DOE/EA--0434

DE90 013404

ENVIRONMENTAL ASSESSMENT
FOR
U.S. DEPARTMENT OF ENERGY SUPPORT
OF AN
IOWA STATE UNIVERSITY LINEAR ACCELERATOR FACILITY
AT
AMES, IOWA

MAY 1990

U.S. DEPARTMENT OF ENERGY

MASTER *zp*

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Environmental Assessment
for
U.S. Department of Energy Support
of an
Iowa State University Linear Accelerator Facility
at
Ames, Iowa

1.0 INTRODUCTION

In June 1986, the U.S. Department of Energy (DOE) issued a Solicitation for Cooperative Agreement Proposal, number DE-SC06-86RL10933 (DOE 1986), for an Iowa Agricultural Commodities Irradiator Demonstration Project (IACIDP). The solicitation listed the following project considerations:

Irradiation processing is being used increasingly for chemical cross-linking, polymer curing, and medical products sterilization. It has also been studied extensively as a treatment for disinfestation, removal of food-borne pathogens and spoilage bacteria from the agricultural product, and for extension of shelf life. Although the use of irradiation treatment of food is accepted in many parts of the world and is recommended by the Codex Alimentarius Commission, it has not been widely used in the United States. However, the Food and Drug Administration (FDA) recently passed rulings (51 FR 13376) permitting low-dose irradiation of fruits and vegetables for disinfestation and shelf-life extension and of pork to control Trichinella spiralis.

The Ninety-ninth Congress, in an attempt to stimulate the use of irradiation in the United States and to aid in the transfer of irradiation processing technology to the private sector, directed DOE to establish regional demonstration irradiators throughout the country to be used for research, development, market testing, and to demonstrate the usefulness of irradiating food and other agricultural products.

Iowa State University (ISU) responded to the above-mentioned solicitation in July 1986. A Cooperative Agreement was signed by Iowa and DOE in December 1986, initiating design activities. The firm of CH2M HILL was engaged to develop functional design criteria for the proposed project and prepare a conceptual design report.

A conceptual design report, "Irradiator Predesign Study Report," was issued in June 1987 (CH2M HILL 1987). The design assumed that byproduct cesium-137, available from DOE, would be the irradiation source selected by the ISU.

In accordance with the Cooperative Agreement responsibilities, the ISU, with the assistance of DOE, evaluated radiation sources and applications technologies that would meet the IACIDP requirements. During this evaluation, it was learned that food products were being successfully processed in Europe by using an electron beam generated by an electric machine. Further investigation revealed that this technology had advanced to the state that it could now be considered a viable alternative to radioactive isotopes as radiation sources. In February 1988, CH2M Hill issued a report analyzing the use of a dual mode electron beam/x-ray machine as the irradiation source for the Iowa demonstration irradiator (CH2M Hill 1988). Ultimately the ISU concluded that an electrically powered electron linear accelerator would best serve the needs of the irradiator project. A more comprehensive design development report was prepared by CH2M HILL in June 1989 (CH2M HILL 1989) for the Iowa State University Linear Accelerator Facility (ISULAF), as the facility is now called.

A Cooperative Agreement reflecting the revision of the functional design criteria and other matters was signed by the DOE on March 10, 1987, and by the State of Iowa on March 14, 1987.

2.0 PROPOSED ACTION

The proposed DOE action is financial and technical support of construction and initial operation of an agricultural commodity irradiator (principally for meat), employing a dual mode electron beam generator capable of producing 10 MeV electrons or x-rays, at the Iowa State University Linear Accelerator located at Ames, Iowa.

The proposed period of DOE financial and technical support under consideration would begin, following completion of the National Environmental Policy Act (NEPA) review process, with DOE's authorization to proceed with construction and would continue through construction and for up to three years of operation.

The planned pilot commercial-scale facility would be used for the following activities:

- conducting irradiation research on agricultural commodities, principally meats; in the future, after the pilot phase, as schedules permit, possibly conducting research on other, non-edible materials;
- evaluating effects of irradiation on nutritional and sensory quality of agricultural products;

- demonstrating the efficacy of the process to control or eliminate pathogens, and/or to prolong the commodities' post-harvest shelf-life via control or elimination of bacteria, fungi, and/or insects;
- providing information to the public on the benefits, safety and risks of irradiated agricultural commodities;
- determining consumer acceptability of the irradiated products;
- providing data for use by regulatory agencies in developing protocols for various treatments of Iowa agricultural commodities;
- training operators, maintenance and quality control technicians, scientists, engineers, and staff of regulatory agencies in agricultural commodity irradiation technology.

