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Department of Energy
Chicago Operations and Regional Office
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Argonne, Illinois 60439


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William E. Mott, Director
Environmental and Safety Engineering, HQ

SUBJECT: INTERIM OVERVIEW/CERTIFICATION ACTIVITIES REPORT FOR THE AMES LABORATORY RESEARCH REACTOR FACILITY, AMES, IOWA

Enclosed for your information is an interim report concerning the radiological overview/certification activities conducted by the ANL MED/AEC Radiological Survey Group at the Ames Laboratory Research Reactor, Ames, Iowa. Any questions you may have concerning this report should be addressed to Edward J. Jascewsky on FTS 972-2254.

Billy D. Shipp, Director
Operational and Environmental
Safety Division

Enclosure:
Interim report

cc: A. Wallo, Aerospace, w/encl. ✓

INTERIM OVERVIEW/CERTIFICATION ACTIVITIES REPORT FOR THE
AMES LABORATORY RESEARCH REACTOR FACILITY, AMES, IOWA

At the request of the Engineering Support Division of DOE-CORO and in accordance with the programmatic overview/certification responsibilities of the DOE-ASEV Environmental and Safety Engineering Division, the ANL Radiological Survey Group conducted a series of radiological measurements and tests at the Ames Laboratory Research Reactor (ALRR), Ames, Iowa, during the weeks of November 21, 1980, and January 12, 1981. At the time, D&D of the reactor facility was in progress under Contract No. W-7405-ENG-82. The first visit was primarily to assess the need for further decontamination of the peripheral faces of a large hole in the reactor room floor. The hole had previously contained the reactor and its shield components. Ames personnel reported, that in the past, a heavy water primary coolant leak had occurred in the vicinity of face No. 9 resulting in tritium contamination of the concrete. Heavy water from the Ames Reactor, at shutdown, reportedly contained 1.8 Curies of tritium per liter.

The D&D plans call for covering the hole in the floor with a new 2 foot thick concrete slab with new lintels added for support and new concrete to refill the vertical substructure beneath the new floor. It, thus, became necessary to reach a decision on the need for continued decontamination in this specific area. It had been reported, by Ames Laboratory personnel, that the peripheral faces contained varying concentrations of tritiated water. Concentrations in certain faces were reported to be relatively high. In addition, the entire structure of the facility was believed to contain tritiated water which in effect is acting as the source term for tritium diffusion back into the facility. The original source term, the heavy water, has all been removed.

Since the initial assessment in November, and the subsequent visit in January, it has become evident that the continued decontamination of the hole area (chipping out of concrete) would be nonproductive and not cost effective in that it would not significantly lower the ambient tritium airborne concentration in the reactor room. The tritium concentrations in the concrete of the exposed face does not appear to be an over-riding source term. It is also quite evident, from the airborne tritium levels encountered, that the release of this structure for unrestricted use is <u>not possible</u> at this time or in the near future. The radiological measurements taken to date substantiate the fact that $^{3}H_2O$ has permeated the concrete and is now diffusing back out. While the kinetics of this process are perhaps somewhat complex, it is speculated from the data gathered to date that it follows an exponential function.

A summary of the activities involved in the assessment included the following:

Concrete samples were taken from each of the ten (10) faces of the exposed hole which corresponded to the reactor faces, as well as from several areas of the reactor room wall. All samples were split with the Ames Laboratory Health Physics Group for the purpose of cross-checking results.

Tritium concentrations in the concrete were determined by the ANL Analytical Chemistry Group utilizing a method similar to that employed by the Ames Health Physics Group. Basically, this in-

involves heating the concrete in a furnace tube to 425°C, flushing the tube with an inert gas and trapping the effluent water vapor in a cold trap.

