UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 15 TO

FACILITY OPERATING LICENSE NO. R-83

TEXAS ENGINEERING EXPERIMENT STATION

TEXAS A&M UNIVERSITY SYSTEM

DOCKET NO. 50-128

1.0 INTRODUCTION

By letter dated January 26, 1998, as supplemented on August 11, 1998, and May 20, August 13, and September 23, 1999, the Texas Engineering Experiment Station (TEES)/Texas A&M University (TAMU) System (the licensee), submitted proposed Technical Specification (TS) changes to limit the quantity of Xenon-125 being produced in an experiment. The Xenon-125 would produce Iodine-125, which is plated out into a decay cylinder and sent off to a State of Texas Licensee who would process the medical isotope. Also, the TS for the Iodine-125 production included radiation sensors to monitor any effluents that may result from the experiment configuration.

Also, the licensee submitted by letter dated January 29, 1998, as supplemented on September 7, 1999, changes to the TS, which reformatted the TS to a WORD 97 format, and incorporated minor changes to conform to the new 10 CFR Part 20, and revised the reporting addresses for special reports.

2.0 EVALUATION

2.1 Overview

With regard to the experiment producing Iodine-125, the purpose of the licensee's submittal is to revise the TS so that a limitation on the quantity of Xenon-125, i.e., 2000 Curies, in any one experiment is specified in order to assure that 10 CFR Part 20 limits are not exceeded in case of total release of the contained Xenon-125. The staff's primary review was to assure that, in the unlikely release of all the material, 10 CFR Part 20 limits for the public and personnel would not be exceeded. The staff also reviewed the overall design envelope of the experiment configuratio to determine if there were any apparent deficiencies.

The licensee's application (Ref. 1) includes a Safety Evaluation for the Production of Iodine-125 at the TAMU Nuclear Science Center (NSC). In response to a request for additional information issued by the Nuclear Regulatory Commission (NRC) staff on June 11, 1998 (Ref. 2), the licensee submitted additional information on August 11, 1998 (Ref. 3). Further clarification was provided by the licensee on May 20, 1999 (Ref. 4), on August 13, 1999 (Ref. 5), and on September 23, 1999 (Ref. 6).

2.2 Description of Production Process

The production of Iodine-125 is a three step process. Xenon-124 is introduced to an irradiation chamber. It is irradiated as a gas in the NSC TRIGA research reactor to produce Xenon-125. The Xenon-125 is transferred as a gas to another chamber (decay cylinder) where it decays to Iodine-125 and is collected on the metallic surfaces of the decay cylinder. Following collection, the Iodine-125 including the decay cylinder is transferred to a materials licensed facility (separate from the reactor license) for processing and distribution. The processing and distribution is outside the considerations of this safety evaluation report (SER), and since Texas is an "Agreement State," the production, once the Xenon-125 has decayed to Iodine-125, and distribution of the Iodine-125 is licensed by the State of Texas.

The transfer of the Xenon gases between the supply, the irradiation chamber and the decay cylinder is accomplished through a cryosorption pump using liquid nitrogen.

2.3 Production System Design and Operation

The system design specifications presented in References 5 and 6 are based on the concept of double encapsulation. The inner system is constructed from stainless steel and consists of the irradiation chamber, the decay cylinder, liquid nitrogen cold traps, instrumentation, valves, connection fittings and interconnecting piping. The inner system design is pressure rated for 1000 psig, except for the pressure gauge, which is rated for 300 psig. The system will be pressure tested without the pressure gauge to 1000 psig before use to 1000 psig. From Ref. 6, experimental data and calculations, the maximum pressure in the inner system should be less than 125 psig.

The outer system is constructed from aluminum and surrounds the entire inner system. It has gasketed access openings for removal of the decay cylinder and introduction of the liquid nitrogen and the Xenon-124. The outer system is designed and leak tested for an internal pressure of 10 psig. Should the contents of the inner system at 100 psig leak to the outer system, the maximum expected pressure in the outer system should be 1 psig. The outer system boundary will be vented and monitored prior to removal of the access cover. Breaking of the secondary boundary and handling of the iodine collection system will be performed under negative pressure created by placing the suction hose of an iodine filtered suction device directly into the irradiation device.