In accordance with the DOE/University of Iowa Cooperative Agreement and its amendments, DOE support has been provided in the following form:

1. phased financial assistance; design (including conceptual, functional and definitive design and machine specifications) - \$1.1 million (mostly incurred; from March 1987 forward); construction - \$3.9 million (committed but not incurred), and operations - \$0.0 million, for an estimated total DOE project support of \$5.0 million; and
2. DOE consultation, review and approval of a Project Management Plan (which details the roles and responsibilities of the participants), technical overview, and oversight of research, training and development activities.

The ISULAF would be owned by the ISU, with disposition and/or ownership at the end of the support period to be determined, if title were to be transferred to a third party. The ISULAF would be operated by the ISU or its contractors. At the end of the period of DOE support, the ISULAF would either be taken out of service or would continue operation under other arrangements, independent of DOE support.

3.0 PURPOSE OF AND NEED FOR PROPOSED ACTION

The purpose of the proposed action is to provide Federal assistance to the ISU pursuant to Congressional Authorization under Public Law 99-195, the Energy and Water Development Appropriations Act of 1986, to pursue the following objectives:

- conduct research on the technical feasibility and efficacy of processing Iowa agricultural commodities, principally meats, by high-energy electron beam/x-ray irradiation;

- provide technology transfer and demonstration of irradiation treatment of Iowa agricultural commodities through

demonstration to private industry of commercial-scale operational feasibility and capabilities, and

demonstration to private industry and the public of operational safety of irradiation facilities;

- develop information for presentation to the public on benefits, limitations, and health risks of irradiation of Iowa agricultural commodities;
- assess public acceptance of irradiated Iowa agricultural commodities; and
- provide data for use by regulatory agencies in developing irradiation protocols for various treatments of Iowa agricultural commodities.

The need for the proposed action is based on the necessity to stimulate investigation (including considerations of technical feasibility, efficacy of treatment, public acceptance, and costs) of irradiation as a practical commercial means of establishing positive control over Trichinella spiralis in pork, thereby enhancing public safety as well as the acceptability and marketability of pork and pork products.

4.0 ALTERNATIVES TO PROPOSED ACTION

The ISU proposed the project for funding by DOE and has selected and contracted with a vendor (CGR MeV of Buc, France) to provide and install an electron linear accelerator at the ISU (Ames) site. Consequently the DOE has considered the following alternatives to the proposed action:

1. a "no-action alternative," in which DOE does not go forward with the proposed action, and does not provide funding and technical support for construction and operation-to-demonstration of a commodities-irradiator in the State of Iowa, and terminates the existing Cooperative Agreement; and
2. other sponsorship alternatives, in which a) the Congress redirects sponsorship to some other Federal agency, for example, the U.S. Department of Agriculture, or b) the State of Iowa, the ISU, or some other State agency assumes sponsorship, or c) a private entity sponsors the construction and operation of the ISULAF.

The ISU proposed the addition of the ISULAF to the existing Meats Laboratory because of its proximity to the facility preparing the meat to be treated, and to the remainder of the research facilities of the agriculturally oriented Iowa State University, and also because the Ames campus is central to a large meat producing region. Since no adverse impacts could be

identified for this site that would be minimized at other potential sites, no other alternative sites were considered in detail.

Since the purpose of the proposed action is to conduct research on the technical feasibility and efficacy of processing agricultural commodities by high-energy electron beam/x-ray irradiation and not to assess the preferability of irradiation over other processes or one means of generating ionizing radiation over another to achieve the same end result, those alternatives were not considered in detail.

Under Public Law 99-195, DOE may provide financial and technical assistance to other proposals for demonstration irradiators at other locations. A similar facility is being installed on the campus of the University of Florida at Gainesville, Florida, and a separate NEPA review (DOE 1990) was prepared for that proposed action. For any other proposals arising under Public Law 99-195, DOE will prepare a separate NEPA review, which will contain an assessment of cumulative effects, if any, of the combined projects. Potential cumulative effects of the Florida facility and the ISU proposed action are addressed in this Environmental Assessment.

5.0 SITE AND PHYSICAL PLANT

A description of the proposed ISULAF, including the irradiator and ancillary facilities and the site chosen for its location, is provided in the following subsections.