Tritium levels, obtained by this method at ANL, corresponded within a factor of two for nine out of the twelve samples when compared to the levels reported by Ames Laboratory. This is in good agreement considering the heterogeneous nature of the tritium involvement in the concrete. Both ANL and Ames results indicate that face No. 9 exhibited the highest tritium concentration. A study conducted by Ames personnel indicates that the No. 9 "hot spot" penetrates laterally for several feet, but does not extend to the floor surface above. To remove this "hot spot" it would require the services of a ram hoe plus cleanup and disposal procedures. The estimated cost for this operation is in excess of $50,000.

Since this area will be covered by a new concrete floor and a concrete vertical wedge (see Figure 2), diffusion of the tritiated vapor from this area will be retarded. In its present open face mode, the contribution from this area, compared to the total amount of diffusion from the entire structure, is thought to be negligible.

Smears, utilizing "popcorn" (expanded polystyrene), were taken throughout the reactor room and service floor areas. All smears were counted in a single cell liquid scintillation counter. Results indicated low-level but positive $^3H$ contamination throughout the entire reactor room and service floor areas.

Due to the tritium involvement throughout the concrete structure and its continuing diffusion to the atmosphere, it was decided to conduct several tests. One of these tests was to shut off the ventilation system to determine the tritium build-up in air during shutdown. This was accomplished by Ames Health Physics personnel during the weekend of December 19 through December 22, 1980. Results of this test indicated an increase in the tritium concentration of from $9.01 \times 10^{-8}$ µCi/mℓ to $8.36 \times 10^{-7}$ µCi/mℓ for the reactor room air (floor level).

Two additional tests were run during the month of January 1981. This involved placing an enclosed airtight structure over the face No. 9 area and a similar structure over an area of the reactor room floor. Tritium concentrations, from both enclosures, were sampled by the standard cold trap method, utilizing a closed cycle system. The following results were obtained: from the face No. 9 enclosure, the concentration ranged from $6.79 \times 10^{-6}$ µCi/mℓ to $4.95 \times 10^{-5}$ µCi/mℓ, with the latter figure indicating apparent equilibrium; the floor enclosure ranged from $3.67 \times 10^{-7}$ µCi/mℓ to $4.04 \times 10^{-7}$ µCi/mℓ. Apparent equilibrium was reached in this enclosure in less than a day. The ambient air concentration from the reactor room air, recorded during these tests, indicated levels of from $5.3 \times 10^{-8}$ µCi/mℓ to

$8.65 \times 10^{-8}$ µCi/mℓ. The tritium levels have fluctuated over this range for the past six weeks, averaging approximately $6.95 \times 10^{-8}$ µCi/mℓ. This level of tritiated water in air, compared with the Chapter 0524 standard value of $2 \times 10^{-7}$ µCi/mℓ (168 hour week), gives a maximum potential dose equivalent of 174 mrem/year, assuming a full time occupancy as indicated below.

$$2 \times 10^{-7}\ \mu\text{Ci/m}\ell\text{/year} = 500\ \text{mrem/year} \times \frac{6.95 \times 10^{-8}\ \mu\text{Ci/m}\ell}{20 \times 10^{-8}\ \mu\text{Ci/m}\ell}$$

$$= 174\ \text{mrem/year}$$

As indicated previously, the ANL Radiological Survey Group returned to Ames, Iowa, during the week of January 12, 1981, for the purpose of taking air samples in the reactor room and service floor areas, and the building exhaust stack. This was to confirm the ambient air results reported by Ames Laboratory. Results from ANL analyses indicate that the tritium levels reported by Ames are essentially in agreement with results reported by ANL.

In light of the results revealed by both Ames Laboratory and the ANL confirmatory analyses concerning the ambient tritium concentrations and the tritium involved in the concrete structure, the following conclusions can be made:

1. The entire concrete structure contains variable quantities of tritium, as tritiated water or closely related precursor chemical forms that have been diffusing back into the atmosphere since the greater source term (reactor heavy water) has been removed.

