequence would be affected by the following:

1. Area and diversity of tri-fly habitats. Hawaii is the largest island in the State of Hawaii (4,038 square miles) and has the most agricultural land. Tri-fly infestations are heaviest on the island of Hawaii because of the abundance of favorable host material. Most tri-fly control experts agree that achievement of eradication would be more difficult on Hawaii than on any

of the other islands because of its large size, intensive agriculture, and mountainous and rugged terrain. These factors must be carefully considered when choosing a sequence for launching eradication efforts across the islands.

2. Influence of prevailing wind. Wind can blow fruit flies from infested areas into areas where eradication has been achieved, complicating eradication efforts. The prevailing wind in the State of Hawaii is the northeast trade wind, but in the winter months (October to April) a strong southwesterly wind (kona) often brings rain, and may bring hurricanes (see page 102). Based on general wind patterns, the following island groupings can be considered fairly distinct, with sufficient distance between units to reduce, to some degree, the threat of wind transport: (1) Kauai and Niihau, (2) Oahu, (3) the Maui County Islands of Maui, Lanai, and Kahoolawe, (4) the Maui County Island of Molokai, and (5) Hawaii.

3. Distribution of endangered or threatened endemic species. Section 7 of the Endangered Species Act, as amended ("Act"; 16 U.S.C. 1536), requires every federal agency to insure that its programs do not jeopardize the continued existence of species listed under the Act as threatened or endangered or destroy or adversely modify critical habitat utilized by the species. To determine an eradication program's impact on endangered or threatened endemic species or, for that matter, any endemic species, detailed information must be available on their distribution and abundance in the particular ecosystems involved. With the completion of the Kauai Fruit Fly and Endemic Insect Survey (Takara et al. 1983), more is known about the distribution of endemic insects, in relation to the tri-fly complex, on Kauai than on any of the islands. The Endangered Species Office of the Fish and Wildlife Service has conducted surveys of flora and fauna on the islands of Hawaii, Lanai, Molokai, and Maui. However, faunal surveys have been limited to birds (Hawaii Audubon Society, scoping comments). The International Biome Program has sponsored limited additional surveys of flora and fauna on the island of Hawaii (Mueller-Dombois et al. 1981).

Appendix D lists the names and ranges of endangered and threatened species that occur in the Hawaiian Islands.

4. Distribution and abundance of each tri-fly species. The spatial distribution and population level of individual species of tri-flies must be determined by monitoring before any eradication effort proceeds. Monitoring information must dictate when and what kind of control action will be required.

The most detailed information available on the distribution and abundance of the tri-fly species is from the Island of Kauai (Takara et al. 1983). This information is not complete, however, and does not eliminate the need for monitoring.

5. Potential and limitation of control tactics. Not all of the available control tactics can be expected to give equal control of all three species of fruit flies. The male annihilation technique, for example, has been effective against the oriental fruit fly when applied on a large scale but is unproven in large scale programs against the melon fly or medfly. For each island, the effectiveness of the available control tactics must be carefully considered, and the potential of each tactic must be weighed carefully against its known limitations.

6. Interisland quarantines. The choice of island sequence will influence quarantine requirements. In 1982, over $104 million worth of commodities subject to quarantines were produced in the State of Hawaii. The Island of Hawaii produced 63% of these commodities (Statistics of Hawaiian Agriculture for 1982). Therefore, elimination of the tri-flies from this island at an early stage in a state-wide eradication effort would minimize the extent, inconvenience, and cost of interisland quarantines. Since most commodity movement is directed into Oahu, it would be most efficient to place this island last in the sequence in a state-wide island-by-island eradication effort. Interisland

quarantines would be necessary to prevent re-introductions of tri-flies into fly-free islands.

7. Sociological, economic, and political factors. There are sociological, economic, and political factors - some island specific, others applying to all the islands - that must be considered when choosing the island sequence of eradication. Ethnic background of an island's inhabitants (the plant composition of home gardens is often influenced by ethnic background, as is the likelihood of transporting certain tri-fly host fruits and vegetables), human population density, land use patterns (agricultural, recreational, natural, commercial, or residential), etc., may affect choice of island sequence.

Complete elimination of the tri-fly complex from the Hawaiian Islands would take at least 6 years. Many island sequences have been advocated. The following two sequences have received the greatest support:

Sequence Option One

This island sequence would be: (1) Kauai/Niihau, (2) Hawaii, (3) the Maui County Islands of Maui, Lanai, and Kahoolawe, (4) the Maui County Island of Molokai, and (5) Oahu. The estimated time apportionment for the five sequence elements in a 6-year eradication effort is shown at the top of Figure III-1.

Sequence Option Two

This island sequence would be: (1) Hawaii, (2) the Maui County Islands of Maui, Lanai, and Kahoolawe, (3) the Maui County Island of Molokai, (4) Kauai/Niihau, and (5) Oahu. The time apportionment for the five sequence elements is shown at the bottom of Figure III-1.

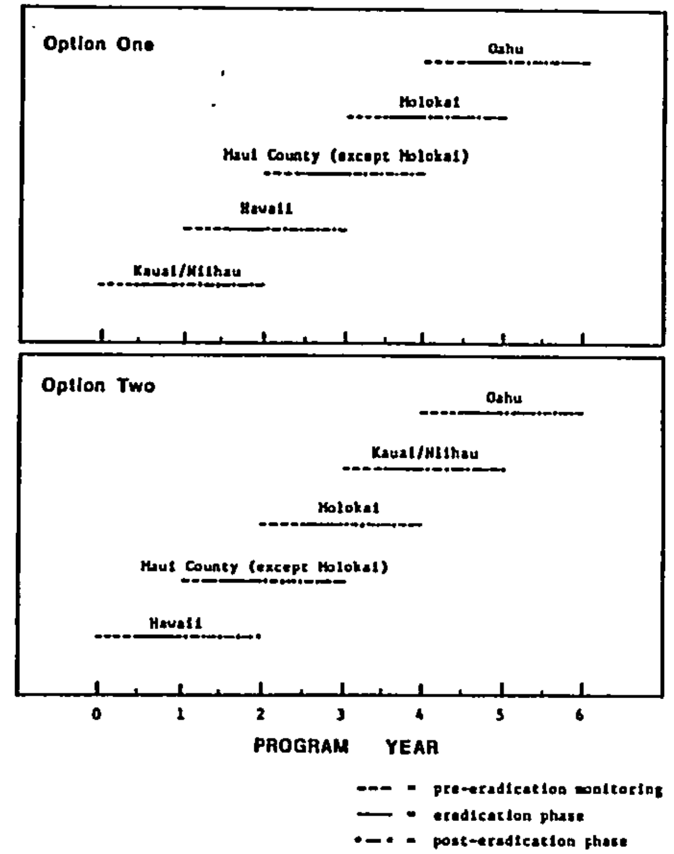

Figure III-1. Island Sequence Options.

For both options, Oahu would be last in the sequence because it is the destination of essentially all agricultural imports into the state and the recipient of the majority of interisland shipments. It is also the site of the new sterile insect mass rearing laboratory which would localize any accidental releases until the final stages of the program.

As noted on page 39, there is a potential problem of tri-flies blowing from infested areas into areas where eradication has already been achieved. This potential is especially high in Maui County where flies from Molokai could be blown to Maui, Maui to Lanai, and Lanai to Molokai. Only through careful monitoring can this problem be diagnosed.

c. Quarantines to Protect Clean Areas

Quarantine programs prevent the movement of a pest species from regulated areas, and are the first line of defense in pest control (Knipling 1979). Enforcement of quarantine regulations at airports and seaports is essential in an eradication effort. New introductions must be detected and treated immediately. The quarantine enforcement must continue indefinitely.

Two kinds of inspections may be used in an interisland quarantine program: postentry and predeparture. Under a postentry quarantine program, outbound material is not inspected, but all material entering a pest-free island is inspected. Under a predeparture quarantine program, outward bound material going from an infested island to a pest-free area is inspected. Airline passengers are generally more willing to accept inspection delays before departure than they are after landing. Tourism should be less affected by predeparture than by postentry inspections.

Any quarantine program has drawbacks. At airports especially, enforcement may cause significant inconvenience to both private and commercial sectors. There are approximately 7 million interisland passengers per year in

the State of Hawaii (B. Shinbara, personal communication). Under interisland quarantine enforcement, individuals traveling between islands may encounter delays and congestion, and baggage containing fruits or vegetables for personal use is subject to inspections, restrictions, and treatments. The Department of Transportation, the Tourist Bureau, airline personnel, and others are already concerned about congestion at the various airports. Interisland quarantines could be expected to increase this congestion. For commercial growers, shipping costs would increase and markets may be lost because certain fruits cannot survive fumigation.

d. Public Education

Experiences of the medfly eradication program in California in 1980-82 showed that public support is a key ingredient to successful eradication (Dreistadt 1983). The majority of infestations of medfly larvae found during the program were reported by homeowners, despite the fact that their fruit was then destroyed and an insecticide application made to their property. The public must be informed of the need for quarantines and prevention of reintroduction of tri-fly species into cleared areas. They also must be informed of the benefits of eradication, as well as the potential problems, such as delays in interisland travel and adverse health and environmental impacts. Education can explain and encourage the use of certain cultural control methods, such as plowing under leftover crop residues or destroying unwanted fruit, that can be marshalled by farmers and homeowners themselves. It also can reduce negative public reaction to pesticides based on misinformation. The program must address both real and perceived risks associated with the use of chemicals.

e. Monitoring Requirements

Monitoring of the tri-fly species, as well as nontarget organisms, must be integral to any pest eradication effort. Monitoring to determine progress of an eradication program or whether eradication is successful should continue for a specified time after the last control tactics have been applied. The minimum time specified for this monitoring computing the day degrees as required to determine the length of tri-fly development.

Surveillance to determine human health effects is another essential aspect of monitoring. Both short- and long-term effects must be determined. The following monitoring was carried out during the 1980-82 California medfly eradication program (HHAC 1982):

1. Short-term effects

* Hospital emergency department surveillance. This surveillance compared the number of visits to El Camino Hospital Emergency Department during the 2 weeks before, and for 1 month after, malathion applications began.

* Ambulance dispatch study. This study compared ambulance utilization during the initial month of malathion spraying with utilization during base line periodr.

* Department of Health Services (Stanford Study). The relative incidence of asthma in sprayed and unsprayed areas was determined.

* Telephone survey. Telephone interviews were conducted to survey for symptoms of malathion related illness.

* On-site interviews. Interviews were conducted before and after the spraying began to determine self reported symptoms for residents in sprayed areas.

* Pesticide illness reporting. Reports of cases of known or suspected pesticide related illness that physicians filed with county health officers formed the basis for this monitoring.

2. Long-term effects

* The objective of this monitoring was to detect

effects of malathion spraying on pregnancy, occurrence of miscarriages and stillbirths, and congenital defects in newborns.

The Governor's Health Advisory Committee, charged with evaluating the health effects of the California medfly eradication program, concluded the following (HHAC 1982):

"The medfly eradication project has been conducted with exemplary regard for the protection of public health. Medically diagnosed instances of health effects have been very few, and these all appear to be cases of nondisabling or temporarily disabling hypersensitivity reactions, not of malathion poisoning. About 150 cases of injury have been claimed. These have not been validated by timely medical observation. The Committee is attempting to review these to evaluate their significance.

"The Committee concludes that completion of the aerial malathion bait application in 1982, using adequate precautions will not constitute a threat to public health. The Committee intends to maintain its surveillance of application precautions and health effects so long as required."

should be based on a thorough understanding of the tri-flies' life cycle. The time required to complete a life cycle is temperature dependent. Egg, larval, and adult development is influenced by air temperature and pupal development by soil temperature. In both above ground and soil environments, a minimum temperature threshold is established below which no measurable development takes place. A model can be designed to use temperature data for all of the life stages and to predict the entire cycle (see USDA/APHIS Action Plans). The number of degrees accumulated above the developmental threshold for a life stage of a tri-fly species is called "day degrees." Using the insect developmental model, a specific number of day degrees must be accumulated before a life cycle can be completed.

The mean developmental times - egg to adult - of the tri-fly species were presented on page 13. Cool temperatures, characteristic of high elevations in the mountains, may greatly extend the period required for the tri-flies to complete their life cycles, and host fruits may also influence development. Under certain conditions, the medfly larval stage can require up to 50 days, the pupal stage can require up to 60 days, and the adults can live up to 10-12 months (Back and Pemberton 1918). Development of the life stages of the oriental fruit fly and melon fly may also span a similarly long period of time (Christenson and Foote 1960). Thus, the high variability in development time complicates the design of a monitoring program aimed at determining if tri-fly eradication has been achieved. The validity of monitoring throughout a set number of average generations is questionable since a few flies in the population may survive for a much longer period of time than the "average" would. To determine if these flies existed after the eradication effort ceased would probably require that monitoring be continued for at least one year after the last control tactics are applied (R. Cunningham, personal communication 1983).

Fruit fly monitoring involves two primary methods: periodically collecting fruits from the field and holding them in the laboratory where they are checked for emerging fruit flies or their parasites; and using traps baited with male lures to attract and capture adult flies. The traps are baited and checked every 2 weeks. The USDA/APHIS Action

Plans for the tri-flies recommend a trapping density of 5 traps per square mile. However, the density may vary from 2-5, depending on the particular tri-fly species and location (R. Cunningham, personal communication). Medfly traps use trimedlure, oriental fruit fly traps use methyl eugenol, and melon fly traps use cuelure. The traps may also contain a toxicant that kills the responding fruit flies.

Pesticides used in an eradication program and their impacts on the environment must also be monitored on a continuous basis. According to the USDA/APHIS Action Plan for the Mediterranean fruit fly, this monitoring must include at least the following elements:

1. Using dye cards to monitor aerial bait application

* Droplet size information,
* Droplet distribution information,
* Bait deposition information,
* Identification of wind drift components,
* Verification of spray block boundaries, and
* Identification of skips.

2. Sampling to evaluate effect on environmental components

* Water sampling to detect insecticide levels through direct application, leaching, and runoff,
* Soil sampling to determine insecticide levels and residues,
* Foliage sampling to identify residues,
* Biological organism sampling to determine impact of insecticides, and
* Air sampling to determine presence of pesticides in respirable air.

Weather monitoring, conducted in selected areas of the eradication program, may also be valuable. For example, weather monitoring is useful when measuring pesticide runoff following heavy rains or tropical storms and also for

APPENDIX K

DRAFT EIS COMMENTS AND RESPONSES

Appendix K
Draft EIS Comments and Responses

Following are comment letters on the Draft EIS and DBED responses. Letters were received from the following people:

	Name	Organization	Date
1.	Bruce S. Anderson	State of Hawaii-Department of Health	10/04/88
2.	Bruce S. Anderson	State of Hawaii-Department of Health	10/20/88
3.	Samuel J. Burris	Leleiwi Community Association	09/30/88
4.	Kisuk Cheung	US Army Engineer District	10/05/88
5.	Paul W. Dixon	University of Hawaii-Hilo	09/19/88
6.	Kathy Dorn	East Hawaii Coalition to Stop Food Irradiation	10/14/88
7.	Patricia G. Engelhard	Hawaii County-Department of Parks and Recreation	10/05/88
8.	Bill Graham	Life of the Land	09/16/88
9.	Robert W. Hall	Hawaii Institute for Biosocial Research	10/12/88
10.	Edward Y. Hirata	State of Hawaii-Department of Transportation	10/06/88
11.	Lorraine R. Jitchaku-Inouye	Hawaii County Council	10/13/88
12.	Carl J. Johnson	-	10/07/88
13.	Arlene M. Kabei	State of Hawaii-Department of Health	09/22/88
14.	Kamaki A. Kanahele, III	State of Hawaii-Office of Hawaiian Affairs	09/23/88
15.	N.P. Kefford	University of Hawaii-Manoa	09/27/88
16.	Harry Kim	Hawaii County-Civil Defense Agency	10/06/88
17.	Yukio Kitagawa	State of Hawaii-Department of Agriculture	10/06/88
18.	Harold S. Masumoto	State of Hawaii-Office of State Planning	10/11/88
19.	Mara Mayo	-	10/12/88
20.	William Meyer	US Geological Survey	09/27/88
21.	Jacquelin N. Miller	University of Hawaii-Manoa	10/03/88
22.	Ralston H. Nagata	State of Hawaii-Department of Land and Natural Resources	08/31/88
23.	Gordon H. Nobriga	Hawaii County-Redevelopment Agency	09/23/88
24.	William W. Paty	State of Hawaii-Department of Land and Natural Resources	10/03/88
25.	H. William Sewake	Hawaii County-Department of Water Supply	09/01/88
26.	Harold T. Smith	US Department of Agriculture	10/05/88

27.	Paul W. Y. Takehiro	-	10/16/88
28.	Teuane Tominaga	State of Hawaii-Division of Public Works	09/07/88
29.	Deborah Ward	Sierra Club	10/14/88
30.	David J. Welhouse	US Department of Transportation	09/19/88

JOHN WAIHEE
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HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

October 4, 1988

In reply, please refer to:
EPHSO

MEMORANDUM

To: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

From: Deputy Director for Environmental Health

Subject: Draft Environmental Impact Statement (DEIS) for the Hawaii Commodities Irradiation Facility, Hilo, Hawaii

During the review of this document, it was noted that an emergency electric power generator is proposed to be utilized in cases of electrical failure (see page 2-16) at the facility. Usually, in situations such as this, an underground storage tank is installed to store the necessary fuel product.

Underground storage tanks which contain petroleum products are regulated by both federal and state regulations. Although this matter was not addressed in the DEIS, the owner of the facility is required to ensure that all regulations are addressed in the final EIS and that provisions are made to meet these requirements for the installation and operation of an underground storage tank.

Should there be any questions, please contact our office at (808) 548-8837.

BRUCE S. ANDERSON, Ph.D.

cc: WESTEC Services, Inc.

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Bruce S. Anderson, Ph.D., Deputy Director
Environmental Programs
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 4, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The facility developer will be required to conform with all federal, state, and local requirements regarding the storage of standby fuel.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

COPY

October 20, 1988

MEMORANDUM

To: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

From: Deputy Director for Environmental Health

Subject: Additional Comments to the Draft Environmental Impact Statement (DEIS) for the Hawaii Commodities Irradiation Facility, Hilo, Hawaii

The following comments should be added to our memorandum dated October 4, 1988 on the subject DEIS:

Air Pollution

The DEIS concludes that the energy of the gamma rays will cause radiolysis of the air in the irradiator room, causing the formation of some toxic gases as well as ozone and nitrogen oxide. Instead of discussing control equipment to abate the air pollutants, the DEIS simply recommends sufficient ventilation capacity for the dilution of the gases exhausting into the atmosphere. Depending on the air pollutant, the toxicity, the concentration and the emission rate, abatement equipment may be appropriate and required. Note that the DEIS does not identify the potential air toxic pollutants nor provide the anticipated concentration levels for all the air pollutants that may result from the irradiation process. Due to the air emissions, construction and operational air pollution control permits from the Department of Health will be required for the irradiation facility.

Emergency Response

The State Civil Defense has a Radiological Incident Response Plan. In addition, the Nuclear Regulatory Commission (NRC), the federal Food and Drug and the Environmental Protection Agency (EPA) will respond in case of an emergency.

BRUCE S. ANDERSON, Ph.D.

cc: WESTEC Services, Inc.
DBO, Hawaii

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

10358:548

November 25, 1983

Bruce S. Anderson, Ph.D., Deputy Director
Environmental Programs
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your second letter (of October 20, 1988) to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The toxic gases referred to in the Draft EIS and referenced feasibility report (CH2M Hill 1987) are ozone and oxides of nitrogen. No other pollutants are expected to be significantly generated by the irradiation process. Dilution through ventilation will be required to ensure that, under worst-case scenarios, ambient concentrations do not exceed federal and state standards developed to protect health and the environment. There is presently no control technology/commercially available for ozone in this country. Accepted control is dilution. The EIS text has been amended to show that Department of Health air permits will be required.

Your comments on State and Federal Emergency response are noted.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

Leleiwi Waves
Leleiwi Community Association, Hilo, Hawaii 967?

September 30, 1988

State of Hawaii
DBED
335 Merchant St Rm 110
Honolulu, HI 96813

COMMENTS ON THE HAWAII COMMODITIES
IRRADIATION FACILITY DRAFT
ENVIRONMENTAL IMPACT STATEMENT

Dear Sirs:

As president of the Leleiwi Community Association it is my feeling that the Draft EIS lacked not only overall supportive documentation, but also assurances of the safety of the plant.

An example of more depth in documentation needed is on pages 4-15 to 4-16 concerning ground water quality. Much more detail is needed here in addressing this critical potential problem. Other shortages of information also exist throughout the draft in various areas of concern.

A summary of the lack of assurances of the safety of the plant is summed up well on page 4-9 which says, "All of these calculations necessarily incorporate assumptions which may, or may not, prove accurate". The sentence is referring to information given in the document on lava flows.

It is my opinion that more detailed supportive documentation on statements about earthquakes, tsunamis, lava flows, etc. must be addressed in order for this document to be viable.

Sincerely,

Samuel J. Burris, PRESIDENT
1875 Kalanianaole Ave. # 705
Hilo, HI 96720
Tel: 935-9126

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Samuel J. Burris, President
Leleiwi Community Association
1875 Kalanianaole Avenue, #705
Hilo, Hawaii 96720

Dear Mr. Burris:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 30, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The EIS addresses the potential effects on ground water to the level of detail necessary to support the conclusion that the proposed project does not pose significant risk to ground water resources. It should be noted that the irradiator would use non-soluble Cobalt-60, not soluble Cesium-137. Thus the potential for contamination of the source pool is very remote. Further, as discussed in the Draft EIS, measures to protect the environment from radiation release will be required in the facility. In the absence of any specific concerns with the analysis, we are unable to respond in greater detail.

Please refer to the risk assessment, summarized in Section 4.12 of the Draft EIS, which correctly points out that, even if a lava flow were to occur, the radiation source could be removed from the facility, obviating risk of release.

References for support data are included in the EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

RECEIVED OCT 11 1988

October 5, 1988

REPLY TO ATTENTION OF:
Planning Branch

Dr. Marvin Miura
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Thank you for the opportunity to review the Draft Environmental Impact Statement (DEIS) for the proposed Hawaii Commodities Irradiation Facility, Hilo, Hawaii. The following comments are offered:

a. The proposed project does not involve work in waters of the United States or adjacent wetlands; therefore a Department of the Army permit is not required.

b. In the second paragraph of section 4.4.1.1 (Susceptibility to Flooding), "May 3, 1982" should be changed to "September 16, 1988" and "Zone C, 'Areas of Minimal Flooding'" should be changed to "Zone X, 'Areas determined to be outside 500-year flood plain'."

Sincerely,

ORIGINAL SIGNED

Kisuk Cheung
Chief, Engineering Division

Copy furnished:

WESTEC Services Inc.
1221 State Street, Suite 200
Santa Barbara, CA 93101
Attn: James W. Frolich

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U.S. Army Engineer District
Building 230
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 5, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

We appreciate your confirmation that a Department of Army permit is not required. The text of the EIS will be changed to reflect the current FEMA designation.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

University of Hawaii at Hilo
COLLEGE OF ARTS AND SCIENCES
SOCIAL SCIENCES DIVISION

SEP 23 1988

Sept. 19, 1988

Mr. Maurice Kaya
Irradiation Project Manager
State of Hawaii
DBED
Energy Division
335 Merchant Street, #110
Honolulu, HI 96813

Dear Sir:

May I take this opportunity to resubmit those items presented under my name in the Environmental Impact Statement for the proposed irradiation facility for the Island of Hawaii.

