TEXAS ENGINEERING EXPERIMENT STATION

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NUCLEAR SCIENCE CENTER
409/845-7551

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98-0228

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington DC 20555

Subject: Reply to Request for Additional Information Letter dated June 11, 1998

References:

1. Texas A&M University Nuclear Science Center Reactor License R-83, Docket 50-128
2. Safety Evaluation for the Production of Iodine-125 at the Texas A&M University Nuclear Science Center
3. Request for Additional Information letter dated June 11, 1998

Dear Sir:

Attached is a reply to the Request for Additional Information letter of June 11, 1998. No material considered proprietary has been included in the reply.

The original request was to include the following statement in the R-83 Technical Specifications (Section 3.6.2.c Material Limitations)

> Each experiment used for the production of Iodine-125 shall be controlled such that the total inventory of Xenon-125 in an individual experiment is no greater than 1000 Curies.

Please contact me if you have any questions or concerns.

Attachments

Sincerely,

Sean O'Kelly
Assistant Director

xc: 12110/Central File
T. S. Michaels NRR/DRPM/PDND
B. D. Russell, Licensee, TEES
W. D Reece, NSC Director

1. **Explain the efficiency of pumping remaining Xe gas back into the irradiation chamber. Does any of the Xe-125 remain in the decay chamber which should be accounted for in the safety analysis?**

The collection of Xenon in the cold traps requires sufficient surface area and collection volume to prevent saturating the trap. The cold fingers use a 25 cc standard volume for gas collection. This is 2.5 times the required volume for complete transfer. The NSC has used this method for movement and collection of other gases. The cryopump system will collect with high efficiency and has pumped relatively large gas systems to greater than 30 inches of vacuum within five minutes. It can be assumed that 99% of the gas is collected in the cold trap. Following the transfer back to the irradiation chamber, two isolation valves are manually shut to isolate approximately 90% of the remaining Xe gas before breaking the primary boundary. Much less than 10 mCi (perhaps less than 1 mCi) of Xe-125 will be available at this point. The low activity of the remaining Xenon does not need to be accounted for in this safety analysis.

2. **The discussion in the system design and operation section is not adequate to get any idea of the design or a clear idea of the operation. Please provide more details on the design of the system. What does VCR-type connection and what does MV mean? Please include relief valves, temperature and pressure sensors, etc. in the discussion.**

Description of the Irradiation Device

The device will double encapsulate the gas sample during irradiation and decay of the gas. The outer boundary will be fabricated from aluminum and the inner components will be constructed from stainless steel.

Design considerations for primary boundary

- All connections and components will be type 304 or 316 stainless steel pressure rated for at least 1000 psig.
- All wetted surfaces will be cleaned, flushed or electropolished as appropriate
- Remotely operated valves will be pneumatic, bellows to body sealed, and withstand temperatures in excess of 400°F
- Fitting for cylinder removal will be VCR-type metal-gasket face seal

- Liquid nitrogen cooling will be a closed system to maintain two boundary isolation

- High density polyethylene plugs will reduce neutron streaming from lower irradiator

- System will be pressure tested to 300 psig followed by vacuum testing

- All NPT connections will require welding for positive seal

VCR connections are a trademarked product manufactured by the Cajon company (part of the Swagelok companies). This connection is called a "face seal" in which the seal is formed by a metal-to-metal contact vice gasket or o-ring. The seals are used in systems that operate at ultra-high vacuum to pressures of 20,000 psi. The designation "MV" in the drawing is a local designation for "Manual Valve."

There is no relief valve in the primary system. A relief is unnecessary based on the operating pressures and system design pressures. The pressure transmitter will provide pressure indication from vacuum to 100 psia. Pressure indication is used to remotely monitor the transfer process. During system pump down following cylinder removal the vacuum will be monitored with conventional vacuum detectors.