5.1 The Site

The location for the proposed ISULAF is on the campus of the ISU in Ames, Iowa, as shown in Figure 1. The ISULAF would be an addition to the ISU's existing Meats Laboratory, whose location is shown in Figure 2. The addition of the ISULAF structure to the Meats Laboratory and provision for utilities, access, and parking would necessitate rearrangement of the existing driveway. A site plot plan showing existing structures and the proposed new construction is given in Figure 3. The site would consist of about three-fourths of an acre.

As determined by the Public Works Department of the City of Ames, the site is not considered as a "wetlands" area and is outside of both the 100- and the 500-year flood plain as defined by the Federal Emergency Management Agency (Wiegand 1990).

According to staff of the ISU Department of Animal Ecology, there are no species on or near the construction site that are on the Federal or State Threatened or Endangered Species List (Clark 1990).

Figure 1. Location of Iowa State University

Figure 2. Location of Meats Laboratory

Figure 3. Site Plot Plan

A recent surface survey (Gradwohl and Osborn 1990) of the ISULAF site by professional archaeologists revealed no indications of a prehistoric component nor evidence of a primary historic feature or occupation. The survey indicated that a structure, "the Cattle Barn," which was apparently eligible for the National Register, was razed in November 1989. Razing of the Cattle Barn was in accordance with ISU development plans that predated consideration of the proposed action.

5.2 Utilities

Utilities required by the ISULAF, such as domestic water, sanitary sewer service, and electrical power, would be provided as extensions of utilities for the existing Meats Laboratory. No permits would be required.

5.3 Physical Plant

The general layout of the ISULAF, showing it as an addition to the Meats Laboratory, is presented in Figure 3. The main floor would contain the irradiator, ancillary equipment, offices, and support facilities. The lower floor would contain the process cell into which the produce to be irradiated would move and into which electron beam or x-rays would be directed. Approximately 6,500 square feet would be used for the ISULAF proper and about 30,000 square feet for the entrance plaza and parking lot. Produce preparation and storage after irradiation would be provided for in the Meats Laboratory.

No permits would be required for the construction and operation of the ISULAF, other than for the irradiator. The Iowa Department of Public Safety's State Fire Marshal Division would review construction documents for the project for compliance with applicable State building codes and would issue a letter of approval prior to start of construction.

5.4 The Irradiator and Ancillary Equipment

A machine-source vendor, CGR MeV, of Buc, France, was selected and contracted in December 1988 by the ISU to provide and install an electron linear accelerator for the irradiator. The type of accelerator to be supplied by CGR MeV is referred to as "CIRCE," and requires about 15 months to build. It uses an electric field varying at a frequency in the microwave region to accelerate packets of low energy electrons in vacuum to high energies. The high energy electrons can be emitted directly into products being treated or converted first to x-rays to obtain other more penetrating treatment capabilities.

The FDA (51 FR 13376, April 18, 1986) requires that x-rays used in food irradiation not exceed energy levels of 5 MeV and that electrons used in food irradiation not exceed energy levels of 10 MeV. ISU intends to retain flexibility of generating x-rays up to 10 MeV for possible future non-food-irradiation research. The machine to be supplied is capable of producing an

electron beam of 5 MeV at 20 kW and 10 MeV at 10 kW. A midpoint energy of 7.5 MeV can also be selected (allowing flexibility for research purposes). A single irradiating station is planned that would provide for 5 MeV x-ray and a 10 MeV electron-beam treatment of box-size loads. A schematic of the machine ordered is shown in elevation in Figure 4.

The accelerator system consists of equipment located in both the shielded accelerator chamber and outside the shield walls in rooms or areas designated for that equipment. An artist's conception of an east elevation of the building addition housing the irradiator is shown in Figure 5.

6.0 AFFECTED ENVIRONMENT

The affected environment would consist principally of the attached Meats Laboratory and adjacent University facilities. All of the proposed site and nearby surrounding property has been disturbed as a result of past ISU construction activities.

Vehicles hauling workers, construction materials, and meats to and from the ISULAF could extend the affected environment beyond the ISU campus. The area of the campus in which the ISULAF is located is served by a four-lane highway that connects with north-south Interstate 35 about 4.5 miles from the site. East-west Interstate 80 joins about 25 miles south of the junction with Interstate 35.

The city of Ames has a population of about 44,300 and ISU has an enrollment of about 25,000 full-time equivalent students. The population of Story County, in which the city of Ames is located, is about 78,000. The surrounding region is generally composed of gently rolling farmland characteristic of much of the central plains states.