For the purposes of clarification, may I request a documented response in regards to the nuclear physics, and cancer demography to each point made in these various documents be given to assure the health and welfare of the citizens of the State of Hawaii.

Additional material is also submitted at this time. A letter published in the Hilo Tribune - Herald on Thursday, May 19, 1988 and an additional study from the journal Nature as mentioned in the letter is also appended for this file.

May I thank you for your kind attention and consideration this matter.

Respectfully submitted,

Paul W. Dixon

Paul W. Dixon, Ph.D.
Professor of Psychology

HILO, HAWAII 96720-4091 TEL: (808) 961-9450
An Equal Opportunity Employer

Letters

Irradiation

Aside from the overwhelming danger to an irradiation facility from volcanic activity, tsunami and seismic events greater than 7 on the Richter scale, all of which are an ever present danger on our Island of Hawaii, we must consider the effects of radiation itself.

As indicated in the testimony of the 81 citizens who testified against the construction of this facility on April 29, regarding the Environmental Impact Statement, irradiated food products would contain radiolytic contaminants which would produce changes in the genetic structure and menstrual cycles of these ingesting these irradiated food products. Also mentioned in the hearing was the isomeric effect and the photonuclear effect which produce radioactive gamma ray emission and radioactive isotopes in the irradiated food products.

Testimony in the hearing also indicated that there is a significant increase in neural cancers, which include brain tumors, surrounding atomic reactor facilities. This finding was published recently in the most authoritative and respected science news journal, "Nature." Evidence was given showing that the radioactive emission from irradiation facilities is twenty (20) times that of nuclear reactors.

It is clear that we would find a disastrous increase in cancerous growths, particulary brain tumors, in the residents of the Big Island of Hawaii from the ordinary operating conditions of an irradiation facility.

Convulsive seizures as well as hemorrhagic extrusions from the ears and nose are common terminal symptoms of intracranial tumors. The pain of this condition is beyond description.

One wonders at the kind of criminal psychopathic disorder associated with those who still support an irradiation facility in the light of the foregoing evidence.

Paul W. Dixon
Volcano

Radio commercials

Cancer near nuclear installations

David Forman, Paula Cook-Mozaffari, Sarah Darby, Gwyneth Davey, Irene Stratton, Richard Doll & Malcolm Pike

There has been no general increase in cancer mortality near nuclear installations in England and Wales during the period 1959-1980. Leukaemia in young people may be an exception, though the reason remains unclear.

THE Office of Population Censuses and Surveys (OPCS) has recently published a report "Cancer Incidence and Mortality in the Vicinity of Nuclear Installations England and Wales, 1959-80"[1]. The report is very detailed and difficult to assimilate. We have, therefore, summarized here what we believe to be the principal results and the main conclusions that can be drawn from them.

The OPCS report

The installations included in the report are shown in Table 1. All pre-1974 Local Authority Areas (LAAs) with at least one-third of their population living within 10 miles of any of these installations were included in the analysis. The report provided standardized mortality and registration ratios (SMRs and SRRs) for 25 specific and combined cancer sites for groups of these LAAs around each installation using appropriate regional rates (age, sex and year specific rates for the Standard Region[2], excluding conurbations, in which the installation was situated) for standardization. These SMRs and SRRs were presented for both sexes combined and essentially for three discrete age groups: 0-24, 25-74 and 75+ years, although the information was also made available for the age group 0-9 years. The report also compared the trends in SMRs and SRRs both over time and with increasing proximity to the installations.

In addition, comparisons were made between the SMRs and SRRs of the grouped LAAs around each installation and the SMRs and SRRs of groups of control LAAs. Each group of control LAAs was constructed by matching each installation LAA with a non-installation LAA, selected, where possible, to be in the same Standard Region[2] and have a similar urban-rural status and population size as its comparison LAA. For LAAs that were County Boroughs, control selection was also based on comparable social class structure when there was a choice within the above constraints. The rates for the same Standard Region were used for calculating the SMRs and SRRs for each installation LAA and for its control.

In order to focus attention on overall patterns the report provided summed results for the LAAs in two mutually exclusive combined groups of installations and the respective control LAAs. These were, firstly, all the installations that started operation before 1955, except Sellafield (the "pre-1955 installations"), and secondly, all the CEGB installations combined, see Table 1.

Four distance zones were considered in the report: (1) LAAs with at least two-thirds of their population within 6 miles of an installation; (2) LAAs with at least two-thirds of their population within 8 miles of an installation; (3) LAAs with at least two-thirds of their population within 10 miles of an installation; and (4) LAAs with at least one-third of their population within 10 miles of an installation.

These cumulative zones are referred to as cumulative zones 1, 2, 3 and 4. For some analyses mutually exclusive ("discrete") distance zones were used; these discrete zones were constructed from the cumulative zones by successively excluding inner zones, for example discrete zone 2 = zone 2 − zone 1, and so on. It should be noted that LAAs in the vicinity of all installations are not represented in every distance zone. In particular, the innermost distance zone, as defined above, contains no LAAs that are near to Sellafield, Aldermaston, Berkeley/Oldbury and Hinkley.

The report provided data for the 22 years 1959-1980, a period that commenced several years after the start of operations at Sellafield and at each of the group of pre-1955 installations. The CEGB installations, however, began operations between 1961 and 1971, and Winfrith became operational in 1964. Data for these installations were also available in the report from the year subsequent to start-up for some types of cancer.

In addition to the analyses of LAAs around installations, the report also presented results for a group of coastal LAAs to the north and south of Sellafield to investigate whether seaborne discharges from Sellafield might be affecting cancer rates. These coastal LAAs have some overlap with the LAAs around Sellafield, Springfields, Capenhurst and Wylfa. Control LAAs were selected for these coastal LAAs using the criteria stated above.

Methods

The principal results, in our opinion, are those relating to mortality at ages 0-24 and 25-74 years for combined groupings of installations, categorized by likely environmental impact or similar start-up date. Other data are less relevant, because:

(a) Cancer registration data are of variable quality[3] and the report itself highlighted a number of inconsistencies in the registration information[1,4]. In particular, the ratio of the number of cancer registrations to the number of cancer deaths was higher in the LAAs around pre-1955 installations than in the corresponding control LAAs, which suggests a general registration bias in favour of the installation areas.

(b) The mortality results for the age group 75+ are less reliable than those for other ages because diagnostic accuracy on death certificates diminishes with age[1,5].

(c) The results for LAAs around individual installations are based on small numbers and are likely to be less informative than those for groups of similar installations. We have, therefore, mainly used the results for combined installation groupings provided in the report. We have analysed data for grouped LAAs around:

(i) The pre-1955 installations excluding Sellafield. Although the activities carried out in these installations are heterogeneous, the grouping combines all the establishments other than Sellafield which, by 1980, had been operating for more than 25 years and around which any long-term effects could most easily be identified.

(ii) Combined CEGB installations. All are thought to have a similar impact on their local environment, in terms of their radioactive discharges[6].

(iii) Sellafield. Sellafield first released waste in 1950, but a specific problem had already been identified in relation to it before the OPCS study[7], and it also needs to be considered separately because the radiobiological impact of the discharges from Sellafield is likely to have been far in excess of that from any other establishment[7,8].

(iv) Winfrith. Winfrith first released waste in 1964, and does not fit into any of the other categories.

(v) All installations grouped together, obtained by summing (i) to (iv) above.

We also analysed results for the group of coastal LAAs to the north and south of that part of mid-Cumbria in which Sellafield is situated. The three LAAs in mid-Cumbria have been excluded as they are already included in the Sellafield group (group (iii) above) and Liverpool County Borough was excluded as it has a very different population density and social class composition from the remaining coastal LAAs. The final group consisted of 58 coastal LAAs.

The 22 "types" of cancer included in the analysis are listed in the Appendix (p. 505). The SMRs given in the report are comparisons with regional standards which make allowance for gross regional and urban-rural variation in cancer rates. However, any remaining difference in the demographic or socio-economic structure of the LAAs around an installation compared to that of a region as a whole will result in an effect on the SMR unrelated to the presence of the installation. This type of effect could be expected to be minimized in the comparison between grouped installation LAAs and grouped control LAAs, so we have largely restricted attention to such comparisons.

Our approach, therefore, has been to compare mortality rates in the above installation groupings within each of the four distance zones and in the coastal LAAs around Sellafield with the rates in their respective control LAAs. Data for the CEGB installations and Winfrith were considered only subsequent to start-up. (In fact, because the OPCS report did not present all the necessary information, it was not possible to divide the data into pre- and post-start-up for certain cancer sites. In these instances data were used from 1966-1980 instead, see Appendix.) The numbers involved in these instances are small and will not affect the overall pattern of occurrence.

For all the 22 types of cancer, the SMRs are presented in (or can be calculated from) the OPCS report for each grouping of installation LAAs that we have considered and for their control LAAs. We have calculated the ratios of the SMRs for the grouped installation LAAs to the SMRs for the grouped control LAAs and called these ratios "relative risks" (RRs). For each cumulative distance zone, one-sided significance tests have been performed to test the hypothesis that the RR for the grouped installation LAAs is greater (or less) than unity. These tests were performed on the observed numbers of deaths which we have assumed follow Poisson distributions with means proportional to the number of deaths expected. Tests for trend in the RRs in the discrete distance zones with increasing proximity to an installation were also carried out using a likelihood ratio test.

Results

All comparisons which lead to the RR for the grouped installation LAAs being significantly greater than unity (one-sided $P<0.05$) in any of the four cumulative distance zones are shown in Table 2 ("positive" results). Table 3 corresponds to Table 2, and shows all comparisons which lead to the RR for the grouped installation LAAs being significantly less than unity ("negative" results). All significant differences between the grouped coastal LAAs and their control areas, irrespective of whether the RRs are greater or less than unity are shown in Table 4.

In Tables 2 and 3 we show all the distance zones in which significant differences are observed between the SMRs in the installation and control areas. We also show the observed number of deaths and the SMRs for the installation and control LAAs in the distance zone which shows the most extreme difference in cancer mortality rates in terms of its statistical significance.

Numerically there are substantially more negative results listed in Tables 3 and 4b than there are positive results listed in Tables 2 and 4a and a greater variety

Table 1 Nuclear installations and summary groupings

Installation	Summary grouping	Date of first criticality or waste release*
BNFL Sellafield	—	1950
BNFL Springfields	Pre-1955 (excl. Sellafield)	1948
BNFL Capenhurst	Pre-1955 (excl. Sellafield)	1953
Amersham International plc	Pre-1955 (excl. Sellafield)	1946
MOD Aldermaston	Pre-1955 (excl. Sellafield)	1952
UKAEA Harwell	Pre-1955 (excl. Sellafield)	1947
UKAEA Winfrith	—	1964
CEGB Bradwell	CEGB	1961
Berkeley & Oldbury	CEGB	1961
Hinkley	CEGB	1964
Trawsfynydd	CEGB	1964
Dungeness	CEGB	1965
Sizewell	CEGB	1965
Wylfa	CEGB	1971

* Referred to as "start-up date" in the text.

Table 2 Comparison of standardized mortality ratios (SMR) between groupings of installation LAAs and their controls*

Category of cancer	Installation grouping	Cumulative distance zone† (a)	(b)	Installation LAAs Obs	Installation LAAs SMR	Control LAAs Obs	Control LAAs SMR	Relative risk‡	P
a Persons aged 0-24 Lymphoid leukaemia	Pre-1955 (excl. Sellafield)	1	2	42	113.4	20	54.1	2.10	0.004
	All installations	1	—	44	112.1	22	56.1	2.00	0.005
All brain	Sellafield	3	—	5	144.6	0	0.0	∞	0.031
b Persons aged 25-74 Liver	All CEGB	2	3, 4	29	189.0	10	62.6	3.01	0.001
	Winfrith	4	—	16	137.0	6	52.0	2.64	0.043
	All installations	4	2, 3	395	100.8	313	81.1	1.23	0.004
Lung	All CEGB	4	3	2,936	95.0	3,134	90.3	1.05	0.025
Hodgkin's disease	Pre-1955 (excl. Sellafield)	3	2, 3, 4	141	95.0	104	70.7	1.34	0.011
	All installations	3	2, 3	149	96.7	112	72.4	1.34	0.011
All lymphomas	Pre-1955 (excl. Sellafield)	1	—	382	98.5	318	86.2	1.14	0.010
Unspec. brain and CNS	Pre-1955 (excl. Sellafield)	4	—	337	109.2	302	95.7	1.14	0.040
All malignancies	All CEGB	4	3	10,355	98.4	11,536	94.5	1.04	0.049
	Sellafield	4	2, 3	2,399	97.7	2,491	89.8	1.09	0.002

* All comparisons where the SMR for the installation LAAs was significantly greater than for the control LAAs ($P<0.05$, one-sided test) in any of the four cumulative distance zones are indicated. Detailed results are given for the distance zone with the most extreme significance level. Sellafield does not appear on the table for leukaemia in the 0-24 age-group because the increase that has been reported was confined to Millom Rural District. In that analysis Millom Rural District is in distance zone 4 where it is combined with Ennerdale Rural District (also in distance zones 2 and 3) and Whitehaven Metropolitan Borough (also in distance zone 3). No increase in leukaemia mortality was found in these other areas.

† (a) With most extreme significant difference (lowest probability); (b) with significant differences ($P<0.05$).

‡ Relative risk = SMR (installation LAAs)/SMR (control LAAs).

Table 3 Comparison of standardized mortality ratios (SMR) between groupings of installation LAAs and their controls*

Category of cancer	Installation grouping	Cumulative distance zone† (a)	(b)	Installation LAAs Obs	Installation LAAs SMR	Control LAAs Obs	Control LAAs SMR	Relative risk‡	P
a Persons aged 0-24									
Myeloid leukaemia	Winfrith	4	—	3	55.0	9	214.9	0.23	0.042
Malignant brain	All CEGB	3	—	5	69.6	15	204.8	0.34	0.023
All brain	All CEGB	2	—	6	64.5	16	167.3	0.39	0.033
Malignant brain	All installations	1	—	34	80.2	51	118.1	0.68	0.030
Non Hodgkin's lymphoma	All CEGB	2	—	0	0.0	5	107.9	0.00	0.034
All lymphomas and leukaemias	Winfrith	4	—	16	94.3	30	168.7	0.56	0.039
All malignancies	All CEGB	2	—	49	81.7	73	118.6	0.70	0.033
b Persons aged 25-74									
Myeloid leukaemia	Pre-1955 (excl. Sellafield)	3	4	473	87.7	533	114.2	0.86	0.008
	All installations	3	4	575	96.7	631	113.2	0.85	0.003
Non-lymphoid leukaemia	Pre-1955 (excl. Sellafield)	3	4	376	97.5	431	111.4	0.87	0.021
	All installations	3	4	701	96.8	773	110.3	0.88	0.007
Lymphoid leukaemia	Winfrith	3	4	2	33.4	12	231.8	0.16	0.007
All leukaemia	Winfrith	3	—	21	87.5	36	150.0	0.58	0.031
	All CEGB	1	2, 3	10	50.1	28	118.8	0.42	0.012
	All installations	1	—	379	89.8	437	101.8	0.88	0.040
Malignant brain	Pre-1955 (excl. Sellafield)	3	4	1,116	95.0	1,303	101.3	0.88	0.003
	All CEGB	1	—	12	47.6	28	122.8	0.31	0.013
	All installations	3	4	1,333	94.3	1,474	107.2	0.88	<0.001
Benign brain	Pre-1955 (excl. Sellafield)	4	3	112	88.6	185	112.5	0.79	0.016
	All CEGB	1	—	0	0.0	7	324.4	0.00	0.010
	All installations	4	2, 3	183	88.0	231	109.0	0.81	0.018
All brain	Pre-1955 (excl. Sellafield)	3	4	1,333	96.7	1,603	107.0	0.90	0.002
	All CEGB	1	—	15	65.0	38	138.7	0.47	0.008
	All installations	3	4	1,831	94.5	1,932	104.6	0.90	<0.001
Lung	Pre 1955 (excl. Sellafield)	2	3, 4	2,500	96.0	2,749	101.8	0.93	<0.001
	Winfrith	3	—	318	101.4	330	119.1	0.85	0.015
	All installations	2	3, 4	8,763	96.3	9,010	102.6	0.94	<0.001
Bone	Sellafield	3	2, 4	4	49.3	16	182.0	0.27	0.011
	All CEGB	4	3	33	88.7	56	136.0	0.65	0.013
	All installations	3	4	231	89.7	277	112.8	0.80	0.006
Multiple myeloma	Pre 1955 (excl. Sellafield)	1	—	144	90.3	117	113.6	0.80	0.031
	Winfrith	4	—	23	75.2	39	130.0	0.58	0.021
	All installations	1	2	133	88.3	199	112.1	0.79	0.016
Testis	All CEGB	4	—	16	61.3	37	117.0	0.49	0.004
All lymphomas and leukaemia	All CEGB	3	2, 3	26	63.0	33	116.4	0.56	0.009
All malignancies	Pre-1955 (excl. Sellafield)	2	1, 3, 4	33,938	96.6	26,874	101.4	0.95	<0.001
	Winfrith	3	—	1,035	102.7	1,142	113.3	0.91	0.015
	All installations	2	1, 3, 4	30,645	97.3	38,815	101.1	0.96	<0.001

* All comparisons where the SMR for the installation LAAs was significantly less than for the control LAAs ($P<0.01$, one-sided test) in any of the four cumulative distance zones are indicated. Detailed results are given for the distance zone with the most extreme significance level.
† (a) With most extreme significant difference (lowest probability), (b) with significant differences ($P<0.01$).
‡ Relative risk = SMR (installation LAAs)/SMR (control LAAs).

of different cancer types are included in the negative results. In this article we are not, however, concerned with the reasons why the risk of death from a number of cancer types is relatively low in the installation areas, except in so far as they help to interpret the opposite findings. We have, therefore, examined further only those types of cancer that had a relatively higher mortality in LAAs around the installations than in the control LAAs.

Cancer at ages 0-24. Two types of cancer have caused death relatively more frequently in persons under 25 years of age around some of the installations than in the corresponding control areas: namely, lymphoid leukaemia and all brain tumours. The RR for lymphoid leukaemia is significantly elevated in cumulative zones 1 and 2 in the LAAs grouped around the pre-1955 installations. As the populations in the LAAs around the pre-1955 installations constitute 81 per cent of the entire study population, this results in a significant elevation of lymphoid leukaemia, though in zone 1 only, around all installations combined. These findings are shown in Table 5 in the context of the overall results for leukaemia (lymphoid, non-lymphoid and all types) in the four discrete distance zones. For lymphoid leukaemia there is a significantly increasing trend in RR with increasing proximity to an installation in the pre-1955 group (two-sided $P=0.048$) and a significantly decreasing trend with increasing proximity to an installation for the grouped CEGB installations (two-sided $P=0.015$).

The RR for all brain cancer (that is, for brain tumours described as malignant, benign or of unspecified malignancy) is significantly elevated in cumulative zone 2 around Sellafield. When data for this type of cancer are examined in the four discrete zones around all the installation groupings, two comparisons show statistically significant trends. One is of an increasing risk with increasing proximity

Table 4 Comparison of standardized mortality ratios (SMR) between the coastal grouping of LAAs† and the control grouping*

Persons aged 25-74 Category of cancer	Coastal LAAs Obs	Coastal LAAs SMR	Control LAAs Obs	Control LAAs SMR	Relative risk‡	P
a Coastal LAAs greater than control LAAs						
Multiple myeloma	439	107.8	318	96.6	1.11	0.043
b Coastal LAAs less than control LAAs						
Bone	249	89.6	284	114.1	0.79	0.003
All malignancies	64,433	97.1	60,913	98.4	0.99	0.009

* All comparisons where the SMR for the coastal grouping was significantly greater or less than the controls ($P<0.01$, one-sided test) are included.
† Excluding mid Cumbria LAAs and Liverpool County Borough.
‡ Relative risk = SMR (coastal LAAs)/SMR (control LAAs).

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Table 5 Standardized mortality ratios (SMR) for leukaemia in installation LAAs and relative risks (RR) of installation LAAs to control LAAs, 0-24 years age group, discrete distance zones

Grouping		Discrete distance zone 1	2	3	4	Trend Sign¶	Trend Probability‖
a Lymphoid leukaemia (1968-1980)§							
Pre-1955	SMR	112.4	100.1	103.8	91.2		
	RR	2.10*	0.89	0.98	0.94	+	0.048
All CEGB	SMR	102.1	76.8	106.4	162.8		
	RR	1.05	0.34	1.54	2.94†	−	0.015
Winfrith	SMR	0.0	—‡	44.8	123.7		
	RR	—#	—	0.29	1.32	−	0.297
Sellafield	SMR	—‡	130.5	33.8	313.7		
	RR	—	1.11	0.23	∞**	−	0.276
All installations	SMR	112.0	103.5	101.0	113.2		
	RR	2.00*	0.73	0.98	1.30	+	0.435
b Non-lymphoid leukaemia (1968-1980)§							
Pre-1955	SMR	110.0	119.8	86.1	125.8		
	RR	0.97	1.10	0.71	1.40	−	0.786
All CEGB	SMR	0.0	115.0	75.6	131.1		
	RR	0.00	1.00	3.85	1.65	−	0.121
Winfrith	SMR	0.0	—‡	110.3	75.4		
	RR	—#	—	1.17	0.28	+	0.340
Sellafield	SMR	—‡	61.0	70.2	345.0*		
	RR	—	1.09	∞**	4.00	−	0.412
All installations	SMR	107.0	116.9	84.8	137.4		
	RR	0.91	1.08	0.84	1.28	−	0.478
c All leukaemia (1959-1980)§							
Pre-1955	SMR	103.9	100.6	93.5	95.5		
	RR	1.20	0.91	0.86	0.94	+	0.094
All CEGB	SMR	130.3	93.6	104.0	111.7		
	RR	1.10	0.35	1.56	1.59	−	0.054
Winfrith	SMR	0.0	—‡	104.7	113.6		
	RR	—#	—	0.82	0.56	+	0.496
Sellafield	SMR	—‡	102.5	83.4	263.21		
	RR	—	0.60	0.47	1.94	−	0.016
All installations	SMR	106.5	107.1	94.8	106.9		
	RR	1.19	0.86	0.86	1.02	+	0.313

* $P<0.01$ (one-sided test for increase above 100 (SMR) or unity (RR)).
† $P<0.05$ (one-sided test for increase above 100 (SMR) or unity (RR)).
‡ No LAAs in this distance zone.
¶ Sign of trend in RR with increasing proximity to installation.
‖ Probability of trend arising due to chance (two-sided test).
§ Data for lymphoid and non-lymphoid leukaemia are only separately available since the introduction of the eighth revision of the International Classification of Diseases in 1968. Data for all leukaemia are presented for the entire time period 1959-1980, but are only included since start-up of the CEGB installations and since 1966 for Winfrith.
# No deaths in installation or control LAAs. ** No deaths in control LAAs.

to Sellafield (two-sided $P=0.026$). The other is of an increasing risk with decreasing proximity to the CEGB installations (two sided $P=0.013$).

Cancer at ages 25-74. Seven types of cancer have caused death relatively more frequently in persons aged 25-74 years around some of the installation groupings or in the grouped coastal LAAs: namely, Hodgkin's disease, all lymphomas, multiple myeloma, liver cancer, lung cancer, tumours of the brain and central nervous system of unspecified malignancy, and all malignancies.