3. **Please provide a more detailed discussion on the irradiation in the reactor. What is the position near the core, the flux, the effect on reactivity, the temperature buildup in the IC, the effect of an accidental pulse, etc?**

The device will be irradiated on the reactor face (called the A-row). Measured flux values are 6E12 n/cm^2/sec. Temperature buildup is proportional to reactor temperature but significantly lower due to the cooling of the irradiator from the reactor pool. The reactivity of similar sized and configured devices in the A-6 position has always been less than –0.30 dollars. Several procedural controls would be violated in order to pulse the NSC reactor with an unapproved experiment in place. The reactor temperature would rapidly rise and fall during the pulse but the temperature of the experiment would be moderated by its location and size. No significant effects are expected during an "accidental pulse."

4. **Please explain the meaning of the Max Reactor Temp of 370°C in the drawing. Is this a fuel meat temperature? What is its significance on the experiment? Please discuss the temperature and pressure in the IC during the irradiation.**

The normal operating fuel temperature, as measured by the Instrumented Fuel Element, is approximately 725F. This equates to 370C. It is assumed that the experiment temperature is not more than reactor temperature. The experiment location is on the reactor periphery (called the A-row) and operates at much lower temperatures. Highest experiment temperatures at that location would be 100-150C. The drawing was a graphical method of showing the pressure rise in the system from an increase in temperature. The upper limit of the graph was chosen as reactor temperature because there would be no conceivable way of attaining a higher temperature.

5. **Please explain how the primary system as designed could develop an over-pressurization that results in a leak. Would not a leaky fitting be a more likely cause?**

A leaking fitting would be a more likely scenario for releasing Xe gas during operation. The system, as designed and operated, will not be able to develop an overpressure condition that would stress or rupture any connections. System integrity will be tested by a 1000 psig pressure test followed by a vacuum leak check. The discussion of the over pressure accident (page 5) was to reinforce the system design safety factors.

6. **Please provide information concerning the specifications for the secondary boundary and its leak testing.**

- All components will be fabricated from welded aluminum
- System will be designed for irradiation in A6 reactor face position
- System will be sized to not interfere with reactor operation while minimizing personnel exposures
- Access opening will be gasket sealed
- Boundary venting and monitoring will be required prior to removal of access cover
- Breaking of secondary boundary and handling of ^{125}I cylinder will be within a confinement tent or closet with filtered ventilation
- Secondary Containment will be pressure tested to 10 psig
- System will be leak checked by submersion for 24 hours at full pool depth

7. **Please explain where the handling and processing of the I-125 will take place. Is this part of a different license not associated with the reactor?**

.The I-125 will be plated to the walls of the Decay Cylinder (DC). The original amendment application was prepared before the final processing location was determined. The I-125 will now remain within the sealed DC and be shipped in a Type A container directly to a processing center. The radioiodine processing lab will be licensed by the State of Texas and is not associated with the NSC.

8. **Please provide a scenario for the analysis of the accidental release of the Xe-125 into containment. Please explain the conservatism stated in paragraph 4 because of the shutdown of the exhaust fan. Does this not convert the release to a ground level release as soon as the ventilation contribution from direct radiation and, if applicable, a ground level release from the reactor building? Is the fence line so far away that there is no contribution from direct radiation?**

It is difficult to conceive a scenario that would produce a complete failure of the inner and outer boundaries of the irradiator. A catastrophic simultaneous shearing or cracking of the inner and outer barriers caused by dropping the irradiator to the pool bottom following irradiation is one remote possibility. Another extreme possibility would be a flooding of the outer chamber caused by damage to a seal or weld concurrently with a failure of the inner boundary. A leaking fitting or connection could cause the failure of the primary system. The small volume of gas thus vented would collect in the upper section of the secondary boundary. The Xenon gas thus concentrated could then potentially leak by the damaged boundary of the outer chamber. This would be a slow leak and detectable by bubbles and the Effluent Xenon monitor.

The dropping and fracturing of the irradiator is prevented by handling the irradiator only while coupled to the facility overhead crane. The inner and outer systems are leak checked prior to operation and following substantial maintenance.