2. The concentration of tritium in the concrete increases in relation to the depth of concrete on face No. 9, reaching a maximum at 6 to 8 inches. The major portion of the tritiated vapor, in other areas of the concrete structure, seems to be in the first 4 inches. Tritium has, however, been detected to a depth of 12 inches.

3. The face No. 9 "hot spot" is not believed to have an appreciable impact on the ambient airborne tritium vapor concentrations in the reactor room air.

4. A reduction or stoppage of the ventilation system, presently in operation, will result in an increase in the tritiated vapor concentrations in air.

Based on our analysis of the total situation as it now exists, for the reactor room and service floor, the following recommendations are made:

1. The reactor room and service floor areas, and thus, the entire building, cannot be released for unrestricted use since the source term for the tritiated vapor involves the total structure, and it is expected that the tritium concentrations in air will continue for some time to come, albeit, at a gradually diminishing rate.

2. Any attempt to build secondary structures within the reactor room shell will result in pockets of increased levels of tritiated vapor, unless sufficient ventilation is maintained in these secondary structures.

3. The removal of the "hot area" in face No. 9 will not appreciably reduce the ambient reactor room air tritiated water vapor concentrations and, therefore, the installation of the new concrete floor and vertical wedge sections should proceed forthwith.

4. Consideration should be given to providing the facility for some conditional use which would essentially allow uncontrolled access. For example, with appropriate ventilation control, it is believed that the reactor room could be converted to classroom use with potential radiation dose equivalents to maximally exposed individuals of less than 50 mrem/year.

5. Some measure of Health Physics surveillance shall be maintained throughout the facility for as long as the tritiated vapor problem exists so as to provide an ongoing assessment and record of the potential radiation exposures.