The mortality from Hodgkin's disease is elevated in all four cumulative zones in the LAAs around the pre-1955 installations in comparison with their control LAAs. This leads to elevated RRs in cumulative zones 1, 2 and 3 for all installations combined. The results for the discrete distance zones are given in Table 6. Statistically significant trends are seen for an increasing relative risk with increasing proximity to an installation for all installations combined (two-sided $P=0.040$) and for Winfrith (two-sided $P=0.002$). Hodgkin's disease is a major component in the category of all lymphomas, the mortality from which is also elevated in distance zone 1 around the pre-1955 installations.

The mortality from multiple myeloma is significantly elevated in the coastal LAAs, but not in any of the LAAs around the nuclear installations. Because of the finding of an increased risk of myeloma with increasing dose of radiation in the Sellafield[9] and Hanford[10,11] workers, the results are examined in detail for the LAAs in each of the discrete distance zones around the grouped installation LAAs in Table 7. There is a statistically significant decrease in relative risk with increasing proximity to an installation (two-sided $P=0.017$) for the LAAs around the pre-1955 installations.

Liver cancer RRs are elevated in cumulative zones 2, 3 and 4 around the grouped CEGB installations and in cumulative zone 4 around Winfrith. These results are reflected in elevated RRs for this cancer in cumulative zones 2, 3 and 4 around all installations combined.

The other positive results around the CEGB installations are those for lung cancer and for all malignancies in cumulative zones 3 and 4. The RR for all malignancies is also elevated in all three distance zones around Sellafield. However, both of these cancer categories have significantly lower RRs around the grouped pre-1955 installations and around all installations combined (Table 3).

The results for liver cancer, lung cancer and all malignancies for all four cumulative zones around the CEGB installations are given in Table 8, which also shows separate data for each zone before and after start-up of the installations. For liver cancer the excesses in zones 2, 3 and 4 were all present before the opening of the installations as well as after, and the earlier SMRs were, in each case, higher than subsequently. For lung cancer and for all malignancies, the RRs were all close to unity both before and after start-up, the highest being 1.06. In cumulative zones 3 and 4, the RRs and the SMRs tended to be higher in the installation LAAs than in the control LAAs after the opening of the installations than before, but the reverse was true for cumulative zones 1 and 2.

The remaining positive result is the increased RR for tumours of the brain and central nervous system of unspecified malignancy in cumulative zone 4 around the pre-1955 installations and around all installations combined. This was more than compensated for by significantly decreased RRs for the other three brain cancer categories (malignant brain cancer, benign brain cancer and all brain cancer) in these installation groupings (Table 3).

Discussion

The comparison of Tables 2 and 4a with Tables 3 and 4b shows that the SMRs for LAAs in the vicinity of nuclear installations or in the 58 selected coastal LAAs are significantly less than the SMRs in their control LAAs more often than the reverse. This, moreover, remains true if attention is concentrated on those types of cancer that have been particularly associated with exposure to ionizing radiation[12]; namely, leukaemia, bone cancer and multiple myeloma. This provides strong evidence that there is no generalized increase in cancer mortality around nuclear installations in England and Wales either in young persons or in adults.

Although many of these results will be chance findings as so many comparisons were made, the tendency for cancer mortality to be lower near nuclear installations than in the control LAAs is too strong to be explained solely on these grounds. We do not think that radioactive discharges can protect against the development of cancer and we conclude that there are likely to have been sufficiently large socio-economic or environmental differences between the installation and the control

Table 6 Standardized mortality ratios (SMR) for Hodgkin's disease in installation LAAs and relative risks (RR) of installation LAAs to control LAAs, 25-74 years age group, discrete distance zones

Grouping		Discrete distance zone 1	2	3	4	Trend Sign*	Probability†
Pre-1955	SMR	95.9	97.9	99.3	101.5		
	RR	2.34†	0.99	1.13	0.96	+	0.102
All CEGB	SMR	63.5	127.4	112.0	79.4		
	RR	0.64	0.96	1.14	0.78	+	0.946
Winfrith	SMR	540.5*	—‡	95.5	101.6		
	RR	∞**	—	1.24	0.56	+	0.012
Sellafield	SMR	—‡	77.1	64.3	92.8		
	RR	—	1.05	0.77	0.74	+	0.441
All installations	SMR	96.7	100.5	99.7	99.2		
	RR	1.34†	0.93	1.14	0.89	+	.040

* P < 0.01 (one-sided test for increase above 100 (SMR) or unity (RR)).
† P < 0.05 (one-sided test for increase above 100 (SMR) or unity (RR)).
‡ No LAAs in this distance zone.
* Sign of trend in RR with increasing proximity to installation.
† Probability of trend arising due to chance (two-sided test). ** No deaths in control LAAs.

LAAs to have had an effect on the pattern of cancer mortality, despite the efforts that were made to choose pairs of LAAs that were socially similar. It follows that the excesses of mortality from some types of cancer in the installation LAAs, if they are not due to chance, may also result from these differences. It is, therefore, necessary to consider carefully whether each of the positive results may be due to chance, or to socio-economic/environmental differences, or to the direct presence of the installations.

We have concentrated initially on the age group 0-24 years, as it might be expected that any effect of the installations on cancer mortality in the general population would first be seen in young people. Studies of the effects of high doses of radiation have shown that children have a greater proportionate increase in risk following a given level of exposure than adults[23]. In addition, for inhaled and ingested radionuclides, children are thought to receive higher doses than adults from similar levels of environmental contamination, under some circumstances[24].

In the age group 0-24 years there are two results of possible concern, those for lymphoid leukaemia and for all brain cancer. In the period 1968-1980, the RRs for lymphoid leukaemia are raised in the LAAs around the pre-1955 installations in cumulative zones 1 and 2, and this is reflected in a raised RR around all installations combined in cumulative zone 1. The differences observed between the SMRs for lymphoid leukaemia in the installation LAAs and the control LAAs are the most highly significant of all the differences in this age group.

Several factors argue against the observed excess of lymphoid leukaemia being a chance association. Most of the evidence for the excess comes from the LAAs around the pre-1955 installations; and any increase in risk that was actually caused by the installations would have had the greatest time to accumulate in these LAAs. For the pre-1955 installations, the increased RR is restricted to those LAAs closest to the installations, that is, in zone 1 (Table 5); and each of the four individual pre-1955 installations with LAAs in zone 1 (Springfields, Capenhurst, Amersham and Harwell), shows an elevated RR in this zone, although for Capenhurst and Harwell the individual increases do not reach statistical significance (Table 9). There is also a suggestion of an increase of lymphoid leukaemia in the coastal areas (RR 1.24, one-sided $P = 0.115$). Because the Sellafield discharges are far in excess of those from any other establishment and a substantial proportion of those discharges are made into the sea, these coastal areas could be expected to be the first to experience any widespread effects associated with the discharges from the plant.

Table 7 Standardized mortality ratios (SMR) for multiple myeloma in installation LAAs and relative risks (RR) of installation LAAs to control LAAs, 25-74 years age group, discrete distance zones

Grouping		Discrete distance zone 1	2	3	4	Trend Sign†	Probability‡
Pre-1955	SMR	90.3	109.7	104.5	164.5		
	RR	0.79	1.14	1.12	1.16	−	0.017
All CEGB	SMR	56.9	90.1	86.4	135.1		
	RR	0.54	0.72	0.87	1.02	−	0.171
Winfrith	SMR	167.3	—‡	90.5	62.5		
	RR	1.77	—	0.71	0.46	−	0.213
Sellafield	SMR	—‡	37.8	97.0	61.2		
	RR	—	0.71	0.78	0.48	+	0.640
All installations	SMR	85.5	100.9	101.5	164.0		
	RR	0.79	0.99	1.06	0.99	−	0.093

‡ No LAAs in this distance zone.
† Sign of trend in RR with increasing proximity to installation.
‡ Probability of trend arising due to chance (two-sided test).

Moreover, because of particular interest in the effects of radiation on very young children[13], we also looked at the lymphoid leukaemia results for the age group 0-9 years, which are available in the OPCS report on microfiche. In this age group all of the above effects were stronger. For the LAAs in zone 1 around the pre-1955 installations the RR for lymphoid leukaemia is 3.95 (one-sided $P = 0.001$) in comparison with 2.10 (one-sided $P = 0.004$) for the age group 0-24 years. There is also a significant positive trend with increasing proximity to the installation (two-sided $P = 0.035$). Finally in the coastal LAAs there is a significantly elevated RR of 1.42 (one-sided $P = 0.038$).

It should be noted that the excesses of lymphoid leukaemia in the LAAs around the pre-1955 installations depend, in large part, on particularly low SMRs in the control LAAs in zone 1. Thus the combined SMR for the age group 0-24 years in the LAAs in zone 1 around the pre-1955 installations is 113.4, whereas that for the corresponding control LAAs is 54.1. For the age group 0-9 the corresponding SMRs are 113.7 and 28.8. The reason for these low control SMRs is unclear, and demonstration of equivalent low SMRs in other possible control LAAs is needed before it can be concluded confidently that the resulting elevated RRs have aetiological significance.

The difference between the results for lymphoid and non-lymphoid leukaemia, seen in Table 5, means that the combined category of all leukaemia shows no increased risk in the coastal LAAs and only a slight indication of an increased RR in zone 1 around the pre-1955 installations (RR = 1.20, one-sided $P = 0.116$). However, the results for lymphoid leukaemia are based on mortality since 1968 (data on leukaemia subtypes were not available before then). The RR for all leukaemia in zone 1 since 1968 is 1.46 and is statistically significant (one-sided $P = 0.029$). Therefore, by restricting attention to the more reliable all-leukaemia category and to the later time period, 1968-1980, there is still reasonable evidence of an elevated risk in the age group 0-24 years. In the younger age group, 0-9 years, the RR is somewhat higher at 1.66, and is of borderline significance ($P = 0.051$). In the coastal LAAs the RRs for all leukaemia in this later period are 1.10 ($P = 0.181$) at ages 0-24 and 1.26 ($P = 0.072$) at ages 0-9. Whether or not these increases are particularly associated with lymphoid leukaemia, as our initial results suggest, is open to question and depends on explaining why the SMRs in the control LAAs are especially low for this type of cancer and not for non-lymphoid leukaemia.

The present finding comes after independent reports of a four-fold

Table 8 Standardized mortality ratios (SMR) for liver cancer, lung cancer and all malignancies in installation LAAs and relative risks (RR) of installation LAAs to control LAAs, 25-74 years age group, all CEGB installations, all distance zones, before and after start-up

Grouping		Cumulative distance zone 1 Before	1 After	2 Before	2 After	3 Before	3 After	4 Before	4 After
a Liver cancer All CEGB	SMR	85.5	183.3	226.4†	189.8*	178.5†	148.8*	162.4†	136.8*
	RR	1.13	2.41	2.21	2.83*	1.91	1.93*	1.59	1.82*
b Lung cancer All CEGB	SMR	110.3	107.8	102.4	100.7	96.6	97.2	92.2	95.8
	RR	1.06	1.04	1.03	1.02	1.04	1.06†	1.01	1.01†
c All malignancies All CEGB	SMR	100.2	101.4	103.5	103.5†	99.1	99.1	97.9	98.4
	RR	1.05	0.95	1.06	1.02	1.02	1.03†	1.00	1.04*

* P < 0.01 (one-sided test for increase above 100 (SMR) or unity (RR)). † P < 0.05 (one-sided test for increase above 100 (SMR) or unity (RR)).

increase in leukaemia mortality in the age group 0-24 years in Millom Rural District, immediately south of Sellafield[7]. Other increases in childhood leukaemia incidence, based on registration data, have also been reported around two nuclear installations in Scotland (Dounreay[15] and Hunterston[16]) and around Aldermaston[17]. However, current assessments of annual radiation doses, in conjuction with estimates of the risk of leukaemia per unit dose, indicate that the estimated doses received by populations living in the vicinity of nuclear installations are not sufficiently high to cause any detectable increase in leukaemia[6,18]. A recent study of the effects of fallout from atmospheric nuclear weapons testing in the 1950s and 1960s provides good evidence that the estimate of the risk of leukaemia per unit dose is not much too low[19]. It follows that either the received doses are grossly underestimated or the excess risk of leukaemia must be due to some other factors that differ between the installation and control LAAs. Thus, on present knowledge, it is difficult to attribute the leukaemia results found here to ionizing radiation, but it is also unclear what the other factors are that distinguish the installation LAAs from the LAAs with which they have been compared.

The other positive observation in the age group 0-24 years, that for all brain cancer, seems most likely to be due to chance. The detailed results for this cancer type are contradictory. The increasing risk with proximity to Sellafield contrasts with a decreasing risk with proximity to the CEGB installations. There is no suggestion of a hazard round Winfrith or the pre-1955 installations. The one significantly raised RR in discrete zone 2 around Sellafield derives from a comparison between five and zero observed deaths, while in discrete zones 3 and 4 the corresponding relative risks are less than unity (0.86 and 0.00 respectively).

Of the positive results in the older age group, 25-74 years, those for Hodgkin's disease present the most consistent evidence for an association with proximity to the installations. There is a tendency for the relative risk to increase with proximity to the installations around the pre-1955 installations, around Sellafield and Winfrith individually, and around all installations combined (Table 6). There is no notable trend in either direction around the CEGB installations. It should be noted, however, that the SMRs tend to be below or only slightly above the regional standard, except around Winfrith where an exceptionally high SMR was recorded in zone 1 (540.5 based on four cases).

Studies of populations exposed to high doses of radiation have not, so far, shown significant increases of Hodgkin's disease[12]. However, the available data are not inconsistent with a small increase. It is also entirely possible that the present results for Hodgkin's disease could be a consequence of the possible socio-economic or environmental differences between installation and control LAAs, especially as there is some evidence that the causes of the disease are influenced by social factors[20]. The positive result for all lymphomas in the innermost distance zone around the pre-1955 installations is accounted for by the result for Hodgkin's disease. If the latter is subtracted out then the remaining "other lymphomas" category shows no increased risk.

Previous observations on mortality from multiple myeloma are perhaps the most suggestive of all the data on adult cancers of a possible hazard associated with nuclear installations. The consistency of the results amongst both Sellafield[9] and the Hanford[10,11] workers has suggested that there may be a special hazard of myelomatosis associated with these installations. A dose-related increase in this disease has also been documented in Japanese atom-bomb survivors[12]. The observation in this study of a small increased relative risk in the LAAs of the coastal regions to the north and south of Sellafield (RR = 1.11, one-sided $P = 0.043$), and the above average value of 107.0 for the SMR in the same coastal areas provides some additional evidence for the association. The hypothesis would, however, seem to be contradicted by the tendency for the RRs to decrease with increasing proximity to all installations combined (two-sided $P = 0.093$) and particularly with increasing proximity to the pre-1955 installations (two-sided $P = 0.017$) and by the low SMRs in the LAAs immediately adjacent to Sellafield. The latter three LAAs are all on the coast and could be combined with the other 51 coastal LAAs. However, because they represent a very small proportion of the population in the group of coastal LAAs, the overall RR in the group is only marginally affected (RR = 1.09, one-sided $P = 0.079$).

All of the positive results around the CEGB installations are probably largely explained by the socio-economic differences between installation and control LAAs. This is made most apparent by considering the results for lung cancer and all malignancies in Tables 2 and 3. Both of these have RRs which are significantly elevated around the CEGB installations and significantly lowered around the pre-1955 installations and all installations combined. As lung cancer is such a major component of all malignancies, the similarity between the two categories is not surprising. Analysis of the results in discrete zones shows highly significant trends in RRs which decrease with increasing proximity to the installation for both lung cancer and all malignancies (two-sided $P = 0.005$ and 0.001 respectively around the pre-1955 installations and $P = 0.001$ and < 0.001 respectively around all installations combined). No significant trends are apparent around the grouped CEGB installations or around Sellafield or Winfrith.

The most likely explanation for these results is that social factors, especially smoking behaviour, have different distributions in the LAAs around the pre-1955 installations, especially within the inner distance zones, compared with the LAAs around the CEGB installations. The matching of control LAAs does not fully allow for this and, as such large numbers of deaths are involved, even moderate differences between installation LAAs and control LAAs produce statistically highly significant results.

A similar explanation can be made in relation to liver cancer which, like lung cancer, is only elevated around the CEGB installations. Liver cancer has not, to our knowledge, been associated with radiation exposure at low doses. A large excess of liver tumours has been seen in patients injected with the radioactive contrast medium thorotrast[17], and the liver was selected as a specific site for this study because inhaled or ingested plutonium might act in the same way. However, the CEGB installations do not discharge substantial quantities of plutonium[4] and one would have expected any effect to have been more evident in LAAs around the pre-1955 installations. The diagnosis of liver cancer as a cause of death after about 45 years of age is, moreover, extremely unreliable and most deaths attributed to this cause are likely to be due to metastases from primary cancers in the lung, stomach or large bowel. It is, therefore, only to be expected that liver cancer will show a similar relationship with vicinity to nuclear installations as is shown by lung cancer and all malignancies.

Further evidence that the significant results around the grouped CEGB installations are not caused by radioactive discharges from the installations is provided by comparing the RRs in the LAAs before and after start-up (Table 8). This shows very little difference between the two time periods in the SMRs or the RRs for liver cancer, lung cancer, or for all malignancies.

The result for "unspecified brain and central nervous system tumours" in the age group 25-74 years is presumably either due to chance or to diagnostic artefacts. The excess is more than compensated for by the deficiency of brain tumours specified as benign or malignant.

Summary

The OPCS report on cancer incidence and mortality in the vicinity of nuclear installations in England and Wales provides a mass of information that is so large that it should be possible to detect quite small changes in disease levels with considerable confidence. The data on cancer mortality are less subject to selective bias than the registration data on which incidence rates are based, and they provide the firmest grounds on which evidence of any effect can be obtained.

These data show conclusively that there has been no general increase in cancer mortality in the vicinity of nuclear installations in a 22-year period beginning several years after the opening of the installations that have released the largest amounts of radionuclides to the environment. On the contrary, the mortality from cancer has tended to be lower in the LAAs in the vicinity of nuclear installations than in control LAAs selected for their presumed comparability with the former. This is unlikely to be due to a protective effect of ionizing radiation and suggests that, despite the efforts that were made to choose comparable control areas, there were non-installation differences between the populations relevant to the risk of dying from one or other type of cancer.

Detailed examination of the few types of cancer that were relatively more common in the installation areas suggests that several of the differences were most likely to be due to chance, diagnostic artefacts or social factors rather than to any hazard specifically related to the installations. One disease provides a possible exception: namely, leukaemia in the age group 0-24 years. Two other diseases need further investigation, multiple myeloma and Hodgkin's disease in the older age group 25-74 years. The excess mortality rates recorded from these cancers were not large, and it has yet to be established that they are not due to general confounding by other environmental or socio-economic factors.

We thank Miss Cynthia Dates for typing the numerous drafts of this paper.

Table 9 Standardized mortality ratios (SMR) for lymphoid leukaemia in installation LAAs and relative risks (RR) of installation LAAs to control LAAs, individual pre-1955 installations, 0-24 years age group, discrete distance zones

Installation		Discrete distance zone 1	2	3	4	Trend Sign[§]	Probability[‖]
BNFL Springfields	SMR	134.2	104.8	184.0*	170.9		
	RR	2.317	1.93	1.071	1.44	•	0.330
BNFL Capenhurst	SMR	70.5	115.4	14.6	81.7		
	RR	1.13	0.84	0.28	1.09	•	0.311
Amersham Int plc	SMR	171.2	61.6	37.4	93.2		
	RR	3.951	0.87	1.03	0.83	•	0.040
MOD, Aldermaston	SMR	—‡	159.1	89.4	46.9		
	RR	—	0.90	0.77	0.52	•	0.701
UKAEA, Harwell	SMR	77.6	67.8	67.1	—‡		
	RR	2.54	0.57	0.41	—	•	0.338

* P < 0.01 (one sided test for increase above 100 (SMR) or unity (RR))
† P < 0.05 (one sided test for increase above 100 (SMR) or unity (RR))
‡ No LAAs in this distance zone
§ Sign of trend in RR with increasing proximity to installation.
‖ Probability of trend arising due to chance (two-sided test).

Appendix Sites of cancer, and combined groupings of sites*, which are covered in the OPCS report[1] and are discussed in this article

All malignant neoplasms (Mn)
All leukaemia
Lymphoid leukaemia†
Non-lymphoid leukaemia†
Myeloid leukaemia†
Monocytic leukaemia†
Other leukaemia†
Unspecified leukaemia†
Mn of liver
Mn of lung‡
Mn of bone
Mn of testis
Mn of thyroid
All brain
Mn of brain
Benign neoplasms of brain and central nervous system‖
Unspecified neoplasms of brain and central nervous system‖
All lymphomas
Hodgkin's disease§
Other lymphomas§
Multiple myeloma§
All lymphomas plus leukaemia

* Three of the grouped cancer sites examined in the OPCS report (namely, all malignancies less leukaemia, all malignancies less leukaemia and lung cancer, and all malignancies less leukaemia and brain cancer) were included for the sake of completion of specific analyses. We have excluded them from our analyses.
† Information on leukaemia subtypes was only available since 1968.
‡ For these cancer sites, for the age group 0-24 years only, data relating to the grouped CEGB installations have been used since 1966 and not since start-up of the installation.
§ For these cancer sites, data relating to the grouped CEGB installations have been used since 1966 and not since start-up of the installation for all age groups.

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The authors are at the Imperial Cancer Research Fund Cancer Epidemiology and Clinical Trials Unit, Radcliffe Infirmary, Oxford OX2 6HE, UK.

STATE OF HAWAII

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

1035B:538

November 23, 1988

Dr. Paul W. Dixon
Social Sciences Division
College of Arts and Sciences
University of Hawaii at Hilo
Hilo, Hawaii 96720-4091

Dear Dr. Dixon:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 19, 1988, to Mr. Maurice Kaya, DBED's Energy Program Administrator, regarding the subject Draft EIS. The following is provided in response to your letter.

Your new submittals will be included in the Final EIS. Your analysis was considered by Dr. Paolo Ricci when he prepared the assessment of risks associated with eating irradiated fruit (see Appendix G.1 of the EIS). His research resulted in the conclusion that there is no measurable risk posed by eating irradiated fruit. He concurs with Drs. Lewin, Rubbia, and Hecker with regard to your analysis.

The article in Nature magazine assesses the cancer risk associated with nuclear power plants in England. It concludes that "[t]hese data show conclusively that there has been no general increase in cancer mortality in the vicinity of nuclear installations..." This conclusion could support the EIS analysis that general operation of the irradiation facility is safe, although this article does not address irradiators, specifically.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

East Hawaii Coalition To Stop Food Irradiation

A Non-Profit Citizen Action Group

October 14, 1988

James W. Frolich
Westec Sevices Inc.
1221 State Street, Suite 200
Santa Barbara, CA. 93101

Dear Mr. Frolich,

Enclosed please find comments on the draft Environmental Impact Statement for the Hawaii Commodities Irradiation Facility. We are looking forward to you comments on our comments.

These comments represent the questions and concerns of the East Hawaii Coalition to Stop Food Irradiation and the 7 members of the Steering Committee:

Kathy Dorn
Anthony Almada
Ginny Aste
Cathy Chow
Colleen Mandala
Hal Schwartz
Susan Gilbert M.D.

Did you ever work on irradiation projects in Oklahoma and/or the Caribbean?