The materials of all components have been selected based on their ability to withstand radiation damage.

The primary system contains a pressure monitor with a range of up to 300 psig. This monitor is primarily used as a remote monitor during the transfer processes and will be utilized during initial operation to monitor system pressure.

Due to the radioactivity associated with the Xenon-125 and the Iodine-125, the system is remotely operated. The transfer of the Xenon-125 within the primary system is made by cryogenic pumping at efficiencies expected to be greater than 99 percent. Following the transfer of the remaining Xenon-125 back to the irradiation chamber, isolation valves are used to isolate 90 percent of the remaining Xenon-125 gas prior to opening the primary boundary for removal of the decay cylinder.

All movements of the entire system (into irradiation position, decay position, decay cylinder removal position, etc) will be performed using the overhead crane to minimize the chances of dropping and damaging the system.

The staff considers the discussions and commitments in the request concerning the design and operation appropriate and acceptable based, in part, on the fact that conservative temperature and pressure specifications will be utilized. Cryogenic pumping is a well known technology and the NSC staff has had experience with applicable techniques.

2.4 Safety Analysis

The Safety Analysis for the system presented by the licensee discusses over-pressurization, radiation hazard of Iodine-125 handling, accidental releases to the environment, and reactivity effects when placing the production device in the reactor.

2.4.1 Over-pressurization

As stated earlier, the inner system is designed and tested to a pressure of 1000 psig, except for the pressure gauge. The expected maximum pressure in the inner system based on calculations and estimates from other experiments is less than 125 psig. The licensee will monitor this pressure during the performance of the irradiations and will terminate the experiment for unexpected pressure. The outer system is designed and tested to 10 psig. The maximum pressure in the outer system from a failure in the inner system is calculated to be approximately 1 psig.

The staff finds this design and these procedures acceptable.

2.4.2 Radiation Hazard of Iodine-125 Handling

The plate-out of the Iodine-125 will fix the material within the cylinder, valves and tubing. The decay cylinder walls provide sufficient shielding from the Iodine-125. The removal of the decay cylinder for processing is performed under negative pressure as stated in Section 2.3. The processing and distribution of the Iodine-125 is performed under a separate radioactive material license, issued by the State of Texas, and is not part of this safety analysis. The staff finds this acceptable.

2.4.3 Accidental Releases to the Environment

The Technical Specifications for the NSC TRIGA reactor require that the central exhaust fan be operating during reactor operation and sample handling. This system exhausts the building atmosphere through a stack. The central exhaust fan automatically shuts down when preset concentrations of radioactive materials appear in the building effluent exhaust stream. Calculations have been performed under the assumption that the central exhaust fan fails to shut down.

The exhaust stream is equipped with detection systems for I-125 and Xe-125, which will shut down the exhaust system at preset concentrations of I-125 and Xe-125.

For the scenario where the exhaust system does not shut off, a Gaussian Plume Model has been used for calculation. Conservative assumptions have been used. This safety analysis concludes that a 2000 Ci release of Xe-125 into the confinement building would result in an exposure at ground level at the point of maximum dose of approximately 50 mrem/year.

For this same Gaussian Plume scenario, the staff concludes that for a 20 Ci release of I-125, the annual dose from direct exposure to the I-125 contaminated ground is about 4×10^{-4} mrem/year.

Based on independent calculations, the staff concludes that the doses resulting from release of Xe-125 or I-125 from an accident involving one experimental capsule would be less than 10 CFR Part 20 maximum allowable public doses. Texas A&M submitted on August 13,1999 (Ref. 5), similar results of calculations which assumed the release of all of the potential inventory of Xe-125 from one capsule.