The five minute shutdown of the facility exhaust fan is conservatively assumed to take into account the time to disperse the gas in the facility and reach the building effluent detectors. The exhaust fan may be manually shutdown by the operator in the event that there is a failure of the shutdown circuitry. The operator is required to shutdown the building exhaust system in the event the release is noted by the Reactor Control Room but an evacuation is needed.

The dilution factor derived in the Safety Analysis Report is based on a ground release. The facility boundary is at least 100 meters from the building. The NSC facility is effectively 1 mile from any building that is routinely occupied. During an emergency situation, the single NSC access road may be blocked by the University Police at approximately the one-mile point. Dose levels at the facility boundary are not expected to be a concern.

9. **Please discuss why the current emergency plan for the alert level needs revision to cover this accident.**

The accidental release of Xenon-125 is not covered under the current NSC Emergency Plan.

10. **The I-125 scenario in the last sentence is confusing. Will the I-125 point of highest concentration be near the decay cylinder? Please explain the meaning and validity of the I-125 conclusions here and in Appendix 2.**

The assumed 10 Ci of I-125 on the ground was the result of a release of 1000 Ci of Xe-125 into the atmosphere. This example was to show that a worst (and impossible) case of the Xe-125 concentrating and decaying at 1.8 km from the point of release would produce an effective dose equivalent of 2.14E-4 mrem/yr from I-125. However, it is acknowledged that the Xenon gas would be far more dispersed and result in substantially less dose to the public.

The highest actual concentration of I-125 will be in the irradiator following complete decay of Xe-125. This iodine will be plated out and fixed and it is not considered in the safety analysis.

11. **Provide a listing of the radiation monitoring systems that will be used and their location. Include these systems in your Technical Specifications along with surveillance requirements.**

The NSC has purchased two Model FM-7ABNI Iodine Air Monitors from Technical Associates. One monitor will be used to monitor the building effluent and the other will monitor the I-125 cylinder handling area.

The systems will be included in Section 5.4 and 4.5 of the Technical Specifications. The monitors will be calibrated annually not to exceed 14 months and will be verified operable weekly.

12. **Please discuss the calculations performed to show that the 2 mph wind produces the minimum dilution factor.**

Attached is Section IX.E of the NSC Reactor Safety Analysis Report. It shows that the calculated dilution factor is 1/202 for stable (2 mph) atmospheric conditions. The average wind speed is actually higher and results in a higher dilution rate. A dilution factor of 200 is used for all NSC accident scenarios.

13. **Please provide the stack height and inside diameter.**

The NSC stack is 85 feet high and 3 feet in diameter.

14. **Provide an analysis which shows that adequate ventilation is provided in the area where I- 125 is present. Where are the inlet and outlet vents located?**

.The radioiodine will be handled in a confined enclosure with a dedicated filtered ventilation fan. The fan has a 800 cfm flow with the inlet located in the area of the I-125 cylinder and discharging through a filter to the facility building exhaust.

15. **How many individual experiments can be performed simultaneously or how many can be performed one after another to build up the inventory that is decaying to I-125? The Xe and I-125 release safety analysis is predicated on the failure of one irradiation.**

Only a single irradiator may be on the reactor at any given period. Current planning anticipates at least one irradiation a week. The Xe-125 produced from one irradiation will decay in about one week. If two irradiators were being used (one on the reactor and one decaying) it is not conceivable that the postulated accidents causing failure would occur to both simultaneously. The requested license change should only limit the total activity of a single experiment and allow multiple, separate experiments.

E. Dilution Factor Calculations

The equations used in developing the dilution factors calculated below are those presented by F. A. Gifford, Jr.[13,14] These calculations are based on release at ground level and utilize the building dilution factor D_B = cAu, where A is the cross sectional area of the building normal to the wind and u is wind speed in meters/second. From reference 13, C is estimated to be 0.5. The cross sectional area of the Nuclear Science Center is 357 m^2.