Aloha,

Kathy Dorn

Kathy Dorn
Director

P.O. BOX 1559 ■ PAHOA, HAWAII 96778 ■ (808) 965-7140

COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT
for the
HAWAII COMMODITIES IRRADIATION FACILITY
from
THE EAST HAWAII COALITION TO STOP FOOD IRRADIATION

I. Technical

1) What were the results of the Queensland Food Research Laboratories studies on the irradiation of mangoes for mango weevil control? Reports have indicated that the dose necessary to sterilize or kill the weevil destroys the quality of the fruit. (Consult with Dr. Jack Armstrong)

2) Since a single hot water dip has been determined to be an essential pre-treatment to the irradiation process, is it correct to insist that irradiation is a cold treatment? Would this single hot water dip cause the hardening and lumpiness occasionally found in winter fruit?

3) Has the USDA-ARS Waiakea Experimental Farms, in Hilo established the fact that a single hot water dip is an effective quarantine treatment for lychee fruit? If this is true, could irradiation ever become a feasible treatment for lychee since the hot water dip would be needed for fungus control?

4) On page 3-7, dry heat is described as an unproven process which cannot be considered a reliable alternative to irradiation. On page 3-9, irradiation is described as an "effective disinfestation method". It seems that irradiation is also an unproven technology for treatment of tropical fruit - otherwise why the need for a 3 year "demonstration" phase? Could it not equally be said that irradiation cannot be considered a reliable alternative to the dry heat method until additional technical and marketing studies have been conducted? Does this reveal an inherent bias in the EIS?

5) Discuss the findings of Robert Paull Ph.D. (Dept. of Plant Molecular Physiology - UH Manoa) on the irradiation of papayas.

6) Does irradiation cause softening of tissues resulting in increased susceptibility to transport injury?

7) Please call each double dip packing plant and ask them exactly how many workers they employ.

II. Economic

1) On Oct. 18, 1984, Manuel C. Lagunas Solar and Stephen M. Mathews from the Lawrence Livermore Laboratory published a report entitled "*Comparative Economic Factors on the Use of Radionuclide*

or Electrical Sources for Food Processing with Ionizing Radiation" In this report the authors stated that Cobalt-60 was in short supply and that there were long delays between the initial purchase order and delivery of the isotope. Is this still true? If it is true how would this situation impact the Hawaii Commodities Irradiation Facility?

2) Congress cut off funding to the Department of Energy's (DOE) Byproducts Utilization Program (BUP) in 1988. The BUP was the source of funding for the DOE's food irradiation projects. How will this recent development effect the Hawaii Commodities Irradiation Facility project? How much money does the DOE have for the food irradiation projects and is this amount enough to fund all 6 demonstration projects? If not, which ones will be eliminated?

3) It has been proven that CH2H Hill was under direct contract to the DOE to promote the Byproducts Utilization Program and had received $3 million for their promotional efforts as of 1987. CH2H Hill is in the business of designing, building, owning and operating irradiation facilities and has had a keen public interest in the promotion of the food irradiation concept. How could this conflict of interest effect the outcome of the feasibility study which the firm conducted for the State of Hawaii in 1987?

4) On page 10-13 of the Feasibility Study conducted by CH2H Hill, the following statement is made: "An irradiator located on the Island of Hawaii could potentially be cost competitive but would need to treat all the current exports." In light of the success of the vapor heat, the refusal of Japan to accept irradiated food, and the optimistic outlook of the dry heat method, how can an irradiation facility ever be economically feasible?

5) On page 2-8 of the EIS, it is stated that the facility would have the capacity to treat at least 20 million pounds. What would be the maximum capacity of the facility? CH2H Hill described a facility which would have the capacity to treat 135 million pounds per year. Is the 20 million pound annual throughput the actual capacity of the proposed facility? If this is true, the facility would be much too small to treat the papayas annually produced on the Big Island let alone lychee and other alternative commodities. Has the Hawaii Commodities Irradiation Facility been downgraded to a research facility? If this is true, isn't it imperative that the papaya industry move ahead with development of the dry heat method as quickly as possible?

6) What was the eventual outcome of the test marketing of irradiated papayas which occured in the Spring of 1987 at 2 supermarkets in Southern California?

7) How much electricity would the irradiation plant use every year?

III Social and Psychological

1) Out of the 66 people who testified on May 5, at the public hearing on the EIS, 64 spoke against the facility and 2 spoke in favor. If this is an accurate reflection of public opinion on the irradiation project, what are the social and psychological implications of proceeding with this project in the face of such concern?

Health and Environmental

1) Please review the recent accident at the Radiation Sterilizers plant in Decatur Georgia which resulted in Cesium-137 contamination of the building, 10 workers and some treated milk cartons.

2) Describe the dangers involved in transportation of radioactive Cobalt-60 by barge, truck and airplane. What would be the result of an accident at sea, on the highway, or as a result of an airplane crash? How would the radioactive Cobalt-60 be transported to Hilo?

3) According to the map in the phone book, Site B is within the tsunami inundation zone. Also, according to Walt Dudley Ph.D, professor of Marine Biology and Oceanography at UH Hilo, the inundation lines are going to be seriously re-evaluated this year. In light of these facts is it valid to conclude that "the risk of the facility to tsunami damage is nonexistent"? (page 4-37)

4) Page G-15 of the External Events Risk Assessment, reference is made to the fact that "During historic times, tephra falls in excess of 15 centimeters have occured within about 2 kilometers of active vents." In the light of the findings of Millineaux and others (Millineaux, D.R., and Petersen, D.W.and Crandell, D.R. *Volcanic Hazards in the Hawaiian Islands;* Chapter 22 in Decker, R.W., Wright, T.L., and Stauffer, P.H.: *Volcanism in Hawaii,* U.S. Geological Survey Prof. Paper 1350 - 1897), who assess the hazard to Zone 3 is 15% to 20% for the last 750 years, can the risk really be considered miniscule?

5) Please cite exact source for the contention that lava flows are too viscous to enter irradiation chamber through the labyrinth (P. G-48)

6) The flow adjacent to the Airport is 1,500 years old. about 2 miles wide and 50' thick. (Lockwood, and Lipman) What would the result be of the irradiation facility being covered by a 50' thick lava flow assuming that the radioactive material was contained within?

7) What would be the effect of a spill of radioactive contaminated water outside the facility as happened at the Hawaii

Development Irradiator (HDI)? How would this efffect the groundwater and Hilo Bay?

8) Is it possible that workers at the HDI whose boots had become contaminated from a spill of Cobalt-60 contaminated water (as assumed in the Baltzo decontamination report), tracked radioactivity into their cars and homes as happened at the recent Decatur Georgia accident? Is there any possibility that there is still contamination at these homes?

9) Is it possible that terrorist activities could occur at the irradiator site?

10) What would be the health effect on the surrounding population of the allowable 500 mrem annual dose of low level radiation?

11) What are the risks of human exposure to the radioactive material due to human error or systems failure?

12) What is the difference between a detectable health effect and a true health risk?

13) Rockwell International is named as a resource for training programs on page 4-7. Review the list of management problems encountered by Rockwell International at the Rocky Flats plutonium plant in Denver as reflected in the case:

14) How do radionuclides concentrate in the food chain?

15) Is there a safe level of exposure to ionizing radiation?

16) On page 4-31, the statement "Explosives detonated in contact with 1.5 million curies of cobalt-60 metal could result in a 50 year effective dose commitment of 25 rems for the maximum exposed individual at a distance of 1 kilometer. . . This level of dose commitment is generally presumed to have no adverse health effects." How can this statement be credible when there is data which shows that a dose of only one tenth of one rem in the first trimester of pregnancy can cause a significant increase in the incidence of childhood cancer and leukemia? How can this be explained in light of the results of the study of workers at the Rocky Flats plant which found significant increases in cancer deaths in those with exposures of greater than one rem as opposed to those with exposures of less than one rem.

17) What would be the result of a fire in which the vaporization point of Cobalt-60 is reached and maintained for more than an hour, assuming that the source is in the exposed position?

18) Could the irradiation facility become a target in the event of a nuclear war? What would be the effect of a spontaneous release of 150,000 curies of cobalt-60?

19) On page G-46 of the External Events Risk Assessment, the following statement is made: "the largest earthquake recorded in Hawaii in modern times was an earthquake of Modified Mercalli (MM) intensity IX." What time span is represented by the term "modern times?" Would not historical time be a more accurate time frame within which to assess the earthquake hazard? In 1868, Ka'u recorded an earthquake of MM intensity X. (Furumoto et al, Hawaii Institute of Geophysics, TACE 72033, 1972). What does this say about ground acceleration and the accuracy of the seismic risk assessment in the EIS?

20) Please give exact reference for the statement on page G-46 which refers to Sanders et al's statement that "this value represents the expected peak horizontal ground acceleration occuring with a frequency of 2.5 x 10-4 per year" What was the rationale upon which this frequency was based?

21) On page G-47, it is stated that the "acceleration necessary to exceed the ultimate static moment of the irradiator facility structure is estimated to be on the order of 1.2g. This figure is approximately twice as large as any recorded earthquake in the U.S." This means that the largest earthquake ever recorded in the U.S. would have been on the order of .6g. Are you sure that this is accurate?

22) Name the exact individuals responsible for the External Events Risk Assessment.

IV Food Safety

1) What rationale did the State of Maine have in banning the sale of irradiated food?

2) Why has the British Medical Association warned of potential adverse long term health hazards from consuming irradiated food?

3) In Appendix G, page G-2, the statement "the types of compounds formed from irradiation have not been found toxic" is inaccurate. On page G-10, it is revealed that indeed, the highly carcinogenic chemical formadehyde (radiolytic sugar products) are present in higher concentrations in irrradiated food than non-irradiated food. What accounts for this conflict in the EIS document?

4) On June 19, 1987, Congressman Henry Waxman, Chairman of the Subcommittee on Health and the Environment of the Committee on Energy and Commerce, held a hearing on H.R. 956, the Food Irradiation Safety and Labelling Requirement Act. At this time experts gave testimony on the well-documented potential adverse effects of eating irradiated food. Please review the testimony of Dr. Donald Louria, Dr. George Tritsch, Dr. Richard Piccioni, and

Dr. S.G. Srikantia. (This information was provided by EHCSFI to Westec)

5) What were Dr. Louria's findings when he reviewed the 5 tests which the FDA relied upon to prove the safety of eating irradiated food?

6) Describe Dr. Srikantia's defense of the Indian Feeding Study.

7) Why has the Chinese study on induced polyploidy never been published in a refereed journal?

8) In the footnote on page G-9, who decided that the Russian studies were no good?

9) Page G-10 a reference is made to the Ames test which showed formation of formaldehyde by irradiation of sugar. Please refer to the following article: Lave, L.B., Omenn, G.S., "Cost Effectiveness of Short Term Tests for Carcinogenicity," Nature. 324:29; 1986. What does this article say about the Ames test?

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

10358:555

November 30, 1988

Ms. Kathy Dorn
East Hawaii Coalition to Stop Food Irradiation
P.O. Box 1559
Pahoa, Hawaii 96778

Dear Ms. Dorn:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 14, 1988, to Mr. James Frolich of WESTEC Services, our EIS consultant, regarding the subject Draft EIS. The following is provided in response to your letter, enumerated to follow the sequence listed in your letter.

I. 1) The facility may be used to test the effects on mangoes, lychee, and other fruits in determining the commercial viability of disinfestation by irradiation.

2) Hot water dip is not an essential part of the irradiation treatment to meet quarantine requirements, but is done to treat for fungus. Thus irradiation is not a hot process.

3) See response 1, above.

4) Irradiation has been proven to be a technically viable method of fruit fly disinfestation. As such, it has been approved by the U.S. Department of Agriculture (USDA) for meeting quarantine requirements. The demonstration project will test the commercial viability of irradiation. Dry-heat has not been demonstrated to meet quarantine requirements and has not yet been approved by the USDA. As noted in the Draft EIS, dry-heat may ultimately prove to be a viable disinfestation alternative.

5) Dr. Paull was consulted during preparation of the Draft EIS and his findings were incorporated (See, for example, page D-8).

6) The effects on the transportability of fruit from commercial level treatment will be addressed during the demonstration project.

7) The packers' association, the Papaya Administrative Committee (PAC), was consulted. PAC declined to provide employment figures.

II. 1) During project development, AECL, a potential cobalt supplier, indicated that the facility can be provided with the required amount of source.

2) The status of DOE's program is important, but irrelevant to the environmental review process. DBED has an agreement with DOE for the project, and completion of this project is contingent on the availability of federal funds to satisfy that agreement.

3) CH2M Hill's role in the irradiation field is irrelevant to the environmental review process. Absent of any specific comments on bias-induced misinformation in the 1987 study, we must assume that it is an objective review of the project's feasibility.

4) CH2M Hill addressed the potential economics of a larger-scale commercial facility. The actual economic viability of commercial treatment is a matter to be confirmed with the demonstration facility.

5) See the previous response. The Hawaii Commodities Irradiation Facility has not been downgraded to a research facility. During the 3-year demonstration period, the facility will have a capacity of at least 20 million pounds per year. The industry reports that it encourages exploration of all potentially viable methods of disinfestation.

6) As discussed in Appendix I of the Draft EIS, consumers preferred the irradiated papaya over that which was double-dip treated. See the reference Bruhn and Noell article for further information.

7) As stated in the Draft EIS (page 2-16), the facility will use 1200 kilowatt hours per day. The majority of this electricity is consumed by refrigeration activities.

III. 1) This EIS is intended to provide the public with objective information on the irradiation project. The educational aspects of the demonstration program are also intended to provide the public with accurate information on irradiation.

1) Based on very preliminary information, it appears that Cesium-137 leaked into the storage pool water where it dissolved, thus contaminating the water. Water may have dripped onto the product, contaminating the product. Such a scenario would not occur in a facility using non-soluble Cobalt-60, as is proposed here. Until the U.S. Nuclear Regulatory Commission (NRC) investigations are complete, it would be inappropriate to speculate further.

2) Refer to the NRC EIS referenced on page G-30 of the Draft EIS for further information on transportation.

3) On September 16, 1988, (subsequent to publication of the Draft EIS), the Federal Emergency Management Agency (FEMA) revised its flood insurance maps. All three sites are now Zone X - outside the 500-year flood plain. (See comment letter from the Corps of Engineers in the Final EIS.) Thus the conclusions in the Draft EIS are valid.

4) The Draft EIS conclusions, based in large part on Mullineaux, are valid.

5) CH2M Hill 1987.

6) The risk to the irradiator from lava flows is covered on pages 4-3 through 4-9 of the DEIS. The risk is extremely low. Further, with short advance notice, the Cobalt-60 could be safely removed from the facility and shipped to a suitable mainland facility.

7) If contaminated water were spilled, contamination would result. The magnitude of effect would depend on the extent and location of a spill and the location of potentially exposed populations. Proper response measures should preempt contamination of water resources.

8) We have no basis to evaluate the HDI incident further. The relevant point to be made here, however, is that the demonstration facility will be required to adhere to strict standards and procedures to avoid contamination.

9) Terrorist activity could occur anywhere. We have no indication that Hilo, or specifically the irradiation facility, would be a unique target.

10) This requires calculation by choice of the appropriate dose response (see Health Risks of Radon and other Internally Deposited Alpha-Emitters BIER IV, National Research Council, 1988) and knowledge of the subpopulations at risk. Thus a rough answer using the single-hit model is not appropriate. If the subpopulations at risk were identified, the linear model can provide an upper bound of risk. Of course, the choice of dose-response function and the uncertainty must be accommodated for.

11) Such effects are addressed. The facility will be designed and operated to ensure that such failure does not result in significant effect to the public.

12) A true health risk is impossible to establish because of limitations in observability and the inherent stochastic nature of radiogenic cancer. A detectable health risk is determined by the population size and its distribution. The larger the population, the lower the detectable excess risk, all other things considered equal.

13) If Rockwell is demonstrated to be less than effective for training, it would not be utilized.

14) Any nuclide (radioactive or not) can be distributed according to its chemical behavior in the various components of the food chain through which it passes. However, some organisms may concentrate it and some may discriminate against it. Generally, when a radionuclide is incorporated into an organism, it is in a way that is governed by another element, usually one that is essential and similar chemically.

15) Yes. This subject is discussed in the EIS document.

16) The cited statement is not found on page 4-31. However, the source of the information presented in comment to the EIS is undocumented and questioned.

17) Under any expected fire scenarios, temperatures would be expected to be below Cobalt's bo''ing point.

18) It is unclear as to why the facility would be a strategic target in the event of a nuclear war. In any case, the effect of a nuclear bomb would far overshadow the effect of any release from the facility.

19) The earthquake intensity utilized in our assessment was identified from the referenced U.S. Geological Survey (USGS) Hawaii report. USGS is usually considered the most reliable source for such information. It is possible that your reference identified the intensity at Ka'u in 1868, very near the earthquake epicenter; intensities at Hilo would likely be less as Hilo is further away from the active fault structure. The analysis and conclusions in the Draft EIS are appropriate. Final facility design will have to demonstrate that the facility can withstand any credible expected earthquake.

20) The Sanders reference is shown on page A-6 of the Draft EIS and includes the equation used here.

21) The comparison of accelerations is included to put the facility in context. The .6g number is approximate.

22) As shown in Section 6 of the Draft EIS, Mr. Bruce Varnado was responsible for the assessment.

IV. 1) We have no information on the rationale for the State of Maine's political decisions. Hawaii's decisions on irradiation will be based on independent object review, such as this EIS.

2) The discussion of irradiated food safety, for purpose of the Draft EIS in review, examines only those scientific studies that offer conclusive, reliable, and sound findings on the irradiation of food and its effects. Although the position of the British Medical Association may be of interest, it does fall within this category of scientific literature.

3) Formaldehyde is not a "highly" carcinogenic chemical. Following are some facts about formaldehyde. (1) Formaldehyde is so widely found in the human environment the National Academy of Science suggests that it is reasonable to consider there is greater human exposure to formaldehyde than any other single chemical, with the exception of chlorine; (2) The EPA does not list formaldehyde for priority regulatory attention under the Toxic Substance Control Act (TSCA); (3) Formaldehyde is normal metabolite and vital chemical in the synthesis of essential biochemical substances in humans; and (4) The most recent epidemiological study on formaldehyde carried out by the National Cancer Institute indicates that deaths from all cases showed no consistent correlation with formaldehyde exposure. Also, you did not consider nor understand the context of the statement on page G-10 of the Draft EIS. The EIS explains that "The formation of these products (radiolytic sugar products) has been shown to be dose dependent and influenced by oxygen concentration as well as other specific conditions such as the presences of metal ions." It is also pointed out that when a food containing sugars is irradiated, the formation of radiolytic products is not the same as when sugars are irradiated in simple solution because of the reasons given.

4) All information provided during the EIS Preparation Notice and scoping process was considered in the EIS analysis.

5) The EIS analysis considered all perspectives on the subject. Specific conclusions of all other analysts need not, and could not, be included in the EIS.

6) No study or comment paper on irradiated food by a Dr. Srikantia was received, reviewed, or found in the literature. See previous response.

7) Information about the study's publication is unknown and is not relevant to the EIS analysis.

8) The FDA and EPA. Refer to Federal Register, Vol. 51, No. 75, April 18, 1986 (p. 13386 - 13387) in Appendix H of the Draft EIS.

9) This question is not appropriate to the EIS. It is not the place of the EIS to review the body of literature regarding the Ames test. It requests information on a review that is, first, obviously already known by the questioner, and second, is not a direct question to the Draft EIS. Review of the Ames, and many other short-term in vitro tests, requires analysis far beyond that required for an EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC ✓

COPY

DEPARTMENT OF PARKS & RECREATION
COUNTY OF HAWAII
HILO, HAWAII 96720

October 5, 1988

Marvin Miura, Ph.D
Office of Environmental Quality Control
465 So. King Street, Room 104
Honolulu, Hawaii 96813

Subject: Hawaii Commodities Irradiation Facility - Draft EIS

We have reviewed the draft report and have no comments to offer. The report is being returned for your further use.

Thank you.

PATRICIA G. ENGELHARD
Director

PE:GM:vy

Enc.

cc: ✓WESTEC Services, Inc.
Attn: James Frolich

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

10358:538

November 23, 1988

Ms. Patricia G. Engelhard, Director
Department of Parks and Recreation
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Ms. Engelhard:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 5, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

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October 12, 1988

John C. Lewin, M.D.
Director
Department of Health
1250 Punchbowl Street
Honolulu, Hawaii 96813

Re: Environmental Impact Statement for a Hawaii Commodities Irradiation Facility.

Dear Dr. Lewin:

How is it that I can casually dig up all sorts of references indicating that the irradiation of food is not something we should rush into when the state claims there is nothing in the literature to indicate any problem?

By a copy of this letter I request that this letter and the attached journal article be included as comments in the envrionmental impact statement. I demand that each and every reference and bibliography reference cited in the attached paper be addressed in the environmental impact statement.

Sincerely,

Robert W. Hall
President & Director

RH:bh
cc: Maurice Kaya
Energy Program Administrator
Energy Division
Department of Business & Economic Development

Enclosure:

K-21

Int J Biosocial Res. Vol. 9(2); 203-212, 1987 0731-9169/87/09/203/$2.50/0 Printed in the USA.

Research Opinion

Analyses of Data on the Impact of Food Processing by Ionizing Radiation on Health and the Environment

Richard Piccioni, Ph.D.
Senior Staff Scientist
Accord Research and Educational Associates, Inc.
New York, New York

Abstract

The author examines the process of food irradiation, its basis of regulatory support, and viability. A review of published bioassay studies on irradiated organic media and foods indicates excessive positive findings for mutagenicity, chromosomal damage, teratogenicity, or cytotoxicity. The author recommends that approval of food irradiation processing by regulatory agencies be rescinded for two reasons: 1) major unresolved microbiological questions arising about the safety of gamma processing of salmonella-contaminated foods; and, 2) the lack of the dose-exaggeration factor essential in toxicological tests related to "massive" feeding studies of irradiated foods. (Int J Biosocial Res., 1987; 9(2); 203-212.)

Key words: Food irradiation; gamma food processing; nutrition; food safety.

The Unique Nature of Food Irradiation Processing

Treatment of food with ionizing radiation presents issues of food safety qualitatively unlike those posed by any other food processing method or food additive. The large amount of energy contained in ionizing radiation provides the potential for exceedingly complex chemical transformation of food components, including the production of mutagenic or carcinogenic substances which were not present or were present in far smaller amounts, before irradiation. This potential far exceeds that of ordinary heat processing, microwave radiation, etc., because the energy contained in each "quantum" of gamma radiation is so great. At the same time, because the production of these "radiolytic products" takes place within the food itself, it is impossible to design a toxicological test in which animals are exposed to exaggerated doses of these products, the chemical identity of which remains largely unknown. Thus toxicologists are limited to biological testing which is thousands of times less sensitive than the testing typically required of other chemical additives or pesticide residues.

Correspondence address:
314 West 91st Street
New York, NY 10024 USA

Received: October 16, 1987. Accepted: November 21, 1987.

LIFE OF THE LAND

Sept 16, 1988

RECEIVED '88 SEP 21 A9:24 OFC. OF ENVIR. QUALITY CONT.

Mr. Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 South King Street
Honolulu, Hawaii 96813

Dear Dr. Miura:

The Hawaii Island Chapter of LOL wishes to comment upon the Draft EIS for the Hawaii Commodities Irradiation Facility.

We find the readability of the Draft EIS to be good.

However, the document falls far short of DOH Chapter 200 requirements in regard to its response to comments received during the Consultation and Preparation process. In most cases Westec has chosen to give a succinct reply indicating that the subject material of the comments will be addressed in the EIS. However, in numerous instances the issues raised were neither addressed substantively in the reply by Westec nor in the EIS. Sometimes the text of the Draft EIS ran counter to the comments received, with no indication that the comments had even been considered whatsoever. Chapter 11-200-18(4) prescribes the obligation of Westec to make appropriate and substantive response.

