ATTACHMENT

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
FEDERAL CENTER DENVER COLORADO 80225

January 7, 1970

Mr. Donald J. Skovholt
Director of Reactor Operations
Division of Reactor Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Skovholt:

Based on our analysis included below request is hereby made for your consideration of the granting of a release from Title 10 Part 20 Code of Federal Regulations to the U.S. Geological Survey TRIGA Reactor Facility concerning the amounts of airborne Argon-41 released from the reactor exhaust.

Currently we are limited to releases of Maximum Permissible Concentrations of Argon-41 for unrestricted areas (4×10^{-8} μCi/cc) as measured at the reactor exhaust stack.

Assuming a duty cycle for our normal exhaust system of 350 days/year, we calculate the allowable annual release as:

$$(350 \text{ days/yr})(1160 \text{ ft}^3\text{/min})(1.44 \times 10^3 \text{ min/day})(2.831 \times 10^4 \text{ cc/ft}^3)(4 \times 10^{-8} \mu\text{Ci/cc})$$

$$= 6.6 \times 10^5 \mu\text{Ci/year} \qquad (1)$$

It is our contention that the exhaust stack and the surrounding area on the roof of the Nuclear Science Building are, in fact, restricted areas. Access to and occupancy of these areas are controlled by the reactor staff. Appropriate personnel dosimetry standards and rules for protection against radiation are applied to all personnel working in these areas.

Accordingly, we contend the nearest point to the exhaust stack which could be occupied by a member of the general public is 23.65 feet away from this exhaust stack. (Note Figure #1).

This spot is 39 feet removed from the nearest sidewalk where the general public would have occasion to inhabit. The anticipated occupancy by the general public to the closest point, point A on the figure, is optimistically estimated to be 4 hours per week while loading or unloading shipments at the next door receiving dock.

We estimate that we could release 141 times the MPC value of 4×10^{-8} μCi/cc as measured at the exhaust stack and the permissible concentrations of Argon-41 will not be exceeded for any member of the general public. We based this estimate on a minimal dilution factor, calculated below, as the exhaust air leaves the stack and mixes with the atmosphere before reaching points of unrestricted access.

These calculations are:

Given: Average Wind Speed 9.5 miles/hr or 13.9 ft/sec
(From Hazards Summary Report)

Exhaust Dimensions 7.5 inches x 7.8 inches
(measured)

Exhaust Velocity = 2900 ft/min
(measured) 48.3 ft/sec

Shortest Distance - source to area where general public could stand
(See Figure #1) = 23.65 ft

References: (1) Diffusion of Vented Gas Around Buildings
James Halitsky
Journal of Air Pollution Control
Volume 12 - #2, 1962

(2) Meteorology and Atomic Energy 1968
TID-24190 - Section 5.5 pp. 221-255

Exhaust Specifications:

Size .625 ft x .65 ft = 0.406 ft^2

Effective Diameter = .406 ft^2
[illegible]

Note: In selecting the values for α, β, and M, the model tests on Clinical Center and surroundings at the National Institutes of Health, Bethesda, Maryland, performed by Halitsky (op. cit. #2, Section 5-5.5.3 pp. 246-252) provided values which correlated against experimental determinations give minimum dilution factors.

With test data for combinations of D and R plotted on a graph with D as the ordinate, it was possible to select constants α and β that allowed equation #4 to be plotted as parabola bounding the data from below. Although there was considerable scatter of the data above the curve, the absence of test points below the curve implied that at a given separation distance no dilutions less than those given by the curve had been found and, therefore, the curves could be used conservatively for design purposes.

Also from these studies the suggested values of M were 1.5 for exhaust and intake on the same roof, 2.0 for exhaust and intake on wings separated by an air space and 4.0 for exhaust on roof and intake in a cavity near ground level.

For conservatism, the additional adjustment for emission-velocity ratio is not made in this calculation. The ratio for the Survey's exhaust stack to average wind speed is 3.47 (equation #3). The ratio of 2.22 is used in the model developed by Halitsky.

Using minimum dilution factors:

$\alpha = 3.16$
$\beta = 0.1$

Then: $D = M\,[3.16 + (0.1)(37)]^2$
$D = 47M$

Note: Table III, page 78 (op. cit. #1) where for ground conditions with values of R similar to the value determined for the GSTR facility the value for M is 3 or greater. (BA, DA, EA). In cases where the value for R is larger (HA and JA) the value for M is < 3 but the total dilution is large because R is large. Accordingly, we believe the selection of the value of 3 for the coefficient M is conservative.

$M = 3$

The resulting diffusion factor is:

$$D = (3)(47) = 141 \qquad (6)$$

To determine the yearly release (total) which would not expose the general public to greater than MPC values for Argon-41, we apply this dilution factor (6) times our present allowable annual release (1).

$$(6.6 \times 10^5\ \mu Ci/year)(141) = 93\ curies/year \qquad (7)$$

We are requesting the release from MPC at this time based on our expected future utilization of the GSTR facility.

This is a re-evaluation of the total Argon-41 releases to be expected from the GSTR facility. This evaluation differs from the Hazards Summary Analysis because more optimistic estimates on power levels and frequency of utilization for the various irradiation facilities have been used. It also considers the facility will be operated 24 hours/day, 6 days/week.

In evaluating our predicted releases of Argon-41, the following assumptions are used.