The equation for the atmospheric dilution factor is:

$$X = \frac{Q}{\pi \sigma_y \sigma_z u} \exp\left\{-\frac{1}{2}\left(\frac{y_2^2}{\sigma_y} + \frac{h_2^2}{\sigma_z}\right)\right\}$$

where

X = Concentration in grams or curies per cubic meter
Q = Original source strength in grams or curies per second
u = Mean wind speed in meters per second
y = Crosswind in meters from the plume axis
h = Source height in meters
σ_y, σ_z = Dispersion coefficients in m^2

By combining the building dilution factor, D_B, with the atmospheric dilution factor and in the downwind direction (y = o), the formula becomes:

$$X = \frac{Q}{(\pi \sigma_y \sigma_z + cA)u}$$

The average wind speed as determined from U.S. Weather Bureau data for this location is 10 mph. The following calculation utilizes dispersion coefficients of σ_y, σ_z for stable conditions and a wind speed of 1 m/sec (2 MPH) to determine the dilution factor available under pessimistic conditions, (Q = 1) at a distance of 100 meters from the point of release.

$$X = \frac{1}{(\pi \sigma_y \sigma_z + cA)u}$$

$$X = \frac{1}{(3.14 \times 4 \times 2 \times 0.5 \times 357)}$$

$$X = \frac{1}{202}$$

This calculation indicates that the minimum dilution at 100 meters is 200/1 under the most adverse conditions. From the wind rose diagram shown in Figure 2-3 these conditions are indicated approximately 10% of the time. however, most calm conditions occur at night while the majority of operations occur during the daylight hours. If the average wind velocity (10 MPH) is substituted into this equation the dilution factor becomes:

$$X = \frac{1}{903}$$

[13] F. A. Gifford, Jr., Nuclear Safety, December, 1960.

[14] F. A. Gifford, Jr.; Nuclear Safety, July, 1961.

Again this is a pessimistic approach since the dilution was calculated at only 100 meters (approximate boundary of exclusion area). The calculation at 1500 meters under stable conditions and with a wind speed of 10 MPH yields a dilution factor of 6,920. If the wind speed is reduced to only 2 MPH it still is 1,570.

The calculations presented in this section clearly show that a dilution factor of 200 can be utilized by the Nuclear Science Center for stack release without endangering the public health and safety.

F. Facility Air Monitoring System

Argon-41 activity is monitored with a gas detector which utilizes a 3" NaI (Tl) scintillation crystal and a gamma spectrometer. The detector which is calibrated for ^{41}Ar activity, continuously samples air from the building exhaust plenum. The system is equipped with an adjustable contact which provides an audible alarm on the console and a warning light on the console and in the reception room. The system is shown schematically in Figure 9-2.

Stack particulate activity is monitored with a moving tape type, continuous air monitor. This monitor samples air from the building exhaust plenum. This monitor is equipped with an alarm circuit which activates an audible alarm and a warning light indicating the channel alarming and also causes an automatic shutdown of the air handling system to isolate the facility.

Building gas activity is monitored by a gas detector which is calibrated for ^{41}Ar activity. Air is sampled on the chase level by this monitor. An alarm circuit actuates an audible alarm when preset alarm levels are reached and a warning light is actuated.

Building particulate activity is monitored with a moving tape type, continuous air monitor. Air is sampled on the chase level by this monitor. An alarm circuit actuates an audible alarm when preset alarm levels are reached and a warning light is actuated.

A fission product monitor with a low sensitivity for the detection of gases is used to essentially eliminate high detector backgrounds due to ^{41}Ar gas. The air sampling region is located approximately one foot above the pool surface at the reactor bridge. Air is drawn through the line and through the monitor filter paper using an air suction pump. A G.M. detector monitors the filter paper 180° from the point of collection. The monitor primarily detects particulates that are produced by decay of fission product gases collected in the sampling line. This monitor is equipped with an alarm circuit which activates an audible alarm and a warning light. An alarm on this system will automatically shut down the air handler units and shut air dampers to isolate the facility.

G. Area Radiation Monitors

The area radiation monitoring system provides a continuous indication at the reactor console and in the reception room of the radiation level in each of the monitored areas. An adjustable contact on each indicating meter provides an alarm on the console annunciator panel. A red light on the indicating meter and on the detector identify the particular area. A block diagram of a typical system is shown in Figure 9-3.