Since more comments will be forthcoming in the review process, there will be a lot of work required to bring the Final EIS up to an acceptable level of quality and thoroughness. Our purpose in bringing this to your attention is not one of harrassment, but rather to ensure that the EIS lives up to its function of complete and coherent disclosure.

In substantive matters, we have two comments/questions. First, since the operation will lower the radioactive material into a large water bath when inactive, what is the disposition of the water, and what is its radioactive level and potential for contamination? If the facility is discontinued, how will the water be disposed of? Second, it appears that decommissioning is to be undertaken only at the discretion of the operator. Does the County or the State have authority to request and require that the facility be decommissioned?

Thank you for your attention to these comments.

Sincerely,

Bill Graham
Box 155
Hawi, HI 96719

cc: Westec

19 Niolopa Place, Honolulu, Hawaii 96817. Tel. 595-3903

K-20

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Bill Graham
Life of the Land
P.O. Box 155
Hawi, Hawaii 96719

Dear Mr. Graham:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 16, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

All EISPN comments were reviewed in depth and seriously considered. Where comments provided relevant direction, they were utilized in the analysis. Chapter 200 does not require rebuttal of all comments that are counter to the conclusions of analysis conducted in preparation of the EIS. We note that you have not provided specific examples; we cannot, therefore, respond any more specifically.

In a wet storage irradiator, water will remain in the pool and its circulating filter system. The pool will have sufficient freeboard to allow submersion of the source without overflow. Under normal operation, water will not be radioactive; monitor systems, as described on page 2-18 of the Draft EIS will confirm this. Should water somehow become contaminated, it would be treated as a radioactive waste under the procedures identified on page 2-21. No contaminated water would be released to Hawaii's environment. Decommissioning can be a required condition by regulatory agencies as a remedy for noncompliance with permit, lease, and license conditions.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

It should be clearly understood that without toxicological testing at exaggerated doses, the carcinogenic risk to large human populations ingesting any additive or residue is impossible to assess. Exposure of test animals to exaggerated doses is the most basic tool in use in estimating carcinogenic risk. In the case of food irradiation, this tool is simply not available.

At the same time evidence from other types of experiments provides a strong indication that mutagens and/or carcinogens are indeed present in irradiated foods. What such experiments are unable to provide, however, is a quantitative estimate of the risk. In the absence of such an estimate, it is completely irresponsible to proceed with the sale and distribution of irradiated foods. Consequently, recent approvals by the U.S. Food and Drug Administration (FDA) for food irradiation processing should be immediately rescinded.

Basis of FDA's Approvals

To understand how this has come to pass, we must briefly review some recent history.

In 1979, after years of controversy and false starts, radiation food processing was re-evaluated by a specially appointed FDA committee, the Bureau of Foods Irradiated Foods Committee (BFIFC). They acknowledged that feeding whole, irradiated foods to test animals, even over long periods of time, was completely inadequate to assess the carcinogenic potential of the radiolytic products present in those foods. As an alternative to direct biological testing, they proposed acceptance of theoretical calculation of the maximum concentration of radiolytic products present in irradiated food and made the extraordinary leap of faith that parts-per-million residues of unknown substances pose no risk when ingested by millions of people over their entire lives.

Subsequently, an FDA task force reiterated the BFIFC recommendation, and reported the results of an elaborate "review" of the available literature on the toxicological testing of irradiated foods, testing which they, as well as the BFIFC, agreed was inherently incapable of providing definitive evidence of the safety of irradiated foods. The five studies which have been mentioned by others at this hearing provided, according to the FDA itself, only the assurance that irradiated food is not wildly mutagenic and/or carcinogenic. The task force therefore justified its conditional approval of irradiation of fruits and vegetables with up to 100 kilorad, and spices with up to 3 million rad, on the same theoretical basis as proposed by BFIFC.

Positive Evidence of Carcinogenic Risk

Proponents of food irradiation commonly claim there are no studies in the scientific literature showing mutagenic or carcinogenic activity in irradiated foods or food components. In fact, as our own literature survey has shown (Table 1.) dozens of such studies exist, observed in a variety of biological systems, published by a variety of authors in a variety of peer-reviewed scientific journals over a period of twenty years. Proponents of food irradiation commonly claim that the chemical changes occurring in irradiated foods are thoroughly understood, and that there have been no studies indicating the formation of known mutagens or carcinogens. In fact, a substantial number of studies can be found in the open scientific literature indicating the presence of known mutagens, carcinogens, or cytotoxic substances in food or food components which have been irradiated (Table 2.). Furthermore, the radiation chemistry of foods is far from fully understood, as evidence by a steady appearance in the literature of studies on new radiolytic products found in various irradiated foods.[1,2] Many of these radiolytic products have not been individually tested for mutagenicity or carcinogenicity.

In short, the available scientific literature provides evidence to make a strong presumption of carcinogencity in some if not all irradiated foods. The question is one of quantifying the risk.

Pesticide Replacement

In the absence of a quantitative estimate of the carcinogenic risk posed by the consumption of irradiated foods, there is no basis to the further claim that food irradiation could replace carcinogenic pesticides with an improvement in the overall quality of the food supply. Recently, the National Academy of Sciences (1987) identified 23 pesticides which are responsible for the vast majority of the total carcinogenic risk posed by the presence of pesticide residues in the U.S. food supply. Food irradiation would make essentially no contribution to the elimination of these pesticides since of the 23, several are herbicides or insecticides applied in the field to prevent pre-harvest losses [3], and the remainder are fungicides, whose replacement by irradiation is a highly dubious proposition.[4] In fact irradiation of fruits and vegetable may well increase, rather than decrease, the requirement of post-harvest application of fungicides because irradiated products are more susceptible to infection by molds and fungi.[5]

Radiation Treatment of Salmonella-contaminated Poultry

On the question of the use of ionizing radiation to inactivate Salmonella in poultry, it is important to understand two points:

Table 1.

Bioassays on Irradiated Organic Media and Foods Showing Positive Mutagenicity, Chromosomal Damage, Teratogenicity, or Cytotoxicity

Author(s)	Date	Irradiated Material	Observation	Observed In
Kuzin & Kryukova	1961	plant leaves	chromosomal damage	plant embryos
Swanubathan et. al.	1962	potato mash	chromosomal damage	barley embryos
Kuzin	1963	plant leaves	mutagenicity of extracts	plant cells
Swaminathan et. al.	1963	culture medium	mutagenicity	drosophila
Chopra & Swaminathan	1964	potato mash	devel. abnormalities	barley embryos
Molin & Ehrenberg	1964	culture medium	cytotoxicity	bacteria
Berry et. al.	1965	various sugars	cytotoxicity	human & mouse cells
Chopra	1965	culture medium	probable mutagenicity	bacteria
Holsten et. al.	1965	coconut milk, sucrose	chromosomal damage	carrot explants
Parkash	1965	nucleic acids	mutagenicity	drosophila
Rinehart & Ratty	1965	culture medium	mutagenicity	drosophila
Frey & Pollard	1966	culture medium	mutagenicity	bacteria
Shaw & Hayes	1966	sucrose	chromosomal damage	human lymphocyutes
Hills & Berry	1967	glucose	cytotoxcity	mouse fibroblasts
Hollowell & Littlefield	1967	plasma	chromosomal damage	human lymphocytes
Makinen et. al.	1967	pineapple	chromosomal damage	onion roots
Parkash	1967	nucleic acids	mutagenicity	drosophila
Rinehart & Ratty	1967	nucleic acids	mutagenicity	drosophila
Rinehart & Ratty	1967	culture medium	mutagenicity	drosophila
Schubert et. al.	1967	sucrose	cytotoxicity	bacteria
Steward et. al.	1967	sucrose	cytotoxicity	carrot explants
Hollowell & Littlefield	1968	plasma	chromosomal damage	human leucocytes
Melette et. al.	1968	wheat endosperm	mutagenicity	wheat
Ammirato & Steward	1969	sucrose	devel. abnormalities	plant root cells
Chopra	1969	culture medium	mutagenicity	bacteria
Moutschen-Dahmen et. al.	1970	laboratory diet	preimplantation death	mouse
Schubert & Sanders	1971	various sugars	cytotoxicity	bacteria
Kopylov et. al.	1972	potatoes	mutagenicity of extracts	mouse (sperm cells)
Kopylov et. al.	1973	potatoes	mutagenicity	mouse
Bhaskaram & Sadasivian	1975	wheat	polyploidy	malnourished children
Vijayalaxmi & Sadasivan	1975	wheat	chromosomal damage	rat (bone marrow)
Vijayalaxmi	1975	wheat	polyploidy	rat (bone marrow)
Vijayalaxmi	1976	wheat	mutagenicity	mouse
Vijayalaxmi	1976	wheat	sperm count reduction	mouse
Vijayalaxmi	1976	wheat	polyploidy	mouse (bone marrow)
Vijayalaxmi	1976	wheat	aneuploidy	mouse (bone marrow)
Vijayalaxmi & Rao	1976	wheat	mutagenicity	rat
Vijayalaxmi & Rao	1976	wheat	sperm count reduction	rat
Aiyar & Rao	1977	various sugars	mutagenicity	bacteria
FAO/IAEA/WHO	1977	potatoes	mutagenicity of extracts	mouse
Renner	1977	laboratory diet	polyploidy	hamster
Levina & Ivanov	1978	laboratory diet	autoimmune disease	rat
Vijayalaxmi	1978	wheat	low antibody levels	rat
Vijayalaxmi	1978	wheat	polyploidy, other effects	monkeys
Wilmer et. al.	1979	nucleic acids	mutagenicity	bacteria
Ivanov & Levina	1981	laboratory diet	testicular abnormalities	rat
Wilmer et. al.	1981	nucleotides	mutagenicity	bacteria

Table 2.

Identification of Mutagenic, Carcinogenic, or Cytotoxic Radiolytic Products in Irradiated Organic Media or Food [9]

Author(s)	Date	Irradiated Material	Radiolytic Product	Comments
Kuzin	1965	plant matter, calf thymus, tyrosine	orthoquinones orthoquinones	carcinogenic carcinogenic
Berry et al	1965	dextrose, fructose	glyoxal formaldehyde	mutagenic mutagenic
El-Zeany	1980	buffalo meat	peroxides carbonyl compound	mutagenic cytotoxic
*Gower & Wills	1986	benzpyrene, starch & oil mixtures	benzo (a) pyrenes quinones malonaldehyde lipid peroxides	carcinogenic carcinogenic mutagenic mutagenic
Schubert et al	1967	sucrose	hydroxyalkyl peroxides glyoxal	mutagenic mutagenic
Schubert & Sanders	1961	D glucose, D fructose, D mannose, D rhamnose, D galactose, D-fructose	alpha, beta-unsaturated carbonyl sugars	cytotoxic (toxicity increased upon heating irradiated solution)
Steward et al	1967	sucrose	formic acid	mutagenic
Frey & Pollard	1966	minimal cell medium	hydrogen peroxide	mutagenic, generated secondary mutagens
Chopra	1969	glucose	organic peroxides	mutagenic
Kuzin	1963	plant tissues	organic peroxides orthoquinones	mutagenic carcinogenic
Wilmer et al	1981	deoxy-D-ribose, D ribose	hydrogen peroxide malonaldehyde carbonyl compounds	mutagenic mutagenic cytotoxic
Brooks & Klemetti	1968	glucose	glyoxal malonyldialdehyde	mutagenic, binds to DNA mutagenic, binds to DNA

1. Doses required for even partial "pasteurization" of poultry meat are far greater than the doses which have been deemed "safe" by any of the evidence or arguments provided by the FDA to date. The "massive" feeding studies of 5 megarad irradiated chicken are no more capable of assessing carcinogenic risk than are any of the other irradiated-food feeding studies the FDA has categorically dismissed before; all lack the dose-exaggeration factor essential to any valid toxicological test. All of the concerns of the presence of trace mutagens or carcinogens in foods irradiated at "low" doses of 100,000 rads are only greater at doses of one million rads, required for even partial Salmonella inactivation.

2. Major unresolved microbiological questions arise regarding the safety of gamma processing of salmonella-contaminated poultry: much of the virulence of recent cases of salmonellosis has been attributed to the presence of antibiotic resistant strains of the pathogen, due in turn to the use of these antibiotics in the poultry industry [6], the addition of a highly mutagenic processing procedure, namely, gamma irradiation, on poultry carcasses still containing low levels of antibiotics is an appalling scenario for the appearance in the irradiated food of new, antibiotic-resistant strains. This issue has received serious, but not adequate, attention in the scientific literature.[7]

Enhancement of Aflatoxin Production

The FDA has also been quick to dismiss concerns that irradiation of *Aspergillis flavus* spores or the grains upon which this fungus can grow, can increase the production of the potent carcinogen aflatoxin [8] citing and dismissing a single study on the subject. The fact (Table 3.) there have been several studies showing serious aflatoxin—enhancement effects at or near the very doses proposed for the irradiation of grain.

Table 3.

Published Studies Indicating Increased Alflatoxin Production After Irradiation[9]

Author(s)	Date	Irradiated material	Dose
Jammali & Guilbot	1969	*Aspergillis flavus* spores	75-200 krad
Schindler & Noble	1970	*Aspergillis flavus* spores	20-500 krad
Priyadarshini & Tulpule	1976	wheat, potatoes, maize, sorghum, millet	10-75 krad
Priyadarshini & Tulpule	1979	wheat	50-250 krad
Schindler et al	1980	*Aspergillis flavus* spores	75-450 krad

Summary: Rescind FDA approval

In summary, the continuing research effort by our organization indicates clearly that recent and pending approvals of food irradiation processing by the FDA should be rescinded, and the same degree of caution now being expressed by several state and national agencies around the world be implemented on a federal level.

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3. Chemical and Pharmaceutical Press. *Crop Protection Chemicals Reference: Third edition.* New York: John Wiley & Sons and Chemical and Pharmaceutical Publishing Corp., 1957
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Biographical Sketch:

Dr. Richard Piccioni, Ph.D. is Senior Staff Scientist at Accord Research and Educational Associates, Inc., a not-for-profit public health research group based in New York City. He holds a doctorate in biophysics from The Rockefeller University, New York, and conducted three years of post-doctoral research at The Rockefeller University supported by grants from the National Science Foundation (NSF) and the National Institutes of Health (NIH). Dr. Piccioni was Assistant Professor of Biological Science at City University of New York (CUNY), where his research was funded by the U.S. Department of Agriculture (USDA) and the MacArthur Foundation of Chicago.

Over the past two years he has directed a team of biologists, chemists, physicians, and statisticians within the Accord Research group to carry out an in-depth examination of the technical basis for the Food and Drug Administration's recent approval of food irradiation processing.

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

10358:538

November 23, 1988

Mr. Robert W. Hall
Hawaii Institute for Biosocial Research
P.O. Box 4124
Honolulu, Hawaii 96812-4124

Dear Mr. Hall:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 12, 1988, to Dr. John Lewin, Director of the Department of Health, regarding the subject Draft EIS. The following is provided in response to your letter.

The article that you sent will be included in the Final EIS, as requested. The irradiator EIS included an extensive review of the effects of eating irradiated food. As part of this analysis, literature representing all scientific points of view on the subject were reviewed. Our conclusions take into consideration all of this information. The EIS is intended to be an assessment of the likely environmental effects of a proposed project. It need not, and realistically should not, be an exhaustive analysis of any particular scientific question.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

OCT 25 '88 09:41 ENERGY DIVISION 808-5315243 P.3

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IN REPLY REFER TO:
STP 8.3181

October 6, 1988

Dr. Marvin Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 115
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement
Hawaii Commodities Irradiation Facility

We have no objection to the proposed Hawaii Commodities Irradiation Facility.

Alternative Sites A and B are under our Airports Division's jurisdiction. While our preference is for Site A, the developer will need to coordinate his proposal closely with our Airports Division prior to design and construction should either Site A or B be selected.

Thank you for this opportunity to provide comments.

Very truly yours,

Edward Y. Hirata
Director of Transportation

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT
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10358:538

November 23, 1988

The Honorable Edward Y. Hirata, Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Hirata:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 6, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

Your siting preference is noted. We will work with the Department of Transportation to ensure that any concerns are addressed should the irradiation project proceed at sites A or B. The project developer would be required to meet all Airports Division requirements for project development.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

LORRAINE R. JITCHAKU INOUYE
Councilwoman

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
25 Aupuni Street
Hilo, Hawaii 96720

October 13, 1988

Mr. Maurice H. Kaya
Energy Program Administrator
Dept. of Business & Economic Development
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Kaya:

RE: Food Commodities Irradiation
Facility EIS Comments

At your public hearing for EIS input to the Food Commodities Irradiation Facility hold at the Naniloa Hotel on May 4, 1988, I submitted five items on behalf of the County Committee on Economic Development. A copy of my remarks is enclosed for your review.

In reviewing the Draft Environmental Impact Statement dated August 1988, general reference was made to some of these concerns, however, no specific comments were rendered. Would you provide me with your thoughts on the following concerns?

1. Article 8 of the Hawaii County Code addresses Nuclear Energy. We would hope that the implications on this Article are addressed in your assessment.

2. Concerns were raised relative to the transportation of the hazardous material to and from the facility. What Federal, State or County standards would govern this activity?

3. Questions were asked on what the County's role would be in the facility. Would it have a regulatory role? Would existing County codes, rules and regulations need changing? The County has

mentioned as the proposed operator of the facility. What are its responsibilities and liabilities in this role?

4. If what is proposed to be spent on this facility were diverted to the effort to eradicate the fruit fly, would this solve the problem and eliminate the need for the facility?

5. When do you intend to implement the education plan as outlined in attachment 3 of the Final Report Attachments?

Your promptness in replying will be much appreciated.

Sincerely,

Lorraine R. Jitchaku-Inouye
Councilwoman

Encls.

LORRAINE R. JITCHAKU-INOUYE
Councilwoman

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
25 Aupuni Street
Hilo, Hawaii 96720

May 4, 1988

TO: State of Hawaii Department of Business and Economic Development, Energy Division
HESTEC Services, Inc.

FROM: Lorraine R. Jitchaku-Inouye, Councilwoman
Chairperson, Committee on Economic Development
County of Hawaii

SUBJECT: EIS Consideration for Food Commodities Irradiation Facility

For several months now the Hawaii County Council's Committee on Economic Development has been receiving testimony from individuals and groups pertaining to the proposed Food Commodities Irradiation Facility. In the course of these deliberations, questions have surfaced relative to the County's role in establishing and maintaining this facility. As Chairperson of this Committee, I would like to recommend that the following concerns be addressed in your environmental assessment process.

1. Article 8 of the Hawaii County Code addresses Nuclear Energy. We would hope that implications on this Article are addressed in your assessment.

2. ✓ Concerns were raised relative to the transportation of the hazardous material to and from the facility. What Federal, State or County standards would govern this activity?

3. ✓ Questions were asked on what the County's role would be in the facility. Would it have a regulatory role? Would existing County codes, rules and regulations need changing? The County has been mentioned as the proposed operator of the facility. What are its responsibilities and liabilities in this role?

4. ✓ If what is proposed to be spent on this facility were diverted to the effort to eradicate the fruit fly, would this solve the problem and eliminate the need for the facility?

5. ✓ When do you intend to implement the education plan as outlined in attachment 3 of the Final Report Attachments?

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT
ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

10358:548

November 25, 1988

Ms. Lorraine R. Jitchaku-Inouye, Councilwoman
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Ms. Jitchaku-Inouye:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 13, 1988, to Mr. Maurice Kaya, DBED's Energy Program Administrator, regarding the subject Draft EIS. The following is provided in response to your letter.

1. Article 8 of the Hawaii County Code generally prohibits the transportation and storage of radioactive material and the construction of nuclear power plants in Hawaii County. Section 14-45(a)(6)(A) lists a number of radiation sources which are not included under this prohibition. Commercial devices, processes, and facilities are included in this list, as are educational endeavors; thus the County prohibition is not applicable to the irradiation facility, as confirmed by the County of Hawaii Corporation Counsel's personal communication to DBED on December 15, 1985.

2. As discussed in Section 2.4.5 of the Draft EIS, source material will be transported to the facility by the supplier under the Nuclear Regulatory Commission (NRC) license. As further stated, spent source pencils and any possible contaminated waste will be transported out of Hawaii under NRC license. NUREG-0170 referenced in the Draft EIS (NRC 1977) further discusses the implications of transporting source material.

3. The County would have a regulatory role, as discussed in Section 2.7.3 of the Draft EIS. Early in the irradiator development process, it was assumed that the County would operate the facility. Our current plans call for the facility to be operated by an outside contractor to DBED for the demonstration period.

4. As discussed in Section 3.4.5 of the Draft EIS, eradication is not considered a reasonable alternative method for meeting quarantine requirements or project objectives.

5. It is unclear as to what education plan you are referring to. Planning for the consumer education program discussed in Section 2.1 of the Draft EIS will commence upon final approval of the project in early 1989.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

rec'd 10/21/88

42 Hillside Drive
Denver, Colorado 80215
7 October, 1988

James Frolich
Hestec Services Inc.
1221 State Street,
Suite 200
Santa Barbara, CA. 93101

Re: Comments on the Environmental Impact Statement concerning the proposed Hawaii Commodities Irradiation Facility.

Dear Mr. Frolich,

The Environmental Impact Statement (EIS) acknowledges that "the operation of any irradiation facility poses some finite risk of operator or public exposures to radiation". The question is whether the risk is significant or very small. The proposed Hawaii Commodities Irradiation Facility (the facility) will utilize the nuclear radiation from 150,000 curies of cobalt 60, about 330 quadrillion nuclear disintegrations per minute, or equivalent to the radiation emitted by more than 200,000 tons of uranium. Cobalt 60 has a half-life of 5.27 years, and releases 2.5 million electron volts with each nuclear disintegration, consisting of two gamma rays with an average energy of 1.25 million electron volts

Apparently the International Commission on Radiological Protection (ICRP) dose limit of 50 millisieverts (mSv, or five rem) for radiation workers and a limit of five mSv (or 500 millirems) for the general population have been accepted in this EIS. The former is equivalent to about 200 chest x-rays per year and the latter, about 20 chest x-rays annually. Apparently these ICRP recommendations will be applied in Hawaii, despite the new information on radiation hazards which suggest much greater effect per rem than previously thought. The ICRP standards do not accept this new information. The conventional terms for radiation absorption and dose, the rad and the rem, are more useful than the newer units, the gray and the seivert. The latter are very large units of greater utility in nuclear physics and military planning than in medicine.

The report cites an average annual measureable dose for radiation workers of 1.6 mSv, or 160 millirem. However, such measurements may not actually represent the actual exposure of radiation workers. Such estimates are often based on radiation monitoring badge data which usually understate actual exposures. A recent study of Rocky Flats nuclear plant

workers with cumulative exposures of only one rem or more had a greater death rate from cancer than those workers with less than one rem after only two years.

The estimates of doses of radiation to man from man-made radiation sources indicated on page 4-4 are not acceptable unless each step of the development of these estimates has been reviewed, with an opportunity to evaluate each of the assumptions made in developing such estimates.

I note that the list of potential accident scenarios on 4-6 describes some cases which actually have occurred. May we see the Nuclear Radiation Commission (NRC)reports which list such accidents with dates and places, etc.?