7.0 REGULATIONS GOVERNING OPERATIONS OF THE ISULAF

The ISULAF irradiator would be registered, regulated and inspected by the State of Iowa, Department of Public Health, Bureau of Radiological Health (DPH). Details of accelerator registration and regulations governing operation thereof are given in the Iowa Administrative Code at 641-39.4(136C). To ensure that shielding calculations have been performed properly, the DPH requires that plans, specifications, assumptions, and calculations be provided to them for review prior to start of facility construction. In regulation of accelerators, DPH applies the numerical restrictions on occupational and public radiation exposure adopted by the U.S. Nuclear Regulatory Commission (NRC). The ISULAF irradiator would not, however, be licensed under NRC or under "NRC-Agreement State" status.

Figure 4. Schematic of Irradiator

S9003048.3

Figure 5. East Elevation of ISULAF

The U.S. Department of Health and Human Services was delegated the authority under the provisions of the Radiation Control for Health and Safety Act of 1968 to regulate the manufacture and use of particle accelerators. Because the primary application at the time was (and continues to be) medical treatment, the program was administered through the FDA's Center for Devices and Radiological Health. The present regulatory authority activity of the FDA encompasses the manufacture of machine sources and usually terminates with their installation in the facility. For the most part, the regulation of installed accelerators and their applications has been relegated to the individual states. The FDA does require the manufacturer to prepare and submit an "Initial Report" describing in detail the machine for the ISULAF and its intended use. The report must be submitted to the FDA by the vendor before the accelerator's arrival in the United States. The FDA requires the reporting of all worker overexposures or manufacturer's recall of parts of devices. Thus, the FDA may become involved in the facility's operation if operations are not in accordance with specifications.

It is anticipated that the NRC limit for permissible dose to individuals in unrestricted areas will change from 500 mrem/yr to 100 mrem/yr. It is also anticipated that the lower value will be subsequently adopted by the DPH. (Under DOE Order 5400.5, the exposure of members of the public as a result of DOE activities shall not cause an effective dose equivalent of greater than 100 mrem per year.) As a consequence, the facility design and shielding calculations and specifications were based on a maximum dose rate at the outside accessible portions of the facility of 0.05 mrem/hr (from 100 mrem/yr and a nominal 2,000 work-hr/yr). The dose rate is zero when the facility is not in operation.

The ISULAF would also be required to comply with the National Ambient Air Quality Standards (NAAQS) codified at 40 CFR 50.9. There would be no releases of radioactive material to the atmosphere attendant to the operation of the ISULAF. However, there would be releases of ozone at levels at or below the permissible 8-hour concentration of 0.235 mg/cubic meter at points accessible to the public.

The State of Iowa incorporates all current EPA air quality regulations in Chapter 455B of the Iowa Administrative Code. These regulations are enforced by the Iowa Department of Natural Resources. An "Air Permit" would be required before start of construction.

Other federal regulations that apply to machine irradiators originate with the Occupational Safety and Health Administration (OSHA) of the U. S. Department of Labor. In particular, regulations for occupational exposure to machine-generated ionizing radiation is given at 29 CFR 1910.96. There, whole body exposure, for instance, is limited to 1.25 rems per quarter with the added regulation that accumulated exposure in rem may not exceed 5 times the worker's age less 18. Exposure of employees under 18 years of age are regulated to one tenth of the cited quarterly limit. In addition, exposure to ozone (which would be produced by radiolysis of air during machine operation) in the work place is regulated by OSHA, at 29 CFR 1910.1000, to 0.2 mg/cubic meter.

8.0 ENVIRONMENTAL EFFECTS OF IMPLEMENTATION OF THE PROPOSED ACTION

Environmental effects that may be associated with construction and operation of the ISULAF are described in the following subsections.

8.1 Construction Effects

About three-fourths of an acre of previously disrupted land would again be disrupted for construction of an addition to the existing Meats Laboratory to house the ISULAF, and to provide an entrance plaza, an improved service entrance, and an enlarged parking lot. Most of the proposed site has been covered by buildings and paved driveways. There is essentially no natural habitat. Therefore, the proposed action is expected to have no impact on land use because of its small size, previous site disruption, absence of wildlife habitat, and the project's overall compatibility with University activities.

Construction of the ISULAF would take place over about 11 months and would result in the presence of additional traffic, vehicular exhaust, and noise typical of construction of a 6,500-square-foot facility with an associated 30,000 square feet for entrance plaza,^(a) service entrance, and parking lot. The maximum number of workers on site at any one time would be 25. No significant socioeconomic effects would be anticipated. Impacts due to construction of the small facility are expected to be minimal and typical of other construction projects of this size.