1. Pneumatic Systems

Production = 4×10^{3} µCi at saturation at 1,000 KW [HSR]

a. $(4 \times 10^{3}\ \mu Ci)$(2 systems)(500 usages/year/system) at saturation

or

b. $(4 \times 10^{3}\ \mu Ci)$(2 systems)(5,000 usages/year/system) at 10% saturation

$$= 4 \times 10^{6}\ \mu Ci/year \quad (8)$$

$$\frac{4 \times 10^{6}\ \mu Ci/year}{1.65 \times 10^{13}\ cc/year} = 2.42 \times 10^{-7}\ \mu Ci/cc \quad (9)$$

$$\frac{4 \times 10^{6}\ \mu Ci/year}{3.156 \times 10^{7}\ sec/year} = 1.27 \times 10^{-1}\ \mu Ci/sec \quad (10)$$

Case "b" seems the more likely mode of operation.

2. Lazy Susan

Production = 8.6×10^{5} µCi at saturation at 1,000 KW [HSR]

$(8.6 \times 10^{5}\ \mu Ci)$(300 days/year)(1% purging/day by sample removal)

$$= 2.6 \times 10^{6}\ \mu Ci/year \quad (11)$$

$$\frac{2.6 \times 10^{6}\ \mu Ci/year}{1.65 \times 10^{13}\ cc/year} = 1.58 \times 10^{-7}\ \mu Ci/cc \quad (12)$$

$$\frac{2.6 \times 10^{6}\ \mu Ci/year}{3.156 \times 10^{7}\ sec/year} = .823 \times 10^{-1}\ \mu Ci/cc \quad (13)$$

3. Central Thimble

Production = 9 x 10^3 µCi at saturation at 1,000 KW (calculation) when operated dry. A dry tube will be used ~100 times/year with 10% purging per utilization.

$$= 9 \times 10^{4}\ \mu Ci/year \qquad (14)$$

$$\frac{9 \times 10^{4}\ \mu Ci/year}{1.65 \times 10^{13}\ cc/year} = \underline{\underline{.054 \times 10^{-7}\ \mu Ci/cc}} \qquad (15)$$

$$\frac{9 \times 10^{4}\ \mu Ci/year}{3.156 \times 10^{7}\ sec/year} = \underline{\underline{.029 \times 10^{-1}\ \mu Ci/sec}} \qquad (16)$$

4. From Reactor Water

Production, assuming saturation and equilibrium with air changes. Operations for 300 days/year.

$$(0.0297 \times 10^{-7}\ \mu Ci/cc\ [HSR])(\frac{300}{365})$$

$$= \underline{\underline{.024 \times 10^{-7}\ \mu Ci/cc}} \qquad (17)$$

$$= \underline{\underline{0.0005 \times 10^{-1}\ \mu Ci/sec}}\ [HSR] \qquad (18)$$

$$(0.0005 \times 10^{-1}\ \mu Ci/sec)(3.156 \times 10^{7}\ sec/yr) \cong 1.6 \times 10^{3}\ \mu Ci/year \qquad (19)$$

Totaling items 1, 2, 3, and 4, the average release rates and concentrations are:

	µCi/cc	µCi/sec
1. Pneumatic Systems	2.42×10^{-7}	1.27×10^{-1}
2. Lazy Susan	1.58×10^{-7}	$.83 \times 10^{-1}$
3. Central Thimble	$.054 \times 10^{-7}$	$.029 \times 10^{-1}$
4. Water	$.024 \times 10^{-7}$	$.0005 \times 10^{-1}$
	~4.1×10^{-7} µCi/cc	~.21 µCi/sec

(20)

Therefore, we assume the average release for 1 year's operation will be 4.1×10^{-7} µCi/cc with a release rate of 0.21 µCi/sec as measured at the exhaust stack.

Converting this estimate to a yearly release, we have:

$(4.1 \times 10^{-7}\ \mu Ci/cc)(1.65 \times 10^{13}\ cc/year)$

or 6.76 curies/year (21)

Comparing this value of 6.76 curies/year (21) to our determination of a yearly release value which would not expose the general public to greater than MPC values for Argon-41, namely 93 curies/year (7), we believe that maximum utilization of the GSTR with the existing irradiation facilities will not endanger the health and safety of the general public. To add an additional factor of conservatism, we request a release of only 100 times the Maximum Permissible Concentrations for Argon-41 in unrestricted areas:

$$(4 \times 10^{-8}\ \mu Ci/cc)(100) = 4 \times 10^{-6}\ \mu Ci/cc \quad (22)$$

This value is 2 times the Title 10 Part 20 Code of Federal Regulations value for releases to restricted areas. $(2 \times 10^{-6}\ \mu Ci/cc)$

Converting this value to a yearly release limit we have:

$(4 \times 10^{-6}\ \mu Ci/cc)(1.65 \times 10^{13}\ cc/year)$

= 66 curies/year (23)

We will, of course, continue to minimize the radioactive Argon-41 concentrations in our exhaust systems by scheduling irradiations which can produce Argon or make available for purging Argon for times when the Argon inventory is minimal, or when the expected purging will be minimal.

Thank you for your consideration of this matter. If we can provide any additional information, we will be happy to do so.

Sincerely,

Thad G. McLaughlin
Reactor Administrator