On 4-7, I see that Rockwell International is listed as a resource for training programs. I believe that the record of Rockwell International at the Rocky Flats plant in Denver has been very bad. A list of the problems in the management of this facility by Rockwell can be seen in the various court documents associated with a lawsuit by local landowners against Rockwell, Dow and the Department of Energy.

On page 4-8, I note that personnel will may wear film badges or thermoluminescent dosimeters. These devices have serious limitations which should be discussed.

On page 4-10, I note that in the U.S. there have been two personnel overexposures to radiation occurring in hot cells or radiators. A third incident in Norway at a cobalt 60 irradiation facility is also reported. The source was not retracted into a shielded position because of mechanical failure. This worker received a fatal dose of radiation, dying 13 days later.

The EIS notes radiological problems occurring because of pool water contamination and loss of pool integrity. In one case there was radioactive contamination of the soil. Further, leaks of water contaminated by cobalt 60 have occurred from leaking capsules or contact with contaminated shipping casks.

In an incident in New Jersey there was a leaking cobalt 60 source caused by a poor weld. Licensee tried to clean up the pool water contamination without notifying NRC. Other areas in the facility were also contaminated. In a second incident in New Jersey, there was also a capsule leak which led to an increase in the radiation level above the pool. A third incident in

New Jersey involved another leaking cobalt 60 source which contaminated pool water. Most of the pool water was pumped out of the pool on to the floor of the facility. The licensee in this case also tried to conceal the release of radioactive water which escaped into the surrounding soil. "The NRC's experience has been that radiation hazards in these events is small". However, the NRC has a policy of supporting the nuclear industry and their interpretation can be questioned on this point.

At the facility at Fort Armstrong on Oahu, there was a leak of radioactivity due to loss of integrity of the cobalt 60 pencils, permitting a release of cobalt 60 into the shipping cask, and about nine curies of cobalt 60 escaped into the storage pool water. "When the contaminated cask and its load of 'pencils' were lifted out of the pool and through the roof of the building, a 'small' amount of the cobalt 60 dribbled on the roof and rain water later washed it on to a section of the lawn". When the irradiator was decommissioned 13 years later, there was still residual radioactivity in the area.

Populations near such nuclear facilities may be exposed to external radiation or to internal radiation from a number of routes illustrated in Figure 1. Further, radionuclides may be concentrated in the food chain to man as illustrated in Table 1. This is because living organisms (including man) metabolize radionuclides according to their biochemical properties, i.e. cobalt 60 ingested by a cow or goat grazing on contaminated grass will appear in milk as cyanocobalamin, or radioactive vitamin B-12, which will be selectively absorbed and retained in body organs by children drinking the milk. In general, plants concentrate cobalt 60 to 200 times the concentration in the environment, and fish by 50 times. This is because cobalt 60 selectively enters the food chain where it plays a vital role in metabolism as a key trace element.

In an incident in Nebraska, a product passing by a radiation source for sterilization became jammed against the source plaque so that the source could not be returned to its storage position and a medical product caught fire. Another facility in New Jersey had its license suspended twice in 1986 for "deliberately and repeatedly bypassing certain safety interlock systems". Further, I understand that there was a recent accident at a facility in Decatur, Georgia involving a source of 13 million curies of radiocesium that involved 10 workers and the products.

Other incidents have occurred involving the careless disposal of nuclear radiation sources. For example, last September I was called for suggestions on how to deal with an accident in

Goiania, Brazil. Two young scavengers found a small cylinder the size of a gallon paint can and sold it to a scrap dealer for 25 dollars. He opened the cylinder and found a platinum capsule with several ounces of a glowing blue salt-like substance, 1400 curies of radiocesium. Others saw the remarkable powder and took bits of it home. His six-year old niece Leide rubbed it on her body like carnival glitter, as did other children. Leide ate an egg sandwich with contaminated hands. She received five to six times the lethal dose of radiation for an adult. Her aunt slept in contaminated clothing and also died. The man who opened the capsule died. One man slept with some under his bed. Another carried a lump in his pocket. In all, 244 people were contaminated and 54 were hospitalized. Parts of the city were cordoned off. Radiation teams washed down buildings and scooped up soil. People tried to block the burial of the first four victims in their 540 kilogram lead caskets. The 20 with doses from 100 to 800 rads were also contaminated internally. They were treated with Prussian blue, an iron compound that binds cesium and aids excretion. However, it is ineffective after radiocesium has gone from blood into body organs. Last November indictments for manslaughter were prepared against officials in both the federal nuclear energy commission and the state. However, those responsible for the deaths of people who die of leukemia or cancer years after exposure have committed the perfect crime ... there are no indictments for murder, manslaughter or any sort of crime.

Public health officials still remember another incident in which a cobalt 60 source was sold to a scrap dealer in Mexico, who melted the source down with scrap iron to make iron rods used to manufacture furniture that was shipped to the U.S. The highly radioactive iron had to be traced and removed, and in the process many people were exposed to the radiation. Apparently there were no immediate deaths.

On page 4-31 of the EIS, we see that "Explosives detonated in contact with 1.5 million curies of cobalt 60 metal could result in a 50 year effective dose commitment of 25 rem for the maximum exposed individual at a distance of one kilometer". The report alleges "this level of dose commitment is generally presumed to have no adverse health effects". However, a dose of only one tenth rem in the first trimester will cause a significant increase in the rate of leukemia and childhood cancer. A single pelvimetry x-ray will nearly double the rate of leukemia and cancer in children when exposed at a later fetal age. Further, as noted above, studies of radiation workers at the Rocky Flats plant found significant increases in cancer deaths in those with exposures greater than one rem, compared to fellow workers with exposures of less than one rem. If the source were only 150,000 curies of cobalt 60 and the dose to an individual one kilometer away received a 2.5 rem exposure, this would still be significant. Obviously the dose would not be sustained uniformly over the 50 year period, but would be greatest at first, declining over time.

The report points out at 4-32 that the melting point of stainless steel is around 1,450 degrees centigrade and the melting point of cobalt is 1495 degrees centigrade. However, we know that the integrity of the stainless steel "pencils" is questionable since they will sometimes spontaneously leak at welding seams. A report states that only about 15 curies of 150,000 curies in a source would be disseminated in a fire. However, suppose that the vaporization point of cobalt 60 were reached; then all of it could be disseminated. Cobalt 60 boils into vapor at 2,870 degrees centigrade. Iron boils at 2,750 degrees centigrade.

I note on page 4-34 that if the shielding on the sources were breached, the exposures at the site boundary in line with the breach would be as high as 175 rems per hour. A person working at the site boundary for three hours could receive a fatal exposure. The report does not address the risks due to safety system failures, operator errors, material handling accidents, etc. (4-52).

They note that the structural characteristics of the facility are not completely defined. Further, "A detailed assessment of potential and natural hazards in the area of the proposed sites has not been performed", nor has a detailed assessment of hazardous materials transported in the vicinity of the sites been performed. They were not able to evaluate potential hazards represented by operations at the military reservation, such as stored munitions, munition shipment routes, etc. Further, "no calculation of the public dose or health effects has been performed". The conclusions listed beginning on page 4-59 must be qualified as suggested by these comments in this critique.

Two research workers at Oakridge correctly anticipate that nuclear power plants, high level nuclear waste storage sites and reprocessing centers may be targets of opportunity in some future war. It is a reasonable supposition that industries using large amounts of radioactive materials could also be targeted, such as a food processing center with 150,000 curies of radiocobalt. While it is certainly true that a nuclear weapon impacting on a food irradiation plant would be in itself extremely destructive and would produce large amounts of fallout, this would be considerably augmented by the vaporization and wide-spread dissemination of the 150,000 curies of radiocobalt. In relation to most radionuclides released in a nuclear explosion, radiocobalt has a relatively long half-life and emits extremely potent and penetrating gamma radiation. This is the concept behind the so-called doomsday machine or

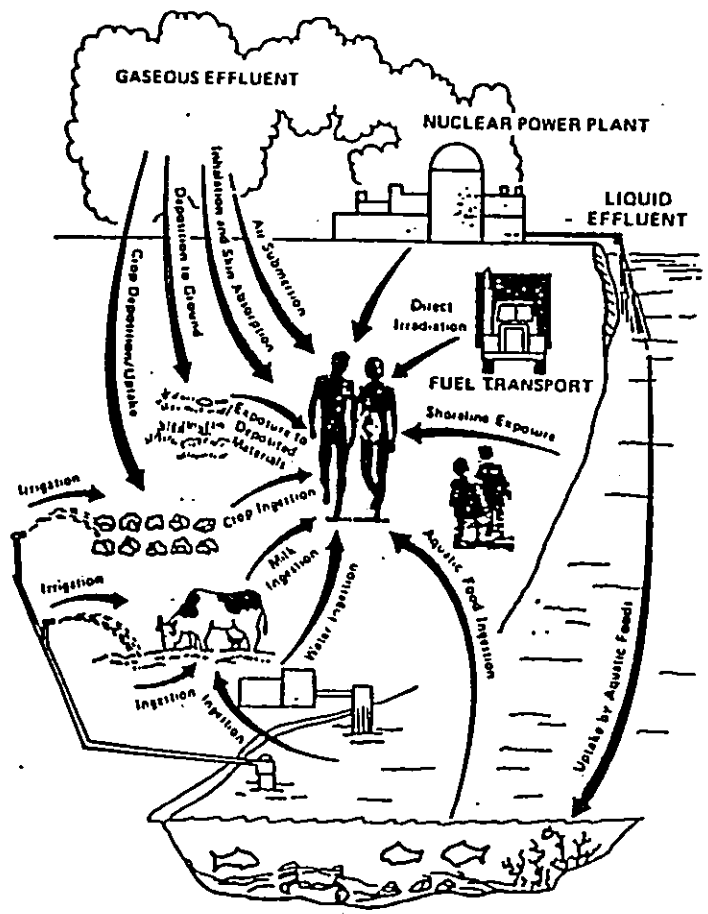
cobalt bomb. I do not think that it is a remote possibility that food irradiation plants would be identified and targeted in some future war, and I think this possibility should also be discussed in the Environmental Impact Statement. I enclose a figure from the Oakridge report which shows their estimates of the effect of targeting nuclear installations in some future war. The dark areas in Figure 2 represent those areas still with lethal radiation one year after the war.

I believe that the nuclear food irradiation industry is based on a very hazardous technology, relying on radiation sources such as cobalt 60 and cesium 137 (a principal constituent of nuclear fallout and high level nuclear waste from nuclear power plants). The history of the industry has shown that accidents occur frequently and have the potential to be very serious. Further, serious questions have been raised about the quality of foods treated with high level radiation, a concern which I have addressed in a recent report.

Sincerely yours,

Carl J. Johnson, M.D., M.P.H.

Figure 1
Pathways of radionuclides to man



*This schematic figure is from NRC and EPA documents. However, the children and the fetus have been added, since the NRC and the EPA consider only non-smoking adults. The children are about ten times more sensitive to radiation than the adults and the fetus about 20 times more sensitive. The children were taken from a photograph by W. Eugene Smith. (CJJ)

nureg-0139

TABLE 1

Freshwater Bioaccumulation Factors

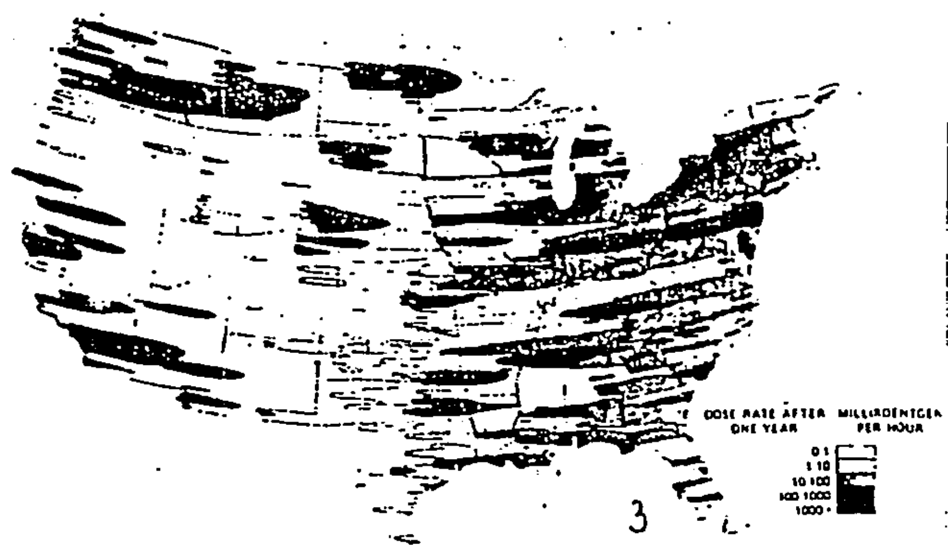
pCi/kg Organism Per pCi/liter water

Elements	Fish	Invertebrates	Plants
C	4550	9100	4550
Na	100	200	500
P	100000	20000	500000
Sc	2	1000	10000
Cr	200	2000	4000
Mn	400	90000	10000
Fe	100	3200	1000
Co	50	200	200
Ni	100	100	50
Zn	2000	10000	20000
Rb	2000	1000	1000
Sr	30	100	500
Y	25	1000	5000
Zr	3	7	1000
Nb	30000	100	800
Mo	10	10	1000
Tc	15	5	40
Ru	10	300	2000
Rh	10	300	200
Ag	2	770	200
Sn	3000	1000	100
Sb	1	10	1500
Te	400	150	100
I	15	5	40
Cs	2000	100	500
Ba	4	200	500
La	25	1000	5000
Ce	1	1000	4000
Pr	25	1000	5000
Nd	25	1000	5000
Pm	25	1000	5000
Sm	25	1000	5000
Cu	25	1000	5000
Gd	25	1000	5000
W	1200	10	1200
Np	10	400	300
Pu	4	100	350
Am	25	1000	5000
Cm	25	1000	5000

From Report UCRL-50564, Rev. 1

FIGURE 2

Year 2000 Attack on Dispersed Reactors and Reprocessing Plants*



* 10 year waste storeage

Oakridge, 1976

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE GOVERNOR
ROGER A. ULVELING DIRECTOR
BARBARA KIM STANTON DEPUTY DIRECTOR
LESLIE S. MATSUBARA DEPUTY DIRECTOR

1035B:548

November 25, 1988

Carl J. Johnson, M.D.
42 Hillside Drive
Denver, Colorado 80215

Dear Dr. Johnson:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 7, 1988, to Mr. James Frolich of WESTEC Services, our EIS consultant, regarding the subject Draft EIS. The following is provided in response to your letter.

The ICRP doses recommendation coincides with U.S. Nuclear Regulatory Commission (NRC) requirements (see page G-24 of the Draft EIS) that will apply to the facility. If regulations become stricter, requirements for the facility would change accordingly. As you note, actual recorded doses are usually orders of magnitude less.

The exposure rates on page 4-4 of appendix G-2 (Draft EIS page G-25) are estimates to provide the reader with a context in which to evaluate project risks and are thus appropriate for this EIS.

Accidents were reviewed in the CH2M Hill feasibility study. Some accident reports were evaluated during preparation of the Draft EIS. The NRC may be able to provide you with copies.

Training programs will require NRC approval. Should Rockwell's California program be determined to be inadequate, another program would be used.

Personnel monitors will be supplemented by more sophisticated ambient radiation monitoring which will allow adequate evaluation of employee exposure.

Your reiteration of accident needs and potential risks discussed in the Draft EIS is noted, as are your descriptions of other past incidents. It is important to keep in mind that events in the past have resulted in an evolution of NRC safety requirements. The proposed facility will be subject to the most up-to-date measure to minimize risk.

The largest fire risk to the facility would be associated with a petrochemical fire (e.g., jet fuel). As discussed on page 4-32 of the external risk assessment (Draft EIS page G-39), such fires generally burn at about 1250°C, well below the boiling point of cobalt. Thus the risk of radiation "vapor" spread is not expected to exist.

As discussed in Sections 2.6 and 2.7 of the Draft EIS, numerous measures are included in facility design and operation to prevent radioactive release as a result of facility operation. The cataclysmic release you discussed (175 rem off site) would not be expected to result from facility operation. The industry's accident record supports this conclusion.

The referenced conclusions are preceded by a statement that they are based on the analysis performed; thus the qualifications, you requested, are included. Further, as noted on page 4-60 of the Draft EIS, additional information showing that military activities do not pose a threat to the facility was received after the risk assessment was performed.

We have no information to lead to any conclusion that Hilo or the irradiation facility would be a target of nuclear attack. Further, the quantity of source used at the facility would be insignificant compared to the amounts of fissionable nuclear material at any nuclear power plant. Finally, the effects of release from the facility would be immeasurable when compared to the primary effects of a nuclear bomb itself.

As discussed in Section 3.3.1 of the Draft EIS, Cesium-137 will not be used in Hawaii.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC ✓

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSO/HW

September 22, 1988

U0909CW

Westec Services Incorporated
1221 State Street, Suite 200
Santa Barbara, California 93101

Attn: James W. Frolich

Dear Mr. Frolich:

Reference is made to the draft environmental impact statement entitled 'Hawaii Commodities Irradiation Facility.'

During the review of this document, it was noted that an emergency electric power generator is proposed to be utilized in cases of electrical failure (See Page 2-16) at the facility. Usually, in situations such as this, an underground storage tank is installed to store the necessary product: diesel fuel.

In November of 1984, Congress amended the Resource Conservation and Recovery Act (RCRA) to include Subtitle I - Regulation of Underground Storage Tanks (See Attachment 1), which regulates tanks containing petroleum and hazardous substances. This new law set forth a prohibition on the installation of bare steel underground storage tanks until federal regulations were established. The Interim Prohibition states that no person may install an underground storage tank unless it satisfies the following provisions:

1) Corrosion prohibition;
2) Structural integrity; and
3) Chemical compatibility.

The U.S. Environmental Protection Agency (EPA), under the authority of RCRA, as amended, issued proposed regulations on April 17, 1987 (See Attachment 2). The final regulations are expected to be published in the Federal Register in late September, 1988.

Also, enclosed is a copy of the Hawaii Revised Statutes, Chapter 342, Part VI-Underground Storage Tanks (See Attachment 3). Presently, the State of Hawaii is operating under a Cooperative Agreement with the EPA. State Administrative rules have not yet been promulgated, therefore, existing Federal Regulations are applicable in the State.

As stated in Section 342-62 of the Hawaii Revised Statutes, notification to the Hawaii Department of Health, Hazardous Waste Program is required within thirty (30) days of the installation of an underground storage tank using the enclosed 'Notification for Underground Storage Tanks,' EPA Form 7530-1 (11-85). Should you require more notification forms, it is acceptable to photocopy this form.

The Department of Health is requesting that a diagram (8 1/2" x 11") showing the location of the facility, identified by buildings, direction arrows and street names be included with the notification form.

Should you have any questions, please feel free to contact our office at (808) 548-8837.

Very truly yours,

ARLENE H. KABEI, Manager
Hazardous Waste Program

CW/ah

Enclosures

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110 HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR

ROGER A. ULVELING
DIRECTOR

BARBARA KIM STANTON
DEPUTY DIRECTOR

LESLIE S. MATSUBARA
DEPUTY DIRECTOR

1035B:538

November 23, 1988

Ms. Arlene M. Kabei, Manager
Hazardous Waste Program
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Ms. Kabei:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 22, 1988, to Mr. James W. Frolich of WESTEC Services, our EIS consultant, regarding the subject Draft EIS. The following is provided in response to your letter.

The facility developer will be required to conform with all federal, state, and local requirements regarding the storage of diesel or other fuel.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

STATE OF HAWAII
OFFICE OF HAWAIIAN AFFAIRS

RECEIVED

'88 SEP 26 P12:06

OFC. OF ENV. QUALITY C.

September 23, 1988

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 S. King Street, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

Subject: Draft EIS: Hawaii Commodities Irradiation Facility, Hilo, Hawaii.

Thank you for the opportunity to comment on the proposed undertaking. Regarding the project's impacts to archaeological sites, it should be noted that the evaluations and recommendations made on this project were made on the basis of a surface reconnaissance survey. There is always the possibility that subsurface cultural features or deposits of significance might be encountered in the course of subsequent land modification activities. When buried sites, archaeological features, or artifacts are found, the State Historic Preservation Office should be contacted immediately.

Sincerely,

Kamaki A. Kanahele, III
Administrator

cc: WESTEC Services Inc.

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:538

November 23, 1988

Mr. Kamaki A. Kanahele, III, Administrator
Office of Hawaiian Affairs
1600 Kapiolani Boulevard, Suite 1500
Honolulu, Hawaii 96814

Dear Mr. Kanahele:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 23, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

If potential cultural resources are discovered during construction, the State Historic Preservation Office will be notified immediately. Section 4.6.3 of the EIS will be modified to clarify this requirement.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

University of Hawaii at Manoa

College of Tropical Agriculture and Human Resources
Gilmore Hall 202 • 3050 Maile Way
Honolulu, Hawaii 96822

Office of the Dean and Director

September 27, 1988

RECEIVED '88 SEP 29 A10:38 OFC. OF ENVIRONMENTAL QUALITY CONTROL

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
State of Hawaii
465 S. King Street, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

SUBJECT: REVIEW OF EIS ON THE HAWAII COMMODITIES IRRADIATION FACILITY

The following comments on the subject EIS have been prepared by Dr. James E. Moy on behalf of this college.

The report: The EIS report is well organized and well written. The contractor, WESTEC Services, Inc., has done an excellent job. The study covers all aspects and more than the "environmental" aspect of building the irradiator in Hawaii. The study is very thorough, and the report is objective and frank.

The conclusion: The main conclusion is that building the demonstration irradiator in Hawaii should not cause any health hazard to the community and operating the irradiator should likewise not cause any health hazard to the workers. Having the irradiator built in Hawaii will provide the state with the opportunity to prove its efficacy as well as meeting several objectives as stated in the summary.

Minor technical errors:

On Page ES-8, it would be more accurate to state that the double hot water dip methods would kill fruit fly eggs instead of saying "...kill fruit flies." Also, the papaya treated by this method should be picked at less than one-quarter ripe rather than "...about one-quarter ripe..."

One Page ES-9, it is stated that the cold treatment method of papaya for quarantine control requires that papayas be cooled to -13 to -12 C (8 to 10 F). This statement should be checked.

Yours sincerely,

N. P. Kefford
Dean

jy
cc: Dr. Nancy Johnson, Dr. James Moy, Dr. Kenneth Rohrbach
Mr. James W. Frolich, WESTEC Services Inc.

AN EQUAL OPPORTUNITY EMPLOYER

E

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

1035B:538

November 23, 1988

Dr. N.P. Kefford, Dean
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa
Gilmore Hall 202, 3050 Maile Way
Honolulu, Hawaii 96822

Dear Dr. Kefford:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 27, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The wording on page ES-8 will be corrected. Further, page ES-9 and related discussions in Section 3 will be corrected. The proper temperature should be 0 to 2 degrees centigrade (CH2M Hill 1987).

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

RECEIVED OCT 11 1988

HAWAII COUNTY CIVIL DEFENSE AGENCY

34 A Rainbow Drive
HILO, HAWAII 96720

Phone 935-0031
935-0032

!doc02790!

October 6, 1988

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, HI 96813

HAWAII COMMODITIES IRRADIATION FACILITY DRAFT EIS

Following are comments regarding stated subject:

2.7 Permits, Licenses and Regulatory Requirements

It is requested that the proposed facility be required to develop an emergency-response plan that must be reviewed and approved by the Hawaii County Civil Defense Agency. Plan development should be done prior to shipment of any radioactive source.