Construction of the ISULAF would also commit consumption of several construction resources such as lumber, Portland cement, rock aggregate, and water. In addition diesel fuel and gasoline would be committed to construction of the facility. Since the facility is relatively small and none of the resources are critical or in limited supply, such use is judged not to constitute a significant impact.

8.2 Operational Effects

Environmental effects of operation of the ISULAF are described in the following subsections.

8.2.1 Transportation Effects

Daily traffic along Pammel Drive, the main arterial that would serve the ISULAF, amounts to about 11,000 vehicles. Operation of the ISULAF would result in about 150 trucks per year arriving at the ISULAF. Thus, at a rate of about one truck every other day, operation of the ISULAF would have a negligible effect on traffic on Pammel Drive.

(a) Future plans (unrelated to the proposed action) for the entrance plaza call for construction of an auditorium.

8.2.2 Radiological Effects of Operations

Operation of the ISULAF would result in the potential for occupational exposure of the irradiator operators to ionizing radiation. According to shielding calculations, the dose rate would be about 0.14 mrem/hr at the point of maximum employee exposure, namely, just outside the maze and past the conveyor doors, in the product handling room. For a 2,000-hr/yr operating time a total annual dose of 0.28 rem would be inferred. This maximum anticipated occupational exposure level is less than 6% of the levels allowed by DPH regulations. A system of interlocks, intrusion detectors, and alarms operate to prevent individuals from entering the exposure chambers while the machine is in operation.

The nearest resident in the direction of the highest dose rate from the irradiator is located in student family housing about 900 feet from the irradiator. Radiation shielding calculations indicate an estimated dose rate of about 0.00003 mrem/hr at the point of residency. The maximum likely operating time of the irradiator is 2,000 hr/yr. Based on the foregoing, the total annual dose to a member of the public residing in the vicinity of the ISULAF would not exceed about 0.06 mrem effective dose equivalent.

Theory suggests that during operation of x-ray sources at an energy of 5 MeV, photons interacting with deuterium (abundance 0.0002 of ordinary hydrogen) in air may yield ordinary hydrogen and a neutron. The probability of this reaction, however, is extremely low. Also interaction of photons with oxygen-17 (abundance 0.037 of total ordinary oxygen) may produce oxygen-16 (ordinary oxygen) and a neutron. Again the probability of the reaction is very small (NAS 1973). The resulting neutron fluxes are then also very small and would be unlikely to interact with other elements in air to result in induced radioactivity of any consequence in air.

Consequences of x-ray operation at 10 MeV (for possible future non-food-irradiation use) are not expected to vary significantly from operation at 5 MeV.

8.2.3 Effects of Noxious Gases During Operations

During ISULAF operation, ozone would be generated by radiolysis of air in the facility. Ozone in high concentrations is hazardous to humans and other biota and is damaging to equipment. For worker protection, concentrations of ozone in the working area would be controlled to within OSHA's permissible limits (0.2 mg/cubic meter - 8 hr limit) by the heating and ventilating system. Part of the ventilation air for the process chambers would be drawn from the work area, thus ensuring that noxious gases would not move from the process chambers to the work area. Ozone monitors would be used to determine time of safe entry to the process areas after shutdown of the accelerator.

According to EPA Region VI, the nearest ozone monitoring station is at the Madison County Hospital in Winterset, Iowa, about 40 miles from Ames. There, the highest one-hour ozone concentration was measured in 1980 at

0.206 mg/cubic meter. The average annual concentration for the peak year was 0.076 mg/cubic meter. The concentration of ozone at the outfall stack was designed to not exceed 0.235 mg/cubic meter. Dispersion calculations (using the EPA-approved Industrial Source Complex Short Term Dispersion Model) indicate that incremental concentrations of ozone at nearby points of public access would be about 0.004 mg/cubic meter. Although it is speculative that the ambient concentrations of ozone at Ames would be the same as at Winterset, this small addition of ozone would be highly unlikely to result in a concentration of ozone at points of public occupancy (the student family housing about 900 feet from the irradiator) exceeding the EPA limit of 0.235 mg/cubic meter.

In terms of annual ozone production, if the accelerator were to operate for 2,000 hr/yr (nominal work year) with an ozone production rate of 0.051 g/s, the total amount of ozone released to the atmosphere would be about 1,600 kg. For perspective, that amount of ozone would be about the same as that produced by 800 feet of a 500 kV transmission line in the same time period (Comber and Zaffenella 1982).