Texas A&M has requested that the total inventory of Xe-125 be limited to 3500 Ci. They plan to irradiate one experiment containing 2000 Ci or less of Xe-125, take that out of the reactor after the irradiation period is complete, and let the configuration decay to I-125 away from the reactor vicinity. They would then proceed to irradiate another experiment in the reactor. The combined curie count of the experiment being irradiated and that decaying away from the reactor could not exceed 3500 Ci. Since the staff could not determine a "common mode failure" or mechanism that would result in two experiments failing simultaneously, we believe this is beyond a probable event. Therefore, the rupture of one experiment was used to determine consequences from the experiment. The staff, therefore, concludes that the offsite consequences from a release due to this experiment would be minimal.

2.4.4 **Reactivity Effects**

The effect on core reactivity from insertion of the production device has been estimated from experience with similarly sized and configured devices to be 0.30 dollars. Accidental rapid removal from the critical reactor is well within the capability of the safety system to shut down the reactor safely.

2.5 **Technical Specification Changes**

1. The licensee has added a Xenon-125 effluent monitoring channel and an Iodine-125 air monitor to the facility. These monitors will track any releases of these isotopes. The specifications dealing with the operation of these monitors is in TS Section 3.5.3. The staff finds these TS acceptable.

2. The licensee has added a limitation on the quantity of Xenon-125 of 2000 curies that can be contained in any one experiment. This limit assures that any accidental release of the total quantity of Xenon-125 in an experiment will be below 10 CFR Part 20 limits (see discussion in Section 2.4.3). Also, the licensee added a total limitation of 3500 Curies of Xenon-125 that can be at the facility. This allows one experiment to be irradiated while

another has been set aside to allow the Xenon-125 decay to Iodine-125. Since the staff could not determine a common mode failure or mechanism that would result in two experiments failing simultaneously, the staff believes that such a failure is beyond a probable event, and finds that the limits on Xenon-125 are acceptable. These limits are in TS Section 3.6.4.

3. By letter dated January 29, 1998, as supplemented on September 7, 1999, the licensee submitted a reformatted set of TS which was scanned into WORD 97. In addition, changes were made to the following sections:

   (a) Section 3.5.2, "Argon-41 Discharge Limit", was changed from $4.8X10^{-8}$ to $1.0X10^{-8}$ μCi/ml. This was done to comply with the current 10 CFR Part 20.

   (b) The terminology of Section 6.6.1.f.1 "Annual Report-Liquid Waste" was changed from "MPC" to "Effluent Concentration." This was done to agree with current 10 CFR Part 20 terminology.

   (c) Section 6.6.2, "Special Reports", was modified to state that the special reports shall be sent to NRC headquarters instead of NRC Region IV. This was done in response to a letter, which was received in July 1997 from Mr. Ellis Merschoff, NRC Region IV.

The staff has reviewed the reformatted TS in their entirety and has verified that they have been accurately transcribed to the WORD 97 format. Changes (3a) and (3b) above merely reflect the requirements of the revised regulations in 10 CFR Part 20. The addresses for special reports are being revised to show the consolidation of non-power reactor management in NRC Headquarters. The staff finds all the changes in this section acceptable.

3.0 ENVIRONMENTAL CONSIDERATION

This amendment involves a change in a requirement with respect to the installation or use of facility components located within the restricted areas defined in 10 CFR Part 20. The staff has determined that this amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and there is no significant increase in individual or cumulative occupational radiation exposure. Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

4.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously evaluated, or create the possibility of a new or different kind of accident from any accident previously evaluated, and does not involve a significant reduction in a margin of safety, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed changes, and (3) such activities will be conducted in compliance with the

Commission's regulations, and the issuance of this amendment will not be inimical to the defense and security or the health and safety of the public.

5.0 References

1. Letter to U.S. Nuclear Regulatory Commission (NRC) from Sean O'Kelly , Assistant Director, Texas A&M University Nuclear Science Center, January 26, 1998.
2. Letter to Sean O'Kelly, from NRC, June 11, 1998.
3. Letter to NRC from Sean O'Kelly, August 11, 1998.
4. Letter to NRC from W. D. Reece, Director, Texas A&M University Nuclear Science Center, May 20, 1999.
5. Letter to NRC from Chan-Hyeong Kim, Acting Assistant Director, Texas A&M University Nuclear Science Center, August 13, 1999.
6. Letter to NRC from Chan-Hyeong Kim, September 23, 1999.

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