3.4.3 Dry-heat Treatment

Statements made about this process do not seem fair since the dry-heat process is admittedly in an experimental stage such as the irradiation process. Objectives as stated for the irradiation project include:

1. Test use of the irradiation process at commercial levels.
2. Test effectiveness of irradiation.
3. Investigation of efficiency of treatment at different radiation levels.
4. Determine cost associated with commercial level irradiation operation.

Are these basically not the same variables presented as negatives for the dry-heat process?

3.4.5 Insect Eradication

Statements made about insect eradication projects are not reflective of the total scope of those projects. The insect eradication studies and projects are being conducted for the control and, ideally, eradication of fruit fly infestation for these islands. Statements made on environmental effects are not reflective of the scope of the projects being conducted and statements tend to be misleading. "The EIS concluded that this alternative has potentially significant environmental effects, such as risk of human exposure to pesticides, destruction of nontarget species . . ."

4.12.2.3 Risk from Damage to the Facility by Outside Events

The event of tropical cyclones should be added to the list. This is especially true for the effects of wind forces.

4.14.3.11 Overcoming Barriers to the Marketing of Tropical Produce

Assuming that Schutz's conclusions are accurate in the area of marketing, who will be responsible for the major effort on public education for consumer acceptance of irradiated papayas?

Note:

It is hoped that inquiry will continue in the area of risk since it is evident that acceptance within the general public, medical profession, and governmental authorities are not in total agreement.

It should be the responsibility of the State of Hawaii to promote continuous inquiry and follow-up on "Health Risks of Consuming Irradiated Food" and "External Events Risk Assessment." Energy and resources for health risk and external risk should be made an objective of this project as well as the promotion of the use of irradiation for fruit disinfestation and the consumption of irradiated fruits.

Harry Kim
HARRY KIM, ADMINISTRATOR
HAWAII COUNTY CIVIL DEFENSE AGENCY

dy

cc WESTEC Services Inc.

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:548

November 25, 1988

Mr. Harry Kim, Administrator
Hawaii County Civil Defense Agency
34-A Rainbow Drive
Hilo, Hawaii 96720

Dear Mr. Kim:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 6, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The operator will be required to coordinate with your agency in developing its emergency response plan. DBED, and the U.S. Nuclear Regulatory Commission (NRC) will require that an acceptable plan be in place before source material is delivered to the facility operator.

Irradiation has been demonstrated as being an effective method for meeting quarantine requirements and has been approved for such use. The demonstration/cost program is intended to determine such treatment's commercial viability, as discussed in Section 2.1 of the Draft EIS. Dry heat is not yet at this stage. Its treatment efficacy has not been conclusively proven and it has not been approved by the U.S. Department of Agriculture for quarantine use. Only minimal assessment of the commercial viability of dry heat has been conducted. As noted in Section 3.4.3 of the Draft EIS, dry heat may, in time, be shown to be a viable treatment alternative.

Eradication has not yet been proven as a viable solution to fruit fly infestation, although it may be in future. The sentence you quoted is a direct summary of the USDA Draft EIS.

The external risk assessment included an evaluation of potential damage to structural integrity of the facility (and resultant possible radiation release) from outside pressure events (e.g., explosion). Energy from high winds can be expected to be less than that associated with explosion.

The public education activities are a part of DBED's proposed demonstration project. Any education required beyond the three-year demonstration period will likely be the responsibility of the users of irradiation process.

More in-depth analysis of safety and risk will be conducted by the Nuclear Regulatory Commission during its review and approval process, as discussed in Section 2.7.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

JOHN WAIHEE
GOVERNOR

YUKIO KITAGAWA
CHAIRPERSON, BOARD OF AGRICULTURE

SUZANNE D. PETERSON
DEPUTY TO THE CHAIRPERSON

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

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'88 OCT 12 A11:07
OFC. OF ENV. QUALITY C.

October 6, 1988

MEMORANDUM

To: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

Subject: Hawaii Commodities Irradiation Facility
Draft Environmental Impact Statement (EIS)
THK: 2-1-12: 106, 107, 108; 56, 74, 75;
2-1-25: 86 Hilo, Hawaii
Area: Various

The Department of Agriculture has reviewed the subject DEIS and has the following comments to offer.

The purpose of the proposed irradiation facility, to determine the technical and economic feasibility of using irradiation to disinfest papaya and other Hawaiian commodities subject to fruit flies, is consistent with actions of the State Agriculture Functional Plan to support pest and disease controls, and promote effective marketing of agricultural commodities.

The DEIS does a commendable job of identifying and analyzing the impacts of the proposed facility. We concur that the primary unresolved issue is uncertainty about the economic effect of the project. As stated in the DEIS, however, one of the primary objectives of the demonstration project is to test the marketability of irradiated fruit vis-a-vis non-irradiated fruit.

Thank you for the opportunity to comment.

Yukio Kitagawa
YUKIO KITAGAWA
Chairperson, Board of Agriculture

cc: WESTEC Services, Inc.
1221 State Street, Suite 200
Santa Barbara, CA 93101
Attn: James W. Frolich

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT
ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

1035B:538

November 23, 1988

The Honorable Yukio Kitagawa, Chairperson
Department of Agriculture
1428 South King Street
Honolulu, Hawaii 96814-2512

Dear Mr. Kitagawa:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your memorandum of October 6, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

OFFICE OF STATE PLANNING
Office of the Governor
STATE CAPITOL, HONOLULU, HAWAII 96813 TELEPHONE: (808) 548 3073

Ref. No. P-8796

October 11, 1988

MEMORANDUM

TO: Mr. Marvin Miura, Director
Office of Environmental Quality Control

SUBJECT: Draft Environmental Impact Statement (DEIS), Hawaii Commodities Facility, Hilo, Hawaii

We have reviewed the subject DEIS and have the following comments.

The subject document states on page S-12, "All three sites are outside the special management area (SMA) as established by the County under the Coastal Zone Management Act." However, the Coastal Zone Management (CZM) area comprises all land in the State except forest reserves and Federal lands, and all ocean waters under the State's jurisdiction. Therefore, although the proposed project is not situated within the SMA, the EIS should discuss the project's relevance to all CZM objectives and policies, as specified in Chapter 205A, HRS, the Hawaii CZM Law. In addition, because the project will require permits and licenses from the Nuclear Regulatory Commission (NRC), the Federal consistency provisions of the National CZM Act and the Federal regulations contained in 15 CFR 930 will be applicable. A Federal consistency determination should be submitted to our office for review in conjunction with the application to the NRC.

Relative to specific concerns, the CZM Program objective for coastal ecosystems is to protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems. The final EIS should discuss potential environmental impacts incurred by emissions of ozone and nitrogen oxides, including problems associated with their corrosive nature. Proposed mitigation measures should be coordinated with the State Department of Health. Permits for airborne emissions and the proposed wastewater septic system may be required.

We are also concerned about the readiness of emergency services responding to accidents or hazardous incidences at the project facility. We concur with the executive summary statement which says, "Emergency plans must be in place and emergency response personnel thoroughly trained to deal with accidents that damage the facility or incapacitate the operators." In addition to training provided for facility operators, the final EIS should describe proposed mitigation to assure that civil defense, fire rescue, and

police personnel are adequately trained and prepared for unique emergency needs of the facility.

Thank you for the opportunity to review this proposal.

Harold S. Masumoto
Director

cc: Mr. James W. Frolich
Senior Project Manager
WESTEC Services, Inc.

Mr. Robert D. Thomas, Chief
Material Radiation Protection
Inspection and Licensing Section
U.S. Nuclear Regulatory Commission

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Harold S. Masumoto, Director
Office of State Planning
State Capitol
Honolulu, Hawaii 96813

Dear Mr. Masumoto:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 11, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The proposed facility is in the Coastal Zone. As discussed in the Draft EIS, the project will not have significant effects on coastal or other ecosystems, and is thus consistent with the objective you discussed. As discussed in Section 4.8 of the Draft EIS, ozone and oxides of nitrogen will not be emitted in concentrations or quantities that will exceed standards implemented to protect the environment. The U.S. Nuclear Regulatory Commission (NRC) license process will have to include a consistency determination.

The operator will be required to obtain all air and wastewater permits.

Specific plans must be developed by the operator to meet the satisfaction of the NRC and state and local agencies involved with emergency response planning. Since final plant design and operation are not complete, and an operator has not been selected, such final plans cannot be prepared at this time. Such plannng is more appropriate during the permitting and licensing of the facility.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

10/12/88

MAURICE KAYA
DBED
465 S. KING ST. RM 104
HONOLULU, HI 96813

DEAR MR. KAYA
HERE ARE A FEW QUESTIONS REGAURDING THE EIS...

1 I REMEMBER VOTING ON A NUCLEAR REFERENDUM, ISN'T THIS SUPPOSED TO BE A NUCLEAR FREE ZONE? DOESN'T THAT MEAN THAT AN IRRADIATION FACILITY IS TECNICALY ILLEGAL?

2 WHAT STUDIES IF ANY, HAVE BEEN CONDUCTED REGAURDING THE SHELF LIFE OF IRRADIATED FOOD? IF ANY OF THE LIVE CELLS. ARE EFFECTED, I'M SURE THE SHELF LIFE COULD HARDLY BE EXTENDED!

3 HOW WILL THIS PLANT BE INSPECTED? IS THIS GOING TO BE FEDERAL, STATE, OR COUNTY REGULATED? WHO IN HAWAII IS QUALIFIED TO DO THIS?

4 WHAT ABOUT MARKETING? HOW WILL THIS POTENTIALLY TOXIC FOOD BE LABELED? WHO IS GOING TO EAT IT?

5 FROM WHAT I'VE READ, I'M NOT AS WORRIED ABOUT THE ACTUAL EMISSION FROM THE PLANT ITSELF, AS I AM ABOUT THE EFFECTS OF EATING IRRADIATED FOOD!?

IT SEAMS LIKE STUDIES INVOLVING IRRADIATION SHOULD SPAN 20 YEARS OR MORE TO ACTUALLY DETERMINE THE EFFECTS OF POSSIBLE MUTATED CELLS ON FUTURE GENERATIONS. ANYTHING LESS SEAMS VERY IRRISPONSIBLE!

6 AND LAST FOR NOW, CONSIDERING THAT 1987 FIGURES FOR ACTUAL PAPAYA OUTPUT SHOW 45-50 MILLION LBS... THE PROPOSED VOLUME CAPACITY OF THE IRRADIATION FACILITY CAN'T BEGIN TO HANDLE THAT MUCH VOLUME) DOES THAT MEEN THIS IS AN EXPIERIMENT? WHY? AREN'T THERE EXPERIMENTAL FACILITIES IN FLORIDA ALREADY?

THANK YOU FOR CONSIDERING THESE QUESTIONS...

SINCERELY,

Mara Mayo

MARA MAYO
RT 4620
KEAAU, HI 96749

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:538

November 23, 1988

Ms. Hara Mayo
Star Route 4620
Keaau, Hawaii 96749

Dear Ms. Mayo:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 12, 1988, to Mr. Maurice Kaya, DBED's Energy Program Administrator, regarding the subject Draft EIS. The following is provided in response to your letter.

1. Article XI, Section 8, of the Hawaii State Constitution (approved by the voters in 1978) prohibits construction of nuclear power plants and disposal of radioactive material in the State without voter approval. Article 8 of the Hawaii County Code makes similar prohibitions. The proposed irradiator is not subject to the Consititutional prohibition since it's not a power plant and because no radioactive material will be disposed of in Hawaii. Commercial facilities, such as the irradiator, are exempted from the County code restrictions, as well.

2. In general, irradiation can extend the shelf life of some commodities. With tropical fruits, however, irradiation is intended to meet quarantine requirements. Shelf life extension is not an objective of this irradiator project.

3. The facility will be inspected by U.S. Nuclear Regulatory Commission staff, as discussed in Section 2.7.1 of the Draft EIS. U.S. Department of Agriculture Animal and Plant Health Inspection Service inspectors will inspect the plant to ensure that quarantine requirements are being met. Additionally, the State Department of Health, the appropriate land management agency, and County permitting agencies may inspect the facility consistent with their permit and inspection responsibilities. It is the responsibility of these agencies to ensure that their inspectors are qualified to perform the activities which they are required to carry out.

4. Marketing is discussed in Section 2.1, Appendix I, and elsewhere in the Draft EIS. Irradiated fruit is currently required to be labeled with the "radura" as discussed in Section 2.7.2 and Appendix H. The market studies will determine who is likely to purchase and eat irradiated fruit.

5. The effects of eating irradiated fruit are assessed in Appendix G. We have concluded that eating irradiated fruit is safe.

6. The proposed project is a demonstration program, as discussed in Section 2.1 of the Draft EIS. Part of the test/demonstration aspect of the project is to evaluate the commercial viability of irradiation for quarantine of Hawaii tropical fruits. This requires: (a) a facility with enough capacity to treat at commercial levels (even if total annual industry output cannot be treated); and (b) proximity to the industry and its lines of transportation. There is no existing facility that meets these requirements.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

United States Department of the Interior

GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
P.O. Box 50166
Honolulu, Hawaii 96850

September 27, 1988

RECEIVED
'88 SEP 29 AIO:24
OFC. OF ...
QUALITY CO...

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 S. King St., Rm. 104
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Assessment Report for the Hawaii Commodities Irradiation Facility Hilo, Hawaii

Dear Mr. Miura:

The staff of the Hawaii District Office of the U.S. Geological Survey, Water Resources Division, has reviewed the subject Draft Environmental Impact Statement, and has no additional comments to make as long as the facility complies with the appropriate radiation safeguards.

Thank you for allowing us the opportunity to review the subject draft, and we are returning the draft EIS for your further use.

Sincerely,

William Meyer
District Chief

Enclosure

cc: WESTEC Services Inc.
1221 State Street, Suite 200
Santa Barbara, CA 93101
Attn: James W. Frolich

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

(ENERGY DIVISION, [illegible] HONOLULU, HAWAII [illegible])

10358:538

November 23, 1988

Mr. William Meyer, District Chief
U.S. Department of the Interior
Geological Survey
Water Resources Division
P.O. Box 50166
Honolulu, Hawaii 96850

Dear Mr. Meyer:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 27, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

rec'd 10/20/88

October 3, 1988

Marvin T. Miura, Director
Office of Environmental Quality Control
465 S. King St., Rm 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

According to the above mentioned document, the Energy Division of the State of Hawaii Department of Business and Economic Development (DBED), proposes to contract for the design, construction, and operation of a demonstration food commodities irradiation facility in Hilo, Hawaii County. The general objective of the proposed commodities irradiation facility is to demonstrate and test, for 3 years, the use of irradiation for fruit disinfestation at commercial levels of operation.

We have been assisted in this review by Kenneth Kaneshiro, Hawaiian Evolutionary Biology Program; Roy Takekawa, Environmental Health and Safety Office; Linda Cox, Agricultural Economics; Jack Fujii, Agriculture, U.H. Hilo and C. Anna Ulaszewski, Environmental Center.

Section 1.2.1 Quarantine Requirement, EDB Ban and Current Disinfestation Practices

As is further discussed in the paragraph below, "Irradiation Treatment", the effectiveness of the treatment is both species and variety specific. For this reason, we suggest that the full scientific names, including the name of the person first describing the biota under discussion, should be included with the initial reference to the plant or animal. For example, the scientific names for Papaya, Carica papaya Linnaeus; Mango, Mangifera indica Linnaeus; and Lychee, Litchi chinensis Sonn; should be included in the initial reference to these fruits. Furthermore, the describer's name should be added to the scientific names for the three species of fruit flies cited on lines 7 and 8 of this section: Certitis capitata (Wiedemann), Dacus dorsalis Hendel and Dacus cucurbitae Coquillet. This information should assure that the particular pest and fruit being treated are clearly identified.

Section 1.2.2 Irradiation Treatment

The recognition that "the appropriate level of irradiation to meet treatment objectives...is fruit-specific" is absolutely correct. In addition, it should be noted that studies undertaken by UH researchers of some 35 different "varieties" of California grown fruits indicate that different dosage levels are required between "varieties" as well as individual species.

The statement is made that, "In order to meet FDA 'Probit 9 Security' (FDA's designation as a level of treatment necessary to meet quarantine requirements by killing flies and larvae), [the] required minimum doses of radiation for papayas and mangoes were set at 150 Gray (GY) and 300 GY respectively; the maximum allowable dose was set at 1000 GY (1 kGY)." Studies at the University of Hawaii, Manoa, indicate that at the Probit 9 dosage for Papayas (about 150 Gy), as much as 50% of the fruit fly eggs might hatch, and many larvae will develop to full maturity and may even pupate. While most of the eggs laid in fruit may not develop into adults, those that do most likely will be sterile, so quarantine requirements may be met. However, the fruits may not be marketable because of the large numbers of developing larvae.

Section 4.12.2.3 Risk from Damage to the Facility by Outside Events

The proposed sites for the irradiation facility are in close proximity to the airport runways and flight paths at General Lyman Field in Hilo. Considerable discussion is offered regarding the potential risk to the facility by "outside" events such as seismic activity, volcanic hazards or aircraft crashes. According to the worst-case scenario for an aircraft crash, the "...health effects from exposure at the facility boundary could be significant" but, the Draft EIS goes on to say that "the probability of this scenario happening, however, appears very low." In view of the rapid growth potential of commercial and general (and perhaps military) airport activies, would the probability of "very low" change significantly during the life time of this project?

Section 4.12.2.5 Mitigation Measures

We appreciate your recognition that there is always the possibility of disaster, and that "emergency preparedness will be a critical element in controlling risk." Since emergency preparedness is a "critical element", an indication of the procedures that are planned to assure "preparedness" should be included in the FEIS, as outlined by section 10.4 of "Guide for the Preparation of Applications for Licenses for the ...Storage Irradiators" (Appendix H-21).

Section 4.14 Economics

Mr. Marvin Miura -3- October 7, 1988

We concur with your statement that, "Many of the economic concerns cannot reasonably be estimated until the demonstration project is underway." However, because the ultimate decisions on the approval and implementation of this project are dependent on the economic benefits that will accrue as a result, the FEIS should identify those individuals or agencies who will be responsible for the development and conduct of the additional economic and marketing studies.

Section 5.5 Unresolved Issues

In part, the decision to proceed with this project and to accept risk was balanced against its possible "positive economic effect." We understand that there is some uncertainty about marketability of irradiated fruit. However, it is also our understanding that there are some markets that are legally closed to irradiated fruit, and these are a certainty. The FEIS should state which markets are closed, the type of produce affected, and Hawaii's market share.

We appreciate the opportunity to comment on this Draft Environmental Impact Statement. We hope our comments will be helpful.

Yours truly,

Jacquelin N. Miller
Associate Environmental Coordinator

cc: OECQ
✓HESTEC Services Inc.
Kenneth Kaneshiro
Roy Takekawa
Jack Fujii
Linda Cox
C. Anna Ulaszewski

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM 110, HONOLULU, HAWAII 96813

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:548

November 23, 1988

Ms. Jacqueline N. Miller
Associate Environmental Coordinator
University of Hawaii at Manoa
2550 Campus Road
Crawford Building, Room 317
Honolulu, Hawaii 96822

Dear Ms. Miller:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 3, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The scientific names for common species expected to be treated will be added in the Final EIS. Addition of the describer's name is not likely to add to the EIS reviewers' understanding of a project's potential environmental effect and have not been included.

The facility is intended to meet Food and Drug Administration (FDA) requirements, as are current practices. Should FDA determine in the future that treatment requirements should be more restrictive, treatment would have to be modified. The packers will be responsible for ensuring that their quality requirements are met by the irradiation process. Investigation of quality effects is an objective of the demonstration program.

Probabilities for a disaster may change in the future. Investigation into the worst-case event, which contemplated explosion of a large bomb during an aircraft accident, did not identify future potential significant increases in transport of bombs through General Lyman Field. In fact, subsequent to the risk assessment, the State Department of Defense notified DBED's EIS consultant that bombs are no longer transported through General Lyman Field, at all (see note on page 4-60 of the Draft EIS). Thus the current probability for such a scenario is approximately zero.

Ms. Jacqueline N. Miller
November 25, 1988
Page Two

Appendix H identifies safety procedures, as does the Draft EIS text. Final plans are more appropriately developed and approved during facility design and U.S. Nuclear Regulatory Commission review and approval.

Economic studies will be a part of DBED's demonstration project.

The majority of Hawaii's tropical fruits are shipped to the U.S. West Coast (where irradiated fruit is accepted), and to Japan. Japan does not currently accept irradiated fruit. Vapor heat will likely be continued to be utilized for this market, where economic conditions (i.e., high prices) allow its use. Irradiation treatment would become more widely accepted as a result of this demonstration project.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

JOHN WAIHEE
GOVERNOR OF HAWAII

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'88 SEP -2 A11:29

OFC. OF ENVIRO.
QUALITY CONT.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

August 31, 1988

Dr. Marvin Miura
Office of Environmental Quality Control
465 South King Steet, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

SUBJECT: Historic Preservation Review -- Draft EIS: Hawaii Commodities Irradiation Facility Walakea, South Hilo, Hawaii

The Draft EIS correctly states the historic preservation compliance situation. No historic sites are in the project area; therefore, the project will have "no effect" on significant historic sites.

Sincerely,

RALSTON H. NAGATA
State Parks Administrator and Deputy
State Historic Preservation Officer

cc: WESTEC Services Inc.

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

1035B:538

November 23, 1988

Mr. Ralston H. Nagata
State Parks Administrator and Deputy
State Historic Preservation Officer
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Nagata:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of August 31, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

We appreciate your confirmation that the proposal will have no effect on significant historic resources.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

HAWAII REDEVELOPMENT AGENCY
COUNTY OF HAWAII
35 WAILUKU DRIVE • HILO, HAWAII 96720 • PHONE (808) 935-0023

RECEIVED
'88 SEP 26 P12:03
OFC. OF ENV. QUALITY CO.

September 23, 1988

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 S. King Street, Room 104
Honolulu, HI 96813

Dear Dr. Miura:

Reference the Hawaii Commodities Irradiation Facility Draft EIS, August 1988.

This Agency has no comments to submit on the referenced report.

Thank you for the opportunity to review the EIS.

Very truly yours,

GORDON H. NOBRIGA
Manager

GHN/dd

cc: WESTEC Services, Inc.

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:538

November 23, 1988

Mr. Gordon H. Nobriga, Manager
Hawaii Redevelopment Agency
35 Wailuku Drive
Hilo, Hawaii 96720

Dear Mr. Nobriga:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 23, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: ✓James Frolich, WESTEC

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

OCT 3 1988

DOC. NO.: 4392E
FILE NO.: 89-110

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

SUBJECT: Hawaii Commodities Irradiation Facility Draft EIS

Dear Dr. Miura:

Thank you for giving our Department the opportunity to comment on this matter. We have reviewed the materials you submitted and have the following comments.

Our Department's Historic Sites Section confirms that the Draft EIS correctly states the historic preservation compliance situation. No historic sites are in the project area; therefore, the project will have "no effect" on significant historic sites.

Please feel free to call me or Roy Schaefer of our Office of conservation and Environmental Affairs, at 548-7837, if you have any questions.

Very truly yours,

WILLIAM W. PATY, Chariperson
Board of Land and Natural Resources

cc: WESTEC Services Inc.

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

10358:538

November 23, 1988

The Honorable William W. Paty, Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 3, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

We appreciate your confirmation that the proposal will have no effect on significant historic resources.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII

25 AUPUNI STREET • HILO, HAWAII 96720

RECEIVED

'88 SEP -6 P1:58

OFC. OF ENVIR. QUALITY CONTROL

September 1, 1988

Marvin T. Miura, Ph.D.
Office of Environmental Quality Control
465 S. King Street, Room 104
Honolulu, HI 96813

HAWAII COMMODITIES IRRADIATION FACILITY
DRAFT EIS - AUGUST 1988

Thank you for the opportunity to review the subject document.