Ozone is the only noxious gas emitted from the ISULAF. Other potential sources of ozone in the area are one television station, two radio stations, one hospital, and high-voltage transmission lines. There are no nearby industrial sources, and none of the above mentioned sources is within 1.5 miles of the proposed irradiator site; thus, there would be no effects from collocated sources.

8.2.4 Operational Accidents

Accidents resulting in overexposure of workers or the public to ionizing radiation are not considered credible; radiation is produced only when the irradiator is in operation, and activating the irradiator requires following a stepwise procedure through a system of interlocks that ensures the absence of anyone in the irradiation chamber during operation. If any element of the procedure is missed in the process, the entire procedure must be repeated. Safety assessments were performed in the context of meeting shielding requirements and designing the interlock and automatic shutdown system.

To prevent accidental exposures to high levels of ozone, the heating and ventilation system would be designed with interlocks such that if the system failed, the accelerator would cease operation upon such failure. Operating procedures would call for evacuation of the building until ventilation could be restored or ozone levels fell to acceptable levels for entry.

The heating and ventilating system is designed such that the concentration of ozone at the outfall of the stack would not exceed regulatory limits for areas of unrestricted public access. As a consequence the impact from generation of ozone from accelerator operation is expected to be minimal.

8.2.5 Induced Radioactivity in Irradiated Commodities

Irradiation of agricultural commodities with up to 5 MeV x-rays or up to 10 MeV electrons at FDA's permissible dosages of 100 krad (51 FR 13376, April 18, 1986) would result in statistically predictable induced radioactivity in the commodities. Dosages received by irradiated commodities would be monitored by calorimeters or other dosimeters. The predicted levels of induced activity would be very small (less than 0.1%) compared to the activity of the unirradiated commodity. For example, induced activity in meat irradiated to 2,500 krad (25 times the dose to be used at the ISULAF) with 10 MeV electrons was determined to be less than 0.25% of the activity of naturally occurring potassium-40 immediately after irradiation and 100-fold less than that one day after irradiation (Lone et al. 1989). Unless elements sensitive to the photonuclear reactions, such as sodium or mercury, are purposely introduced into the commodities to be irradiated, measurement of induced activity is usually not possible because it is so small. Also, for the most part the radionuclides so formed are short lived; that is, in most applications they would not persist to time of consumption (ACINF 1986). In addition a very small amount of short-lived isomeric radionuclides may be theoretically induced in foods through a photon-photon reaction. The most significant element for this reaction is tin; however, the activity produced is less than 0.01 % of the activity of the unirradiated commodity (NAS 1973).

At doses to be delivered to agricultural commodities in the ISULAF, radioactivity induced by x-ray or electron irradiation is largely of theoretical interest and of no practical consequence, but it cannot be said to be zero. The upper energy limit for electron beam irradiation of foods was set at 10 MeV in order to avoid induced radioactivity in food (NAS 1973).

Though theoretically not zero, machine induced-activity is sufficiently small as to constitute no significant threat to humans and the environment.

8.2.6 Radiolytic Products and Nutritional Quality in Irradiated Food

During irradiation of a food, the ionizing energy, in addition to splitting molecules in unwanted organisms, splits some molecules of the food itself. The stable molecules thus produced are referred to as radiolytic products. There has been concern among opponents to food irradiation over whether some of these products might be different from products either found naturally in the food or formed upon processing foods with other accepted means and whether these products would be detrimental in human diets (CAST 1986). Research on radiolytic products has been carried on for more than 40 years to discover their nature, the amounts formed, and their effects. The scientific literature on the subject is extensive. Two results that are particularly germane to the present assessment are 1) for 100 krads of absorbed dose (the FDA limit) in 1 kilogram of food, approximately 6 chemical bonds are broken in each 100,000,000 chemical bonds present; and 2) all of the known radiolytic products derived from major food components are found in unprocessed foods or in foods subjected to other accepted types of processing, such as cooking (CAST 1986).

No significant impairment in the nutritional quality of protein, lipid, and carbohydrate conditions has been reported in foods exposed at approved levels. Exposure of foods to ionizing energy is somewhat destructive of vitamins, but no more so than are other food preservation methods used commercially (CAST 1986).

8.2.7 Effects of Other Aspects of Operations

Operation of the ISULAF would involve a staff of about four, with a lead operator, and three assistants, including a radiation monitor. With such a small staff there would be no socioeconomic effects associated with operation of the ISULAF.