R. A. Wynveen, Health Physics Manager

W. H. Smith, Senior Health Physicist

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ANL-HP DWG NO 81-2

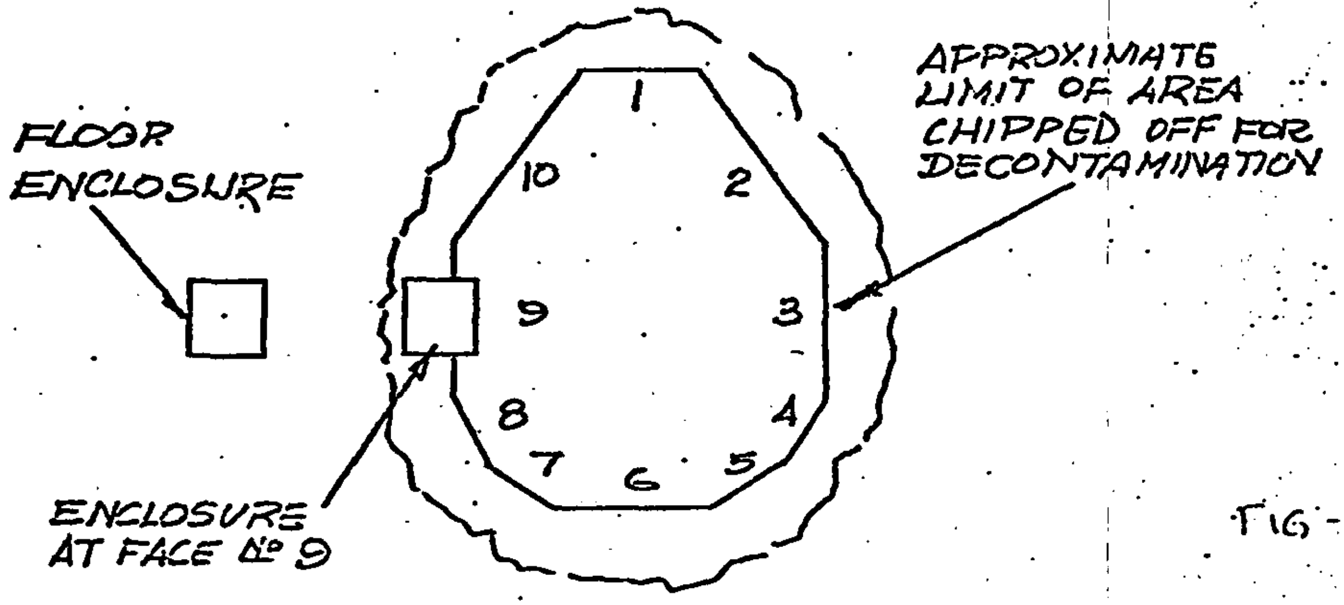
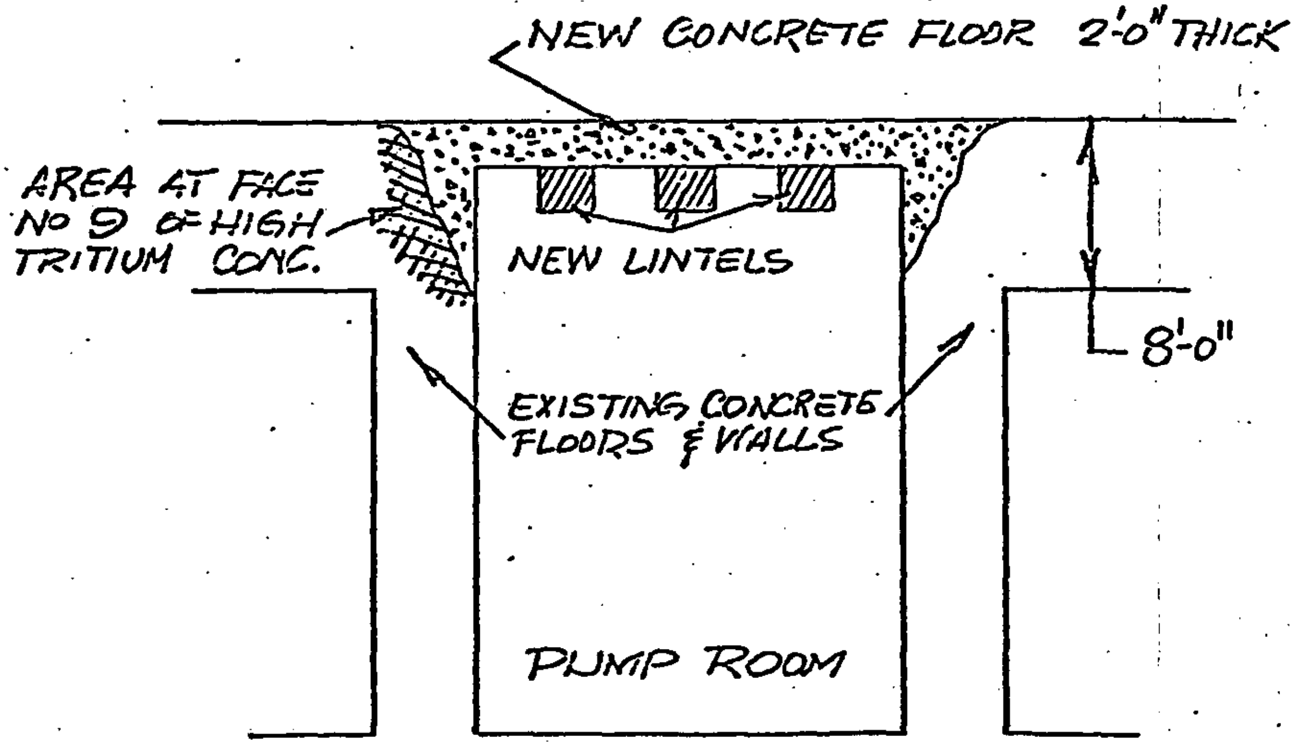



FIG-1




SECTION THRU FACE 9 & 3

FIG-2

NOT TO SCALE