Please refer to Section 4 of the Site Evaluation Report or Appendix D of the document. Facilities charges are based either on the anticipated maximum daily demand or size of meter to be installed for the project. The greater amount of the two methods will be charged. For each 600 gallons per day (gpd) of maximum use, the facilities charge is $300 for the first 600 gpd and $1,500 for each additional 600 gpd.

Based on size, the following are facilities charges for various sizes of meters:

Meter Size	Facilities Charge
5/8"	$ 300 ($1,500 if other service is existing)
1"	3,750
1-1/2"	7,500
2"	12,000

Meter sizes are determined from the peak hour demand requirements for the project. Therefore, the engineering consultants for the project must evaluate the peak hour demand as well as the maximum daily demand requirements.

In Table 4-1, notation of a Type III meter box is made. Please be informed that this type of box is utilized by Kauai and Oahu only. Hawaii County utilizes a box with different details. Refer to the State of Hawaii Water System Standards, 1985, Volumes 1 and 2.

William Sewake
H. William Sewake
Manager

QA

cc - WESTEC Services, Inc.
(Attention: Mr. James H. Frolich)

...Water brings progress...

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. H. William Sewake, Manager
Department of Water Supply
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Sewake:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 1, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The project developer would be required to meet all Hawaii County requirements for water supply facilities and facility charges.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling
Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

United States Department of Agriculture

Animal and Plant Health Inspection Service

Federal Bldg. Hyattsville, MD 20782

October 5, 1988

RECEIVED '88 OCT 11 P2:09 OFC. OF E...

Dr. Marvin T. Miura
Office of Environmental Quality Control
465 S. King Street, Rm. 104
Honolulu, HI 96813

Dear Dr. Miura:

I have reviewed the Hawaii Commodities Irradiation Facility Draft Environmental Impact Statement (EIS) and have the following comments to offer:

In your Draft EIS, the stated objectives of the proposed facility include research on efficacy of irradiation, economics, and consumer acceptability. They do not specifically include what should be considered as the primary objective--irradiation treatment of fruit for disinfection to meet quarantine requirements for export to mainland United States. This seems to be the single, overriding purpose of the facility and its irradiation process, and should be stated as such.

The Animal and Plant Health Inspection Service (APHIS) has reviewed and concurred with the Food and Drug Administration Environmental Assessment, Finding of No Significant Impact (FONSI), and Final Rule for Irradiation in the Production, Processing, and Handling of Food (21 CFR Part 179--April 18, 1986). Enclosed is a copy of the APHIS FONSI, dated July 12, 1988, (enclosure 1), and the APHIS record of decision, dated July 13, 1988, (enclosure 2). A Federal Register Notice will soon be published to allow gamma irradiation of papayas as an additional quarantine option and establish a protocol for carrying out the irradiation. Since the purpose of building the demonstration irradiation facility is to provide the capability of meeting quarantine requirements for exportation of fruit to mainland United States, APHIS concurrence with the treatment method should be acknowledged in your Final EIS.

In the Draft EIS, some nonirradiation technologies were stated to be of "limited efficacy" (as on page ES-8, line 14). This is not accurate, as the APHIS approved treatments have been confirmed efficacious in killing fruit flies. The alternative treatments may have varying undesirable characteristics which influence their acceptability to industry (the principle of these being reduced quality of fruit), but the approved treatments are effective.

Your Draft EIS stated on page ES-9 that "APHIS prepared an EIS on the eradication of fruit flies in Hawaii (USDA APHIS 1986)." APHIS did not prepare an EIS; a Draft EIS was prepared, but a Notice of Intent to Withdraw (enclosure 3) was published in the Federal Register and a Final EIS was never published. The citation shown on page ES-9 has no entry under Appendix A, A.1 (References and Bibliography).

APHIS—Protecting American Agriculture

2

The excerpt in Appendix J (Relevant Regulations and Government Documents) is from the APHIS Draft EIS, has pages transposed on pages J-16 and J-17, and is taken out of context. The proposed action in the APHIS Draft EIS was eradication of the three species of flies from Hawaii. The alternative strategies to eradicate wild freeliving fruit flies are not necessarily the same as the alternative strategies for quarantine export treatment of fruit and produce, and therefore this excerpt is of questionable importance here.

Sincerely,

Harold T. Smith
Harold T. Smith
Acting Senior Staff Officer
Program Planning Staff
Plant Protection and Quarantine

3 Enclosures

Enclosure 1

FINDING OF NO SIGNIFICANT IMPACT
IRRADIATION AS A QUARANTINE TREATMENT FOR PAPAYA

Use of low dosage gamma radiation for disinsection of papayas is proposed as a quarantine treatment for prevention of introduction of the oriental fruit fly (<u>Dacus dorsalis</u>), Mediterranean fruit fly (<u>Ceratitis capitata</u>), and melon fly (<u>Dacus cucurbitae</u>) into the continental United States, Guam, Puerto Rico, and U.S. Virgin Islands, from Hawaii. The Animal and Plant Health Inspection Service (APHIS) has reviewed the Food and Drug Administration (FDA) Environmental Assessment (EA), Finding of No Significant Impact (FONSI), and Final Rule (21 CFR Part 179--April 18, 1986) for Irradiation in the Production, Processing, and Handling of Food, in order to determine applicability to a proposed gamma irradiation treatment not exceeding 100 kilorads for papaya. For the purpose of the proposed treatment, APHIS has determined that potential environmental affects have been adequately considered by the Food and Drug Administration (FDA) and concurs with the conclusions of that Agency's EA and FONSI.

The FDA regulations permit use of irradiation at doses not to exceed 1 kGY (100 krad) to inhibit the growth and maturation of fresh foods and to disinfest food of arthropod pests, permit use of irradiation at doses not to exceed 30 kGY (3000 krad) to disinfect dry or dehydrated aromatic vegetable substances (spices and herbs) of microorganisms, require irradiated foods be labeled to show this fact at both wholesale and retail level, and require that irradiation treatment records be maintained and available for FDA inspection.

Reasons for the APHIS FONSI include:

1. No adverse environmental affects are anticipated at food processing facilities using a radioactive source to sterilize food. Similarly, no adverse environmental effects are anticipated from the transportation of radioactive sources for the irradiation treatment.

2. Machine-generated radiation sources are subject to the Radiation Control for Health and Safety Act of 1968 and must comply with appropriate reporting requirements (21 CFR Part 1002) established by the Bureau of Radiological Health, FDA.

3. No cumulative effects of radiation are expected from eating irradiated fruit. The process would treat papayas only for disinsection, and would not expose humans to gamma radiation. The process does not make the fruit radioactive. (21 CFR Part .79, 51 FR 13376, Docket No. 81N-0004)

4. FDA has determined that chemical differences between irradiated foods processed at less than 100 kilorads and nonirradiated food are too small to affect the safety of the food. (21 CFR Part 179, 51 FR 13376, Docket No. 81N-0004)

5. There is no evidence that insects or microorganisms surviving irradiation give rise to mutants with undue resistance to radiation or of abnormal virulence. (21 CFR Part 179, 51 FR 13376, Docket No. 81N-0004)

6. FDA has determined that concerns over potential adverse human health effects (abnormally high rates of testicular tumors, kidney disease, death in

offspring, lessened life spans, and abnormal increase in white blood cells) were not substantiated. (21 CFR Part 179, 51 FR 13376, Docket No. 81N-0004)

7. FDA indicated, upon review, that there was no evidence to conclude that food irradiated and stored under normal handling practices would show increased production of aflatoxin (a toxic fungal metabolite implicated in the causation of liver cell carcinomas, produced by some strains of <u>Aspergillus flavus</u> and <u>Aspergillus parasiticus</u> in stored products.) (21 CFR Part 179, 51 FR 13376, Docket No. 81N-0004)

8. To the extent that irradiation replaces fumigation by toxic chemicals (ethylene trioxide and ethylene dibromide) and byproducts (ethylene chlorohydrin, ethylene bromohydrin), there is a reduction in the amount of toxic residues of these substances in the environment. (21 CFR Part 179, 51 FR 13376, Docket No. 81N-0004)

9. No reduction in vitamin, mineral, nutritional content, or quality of fruit is expected. A delayed senescence (aging) of the papayas may be expected.

DETERMINATION:

The potential environmental effects of low-dosage (less than 100 kilorads) gamma irradiation of food were analyzed in the EA and FONSI developed by FDA and were the basis of a final rule (21 CFR Part 179) by FDA. On the basis of the information contained and referenced in those documents, it is my determination that the use of irradiation as a quarantine treatment for papaya will not result in significant adverse effect to the human environment. It is also my determination that this proposed action does not constitute a major Federal action and therefore an environmental impact statement is unnecessary and will not be prepared.

James W. Glosser, Administrator
Animal and Plant Health Inspection Service

July 12, 1988
Date

RECORD OF DECISION
IRRADIATION AS A QUARANTINE TREATMENT FOR PAPAYA

I have reviewed the Animal and Plant Health Inspection Service (APHIS) Finding of No Significant Impact (FONSI) for Irradiation as a Quarantine Treatment for Papaya, which analyzes the Food and Drug Administration (FDA) Environmental Assessment (EA), and FONSI for Food Irradiation. I conclude that the APHIS proposed quarantine treatment for papaya, use of gamma irradiation not exceeding 100 kilorads in intensity, is an effective disinfection treatment and is consistent with the analysis of irradiation treatment by the FDA and the conclusions FDA derived.

I concluded that no significant direct or cumulative effects on the human environment will result from the proposed treatment. The treatments will not result in lessened quality or safety of the treated fruit, will not result in radiation in the fruit which will be consumed, and will not constitute a risk to food handlers. An Environmental Impact Statement is not required.

I have determined, based upon evidence presented in the previously identified documents and analyses, that the proposed irradiation treatment is efficacious and environmentally safe, that APHIS will employ this method in the quarantine treatment of papaya.

James W. Glosser, Administrator
Animal and Plant Health Inspection Service

July 13, 1988
Date

48448

Federal Register
Vol. 50, No. 227
Monday, November 25, 1985

Notices

This section of the FEDERAL REGISTER contains documents other than rules or proposed rules that are applicable to the public. Notices of hearings and investigations, committee meetings, agency decisions and rulings, delegations of authority, filing of petitions and applications and agency statements of organization and functions are examples of documents appearing in this section.

DEPARTMENT OF AGRICULTURE

Human Nutrition Board of Scientific Counselors Board Meeting

According to the Federal Advisory Committee Act of October 6, 1972 (Pub. L. 92-463, 86 Stat. 770-776), the Office of the Secretary announces the following meeting:

Name: Human Nutrition Board of Scientific Counselors.

Date: January 9-10, 1986.

Time and Place: January 9, 1986, 9:00 a.m.-5:00 p.m.; January 10, 1986, 8:30 a.m.-3:00 p.m.; Room 104 Administration Building, United States Department of Agriculture, Independence Avenue, between 12th and 14th Streets, SW., Washington, DC.

Type of Meeting: Open to the public. Persons may participate in the meeting as time and space permit.

Comments: The public may file written comments before or after the meeting with the contact person below.

Purpose: To review as appropriate and advise the Department as to the scope and quality of the human nutrition research and education carried out in the Department of Agriculture. The board also will prepare a report of its review, including evaluation and recommendations, to be submitted to the Secretary of Agriculture.

Contact Person: Anne Winslow, Confidential Assistant, Office of the Assistant Secretary for Science and Education, U.S. Department of Agriculture, Room 217-W, Administration Building, Washington, D.C. 20250, telephone (202) 447-5015.

Done at Washington, DC, this 6th day of November, 1985.

Orville G. Bentley,
Assistant Secretary, Science and Education.

[FR Doc. 85-28084 Filed 11-22-85; 8:45 am]
BILLING CODE 3410-01-M

Animal and Plant Health Inspection Service

[Docket No. 86-378]

Withdrawal of Intent To Prepare a Trifly Environmental Impact Statement

AGENCY: Animal and Plant Health Inspection Service, USDA.

ACTION: Notice.

SUMMARY: This document withdraws a notice of intent to prepare an environmental impact statement on proposals to eradicate the Mediterranean fruit fly, the Oriental fruit fly, and the melon fly in Hawaii.

FOR FURTHER INFORMATION CONTACT: Michael J. Shannon, Senior Staff Officer, Field Operations Support Staff, Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Room 663, Federal Building, 6505 Belcrest Road, Hyattsville, MD 20782, 301-436-8295.

SUPPLEMENTARY INFORMATION: In a document published in the Federal Register on December 30, 1983, (48 FR 57577-57578) notice was given of the intent of the Department to prepare an environmental impact statement (EIS) on proposals to eradicate in Hawaii the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), the Oriental fruit fly, *Dacus dorsalis* (Hendel), and the melon fly, *Dacus cucurbitae* (Coquillet). These flies are referred to collectively as "Trifly". An EIS was being prepared because the Department had been considering undertaking a joint Federal/State program to eradicate the Trifly in Hawaii.

On December 6, 1984, a notice was published in the Federal Register (see 49 FR 47843) announcing the availability of a draft Trifly EIS and that written comments on the draft would be received until January 18, 1985. The December 6, 1984, notice also announced that public meetings would be held in Hawaii on December 18-20 to receive comments on the draft EIS. On January 25, 1985, a notice was published (see 50 FR 3580) which reopened the comment period until March 26, 1985. Five hundred and thirty-eight comments were received on the draft EIS.

Most of the comments that were received indicated that the eradication alternatives could have an adverse impact on Hawaii's unique plant and animal ecosystems on land and in water, and also on the human environment. Many comments further indicated that information was deficie[nt] in the draft as to how such adverse impacts could be mitigated. It appears that further consideration of these fac[tors] is necessary prior to the preparation o[f a] Trifly EIS.

In addition, both the House and Senate Committees on Appropriations[, in] their 1986 appropriation bills for the Department, directed that further research be done concerning techniqu[es] of eradication, control and suppressio[n] before proceeding with a Trifly eradication program.

Under these circumstances, the Department is withdrawing its December 30, 1983 notice of intent to prepare a Trifly EIS.

Done at Washington, DC, this 19th day o[f] November, 1985.

Harvey L. Ford,
Deputy Administrator, Plant Protection an[d] Quarantine, Animal and Plant Health Inspection Service.

[FR Doc. 85-27908 Filed 11-22-85; 8:45 am]
BILLING CODE 3410-34-M

Forest Service

Bridger-Teton National Forest Gra[zing] Advisory Board; Meeting

The Bridger-Teton National Forest Grazing Advisory Board will meet at 1:00 P.M., December 11, 1985, in the Conference Room of the Sublette Cou[nty] Library, Pinedale, Wyoming. The purpose of this meeting is to discuss utilization of range betterment funds and the development of allotment management plans.

The meeting will be open to the public. Persons who wish to attend should notify Forest Supervisor Reid Jackson, Box 1888, Jackson, Wyomin[g] 83001, telephone (307) 733-2752. Wri[tten] statements may be filed with the boa[rd] before or after the meeting.

The board has established the following rules for public participatio[n]:

1. If a group wishes to be heard at [the] meeting, they are required to select a chairman to voice their ideas.

2. Persons or groups may send wri[tten] statements to the Forest Supervisor f[or] presentation at the meeting.

3. The Chairman of the Forest Gra[zing] Advisory Board will set aside a time

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Harold T. Smith, Acting Senior Staff Officer
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
Federal Building
Hyattsville, Maryland 20782

Dear Mr. Smith:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 5, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS. The following is provided in response to your letter.

The objective of this federally and state funded project is to demonstrate irradiation treatment and test such treatment of tropical fruits at commercial production levels for three years, as discussed in Section 2.1 of the Draft EIS. Section 2.1 further states that the facility will be available for commercial treatment. Under the State's demonstration program, however, such treatment would have to occur only on an as-available basis, depending on demonstration/test activities. Commercial treatment utilizing the facility could occur with the successful conclusion of the demonstration period.

APHIS concurrence with the use of gamma irradiation for papaya disinfestation will be noted in the Final EIS. The Final EIS text will also reflect your comments on the fruit fly eradication EIS. Eradication would achieve the same purpose as quarantine, namely avoidance of export of infested fruit. It is, therefore, a possible alternative that should be addressed under State EIS requirements.

As discussed on page 3-5 of the Draft EIS, the double-hot-water-dip treatment method has been shown to be riskier as treatment for fruit fly disinfestation.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

Oct. 16, 1988

Maurice Kaya
DBED
465 S. King St. RM 104
Honolulu, HI 96813

Dear Mr. Kaya

As a person involved in agriculture on the Big Island for over a decade, I am very concerned with the future of Hawaii's agribusinesses. However, I am not convinced that irradiation is the answer to help the current shipping problem facing the papaya industry.

My main concern is for the marketability of the irradiated fruit. It is premature to build a plant to treat the fruit before knowing that a market exists for irradiated papaya. I was surprised not to find more information on marketing in the draft E.I.S.

I know some brokers that would not sell the irradiated fruit if it were available today. If the irradiated fruit is really safe, then where are the figures? I would be supportive of this treatment if I could be convinced that there are no health hazards involved. I believe we need to help our farmers, but would this project be beneficial or detrimental?

Paul W.Y. Takehiro
Hilo, HI

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. Paul W.Y. Takehiro
1420 Kilauea Avenue
Hilo, Hawaii 96720

Dear Mr. Takehiro:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 16, 1988, to Mr. Maurice Kaya, DBED's Energy Program Administrator, regarding the subject Draft EIS. The following is provided in response to your letter.

Determination of the marketability of irradiated fruit is a major objective of this demonstration project, as discussed in Section 2.1 of the Draft EIS. An extensive assessment of the risks of eating irradiated fruit is contained in Appendix G of the Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC

RECEIVED

'88 SEP -8 P1:23

OFC. OF ENVII QUALITY CO.

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
DIVISION OF PUBLIC WORKS

LETTER NO. (P)1781.8

SEP 7 '88

Dr. Marvin T. Miura
Director
Office of Environmental
Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Hawaii Commodities Irradiation Facility
Draft Environmental Impact Statement

We have reviewed the subject document and have no comments to offer.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

LO:jk
cc: WESTEC Services, Inc.

DEPARTMENT OF BUSINESS
AND ECONOMIC DEVELOPMENT

10358:538

November 23, 1988

Mr. Teuane Tominaga
State Public Works Engineer
Department of Accounting and General Services
P.O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Tominaga:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 7, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC

NOV 04 '88 11:05 ENERGY DIVISION 808-5315243

MOKU·LOA·GROUP

SIERRA CLUB • HAWAII CHAPTER

OEQC
Roy Sakamoto
465 S. King St. Rm. 104
Honolulu, HI 96813

RECEIVED

'88 NOV -2 AM1:21

OFC. OF EN...
QUALI...

October 14, 1988

SIERRA CLUB RESPONSE TO THE DRAFT EIS

Sierra Club feels there is insufficient disclosure in the draft EIS. We would urge the OEQC and Governor Waihee not to accept this document unless substantive changes are made.

Of primary concern to the Club is the lack of disclosure of risks associated with the irradiator facility.

APPENDIX G ON RISK was lacking assessment of INTERNAL RISK. The club feels this is a fatal defect if not addressed in the final EIS. TO ADMIT THIS INSUFFICIENCY IS NOT ENOUGH.

" Risks due to safety system failures, operator errors, material handling accidents, etc. are not addressed." DEIS Appendix G. Page 4-52.

Unsatisfactorily answered is our question (in response to the Preparation notice) of "contaminated materials" generation from the facility under normal and worst case scenarios (quantities), and where they would be disposed.

Unanswered were numerous questions relating to contaminated water. How much contaminated water can this facility hold? For how long?

Unanswered were numerous questions on transportation risk and what levels of radiation could workers or citizens of the Big Island be exposed to.

Unanswered were numerous questions relating to the economics of this facility, and the economic impact it would have on the papaya industry.

Thank you for the opportunity to comment on the Draft EIS. We request a copy of the Final EIS for our Club to review and analyze.

MAHALO,

Deborah Ward

DEBORAH WARD, GROUP CHAIRPERSON

c.c. Governor Waihee
Sierra Club Legal Defense Fund

P.O. BOX 1137 · HILO · HAWAII · 96721

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

1035B:548

November 25, 1988

Ms. Deborah Ward
Moku Loa Group
Sierra Club Hawaii Chapter
P.O. Box 1137
Hilo, Hawaii 96721

Dear Ms. Ward:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of October 14, 1988, to OEQC, regarding the subject Draft EIS. The following is provided in response to your letter.

Operational risks are carefully regulated by the U.S. Nuclear Regulatory Commission (NRC), which must approve the facility and its operating and contingency plans prior to delivery of the irradiation source. The operator's application to the NRC must carefully describe and document the measures designed to ensure operational safety. Such measures are based on specific design and have not yet been developed. It is premature to hypothesize on such measures in the EIS process. The final NRC approval is the appropriate step in the project development process for complete analysis of operational safety.

As discussed in Section 2.4.5 of the Draft EIS, "contaminated materials" will be removed from Hawaii to an NRC-approved disposal or treatment facility. The source storage pool is designed to store all water used in irradiation operation. Any contaminated water can be stored in the pool until decontamination or disposal activities could commence.

Safety of transportation is addressed on page G-31 of the Draft EIS. Under normal operation, source transportation poses no measurable risk to humans or the environment. As discussed, source transportation has a demonstration record of safety.

Ms. Deborah Ward
November 25, 1988
Page Two

As discussed in Section 2.1, the determination of marketability, and hence economic effects, of irradiated fruit, are a primary objective of the demonstration project.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

for Roger A. Ulveling

RAU/JWF:geo

cc: James Frolich, WESTEC ✓

U.S. Department of Transportation
Federal Aviation Administration

AIRPORTS DISTRICT OFFICE
BOX 50244
HONOLULU, HI 96850-0001
Telephone: (808) 541-1243

RECEIVED

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OFC. OF ENVIR. QUALITY CONT.

September 19, 1988

Mr. Marvin T. Miura
Office of Environmental Quality Control
465 S. King St., Room 104
Honolulu, Hawaii 96813

Dear Mr. Miura:

We have reviewed the Draft EIS for the Hawaii Commodities Irradiation Facility at Hilo, Hawaii and have no substantive comments. There are some minor items noted in the report by turned down pages you may wish to check.

Two copies of the Draft EIS are returned.

Sincerely,

David J. Welhouse
Airport Engineer/Planner

Henry A. Sumida
Airports District Office Manager

Enclosures

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

JOHN WAIHEE, GOVERNOR
ROGER A. ULVELING, DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR
LESLIE S. MATSUBARA, DEPUTY DIRECTOR

10358:538

November 23, 1988

Mr. David J. Welhouse, Airport Engineer
U.S. Department of Transportation
Federal Aviation Administration
Airports District Office
Box 50244
Honolulu, Hawaii 96850-0001

Dear Mr. Welhouse:

SUBJECT: Draft Environmental Impact Statement (EIS)
Hawaii Commodities Irradiation Facility
Hilo, Hawaii

This is to acknowledge receipt of the copy of your letter of September 19, 1988, to Dr. Marvin Miura, Director of the State Office of Environmental Quality Control, regarding the subject Draft EIS.

Thank you for your comments and participation in the Draft EIS review process. Your letter and this response will be appended to the Final EIS.

Very truly yours,

Roger A. Ulveling

RAU/JMF:geo

cc: James Frolich, WESTEC