If the demonstration of the use of a linear accelerator to accomplish the objectives to the ISULAF were successful, the following effects could be expected:

- Irradiation of pork and pork products would become commercial, and additional irradiation facilities would be built to fill the needs of the pork industry.
- Additional test facilities would be built to determine the efficacy of irradiation of other agricultural commodities specific to other regions.
- Additional sources of ozone would result from the operation of additional electron beam/x-ray machines. These would, by reason of the small quantities produced and by compliance with the NAAQS, not result in any deterioration of the environment.

9.0 ENVIRONMENTAL EFFECTS OF ALTERNATIVES TO THE PROPOSED ACTION

Under the "no-action-alternative" the benefits implied in Section 2.0 would not be realized nor would the environmental effects of construction and operation (described in Section 8.0) occur.

Under implementation of any of the "other sponsorship alternatives" the benefits implied in Section 2.0 and the environmental effects cited in Section 8.0 would be the same as in implementation of the proposed action. The principal difference would be the name of the entity providing support for the demonstration irradiator.

10.0 IMPLICATIONS OF DOE'S IMPLEMENTING THE NO-ACTION ALTERNATIVE

Implications of DOE's implementing the no-action alternative would include the following:

- delay further research on potential beneficial uses, if any, of agricultural commodities irradiation, and delay in establishing effective control of Trichinella spiralis, until an alternate Federal

agency is authorized by Congress to sponsor the ISULAF, or until the ISULAF could be built with ISU or other Iowa State funds; or

- delay determination of the possible benefits, if any, of commercial-scale irradiation of agricultural commodities until the agricultural commodities industry decides, if ever, to fund such demonstration irradiators privately or to proceed with commercial-scale irradiation without a demonstration phase.

11.0 CUMULATIVE IMPACTS

DOE is providing financial and technical support for construction and initial operation of a similar demonstration food irradiator for the State of Florida, Department of Agriculture and Consumer Services, at Gainesville, Florida. The major thrust of that facility is research on the efficacy of ionizing radiation in disinfestation and preservation of citrus fruit and to augment a program attempting to control the Caribbean fruit fly. The impacts of that proposed DOE action were discussed in an Environmental Assessment (DOE 1990) and a Finding of No Significant Impact for that proposed action was issued on March 28, 1990. Because these proposed actions are remote from each other and address different research objectives, their implementation and success or failure are not expected to be dependent in any way.

The impacts of construction and initial operation of the food irradiator facility, taken together with surrounding facilities, are not expected to cause significant effects on land use, traffic, or air quality at Iowa State University. No additional waste would be generated from operation of the facility.

12.0 INDIVIDUALS AND AGENCIES CONTACTED IN PREPARATION OF THIS EA

This Environmental Assessment was prepared, reviewed, and approved in accordance with DOE Order 5440.1C, "Implementation of the National Environmental Policy Act" (DOE 1985), and DOE NEPA guidelines (52 FR 47662).

Staff of the ISULAF and their contractors were consulted in the preparation of this Environmental Assessment. The ISU would be the owner and operator of the ISULAF, and their views on the utility of the irradiation facility are embodied in the aforementioned Cooperative Agreement.

A copy of the Iowa State Department of Public Health (DPH) Radiation Machines and Radioactive Materials Rules was obtained from DPH to determine Iowa's requirements regarding radiation protection of linear accelerator operations.

The Public Works Department of the City of Ames, Iowa, was contacted for an opinion on the status of the ISU site with respect to "wetlands" classification and determination of status with respect to 100- and 500-year flood plains.

The ISU Department of Animal Ecology was contacted for a determination of occurrence of threatened or endangered species on or near the ISULAF site.

13.0 PUBLIC AWARENESS OF THE PROPOSED IOWA AGRICULTURAL COMMODITIES IRRADIATOR

Although no public hearings have been requested or held on the ISULAF, there has been considerable public notice made through articles in several regional newspapers. A synopsis of that newspaper coverage is provided below.

The ISU's success in receiving a grant to pursue acquisition of a meat irradiation research laboratory was announced in an article in the Des Moines Register of Des Moines, Iowa, on January 28, 1987. That article advised that exposing food products, including meat, to low doses of radiation increases their shelf life and kills micro-organisms including bacteria and the parasite that causes trichinosis. However, the article also noted that food irradiation is controversial: critics have expressed concern over tests showing that irradiated food can reduce the number of offspring borne by animals, and concern that the radiation could cause bacterial mutations that could cause cancer.

The ISU irradiator was again the topic of an article in the Waterloo Courier of Waterloo, Iowa, on March 1, 1987, that described the proposed ISU facility (at that time use of cesium-137 was planned) in more detail. The article also presented broad-ranging concerns with food irradiation of the San Francisco-based National Coalition to Stop Food Irradiation; however, the ISU facility was not cited specifically in that context in the article.

Pros and cons of food irradiation were again presented in the Iowa State Daily on April 9, 1987, and the debate continued in an article in the Daily on April 6, 1988, which embodied a news release from the ISU stating that an electron linear accelerator rather than cesium-137 would be the source of radiation used. The opposition represented principally by the Iowa Coalition to Stop Food Irradiation contended that, among other things, food irradiation to prevent trichinosis was not necessary and that money spent on irradiation could be better spent on AIDS research.

14.0 REFERENCES

(ACINF) Advisory Committee on Irradiated and Novel Foods (Department of Health and Security, Ministry of Agriculture, Fisheries and Food, Scottish Home and Health Department, Welsh Office, Department of Health and Social Services, Northern Ireland). 1986. "Report on the Safety and Wholesomeness of Irradiated Foods." Her Majesty's Stationery Office, London.

(CAST) Council for Agricultural Science and Technology. 1986. "Ionizing Energy in Food Processing and Pest Control, 1. Wholesomeness of Food Treated with Ionizing Energy." Council for Agricultural Science and Technology, Ames, Iowa.

CH2M HILL. 1987. Irradiator Predesign Study Report. Prepared for Iowa State University, College of Agriculture, Experiment Station, Ames, Iowa. Available from R.B. Goranson, U.S. Department of Energy, Richland Operations Office, P.O. Box 550, Richland, WA 99352.

CH2M HILL. 1988. Applicability of Linear Accelerator Technology - Addendum No.1 to the Irradiator Predesign Report. Prepared for the Iowa State University Meat Irradiator Technology Center, Ames, Iowa. Available from R.B. Goranson, U.S. Department of Energy, Richland Operations Office, P.O. Box 550, Richland, WA 99352

CH2M HILL. 1989. Design Development Report. Prepared for the Iowa State University Meats Laboratory, Linear Accelerator Service Center. Available from R.B. Goranson, U.S. Department of Energy, Richland Operations Office, P.O. Box 550, Richland, WA 99352.

Clark, W.R. 1990. Letter dated April 4, 1990, from W.R. Clark, Department of Animal Ecology, Iowa State University to Iral C. Nelson, Pacific Northwest Laboratories, P.O. Box 999, Richland, WA 99352.

Comber, M.G., and L.E. Zaffanella. 1982. "Corona Loss." In Transmission Line Reference Book. Electric Power Research Institute, Palo Alto, California.

Gradwohl, D.M., and N.M. Osborn. 1990. Letter dated April 15, 1990, from D.M. Gradwohl, Ames, Iowa, and N.M. Osborn, Ames, Iowa, to A.D. Morton, University Architect, Facilities Planning and Management, Iowa State University, Ames, IA 50011-4000.

Lone, M.A., P.Y. Wong, J. McKeown, K. Mehta, and J. Barnard. 1989. "Activation Products in Radiation Processed Meat." In Proceedings of Workshop/Symposium on: Radiation Protection: Past and Future, eds D.J. TerMarsch and D.K. Myers, AECL-9959. Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada.

(NAS) National Academy of Sciences. 1973. "Radionuclides in Foods." Committee on Food Protection, Food and Nutrition Board, National Academy of Sciences, Washington, D.C.

(DOE) U.S. Department of Energy. 1985. DOE Order 5440.1C, "Implementation of the National Environmental Policy Act," Washington, D.C.

(DOE) U.S. Department of Energy. 1986. "Solicitation for Cooperative Agreement Proposal No. DE-SC06-86RL10933." Available from R.B. Goranson, U.S. Department of Energy, Richland Operations Office, P.O. Box 550, Richland, WA 99352.

(DOE) U.S. Department of Energy. 1990. U.S. Department of Energy Support of State of Florida, Department of Agriculture and Consumer Services' Florida Agricultural Commodities Irradiator Demonstration Project at Gainesville, Florida. DOE/EA-0427, Washington, D.C.

Wiegand, P.D. 1990. Letter dated March 28, 1990, from P.E. Wiegand, Public Works Department, City of Ames, Iowa, to A.D. Morton, Facilities Planning and Management, Iowa State University, Ames, IA 50011-4000.