DOW CHEMICAL U.S.A.

MICHIGAN DIVISION
MIDLAND, MICHIGAN 48640

August 14, 1987

Director, Office of Nuclear Reactor Regulation
Attn: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Docket No. 50-264

Sir:

I enclose four copies of supplementary information requested by the Project Manager, Mr. Alexander Adams, for consideration of the renewal of license R-108 for the Dow TRIGA Research Reactor.

Very truly yours,

L. W. Rampy
Chairman, Radiation Safety Committee
1803 Building

(Attachment)

A020
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DOW TRIGA RESEARCH REACTOR

LICENSE R-108

DOCKET NO. 50-264

SUPPLEMENTARY INFORMATION

10 AUGUST 1987

1. Please provide an ALARA policy statement signed by a corporate officer or some similar person.

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ALARA - AS LOW AS REASONABLY ACHIEVABLE - POLICY STATEMENT

The principle of ALARA - As Low As Reasonably Achievable - forms the basis of the radiation protection program of Dow Chemical U.S.A.

Close adherence to the principle of ALARA is of paramount importance to the achievement of the Dow goal of minimizing occupational exposures to radiation and releases of radioactive materials.

I. G. Snyder, Jr.
Vice President
Director of Applied Research and Development
Dow Chemical U.S.A.

LIFE IS FRAGILE HANDLE WITH CARE

2. Please provide calculations of the possible radiation levels in the area of the water purification skid if 250 gallons of water at some known concentration of radioactive materials were to escape from the reactor primary system and collect on the floor (question 3 of the May 1987 submittal).

Consider the release of 250 gallons of water from the reactor into a 10-foot by 50-foot area in the basement of 1602 Building following a Maximum Hypothetical Accident (MHA). Assume that the entire release fraction (10^{-4}) of the elements given in table 4 of ref. 1 (Gaseous Fission Product Activity in the TRIGA Element Containing the Greatest Activity Following Operation at 365 MWD), modified by factors of 50/78 because of the number of elements in the Dow reactor and by 300/1000 because of the power level of the Dow TRIGA reactor. Assume that none of this material is released from the water before the water is leaked into the basement of 1602 Building. We can then calculate an areal concentration of each of the isotopes given in table 4, reference 1, where the total concentration of radioisotopes is 0.165 μCi/ml and the areal concentration is then 0.36 $\mu Ci/cm^2$. Then assume that we have an infinite plane with each of those concentrations, neglect the absorption of gamma radiation in the water (about 2.16 cm thick) and calculate the dose rate at a position 1 meter above that plane, using the energies and population factors of each of the gamma rays. Use Equation I-4.1, with h=0 (infinite-plane source), given on page 353 of reference 2, and the appropriate graphs in the same reference for the evaluation of the integrals involved, to find the gamma-ray fluxes for each isotope at the desired point, and use the data of reference 3 to calculate the dose rates due to each gamma-ray of each isotope.

Under these conditions the dose rate at a point one meter above this infinite plane would be 110 mR/hr. The actual dose rate near the postulated spill would be lower than the calculated dose rate due to the conservative assumptions.

References:

1. S. C. Hawley and R. L. Kathren, Credible Accident Analyses for TRIGA and TRIGA-Fueled Reactors, NUREG/CR-2387, PNL-4028 (1982)

2. T. H. Rockwell III, Editor, Reactor Shielding Calculations, TID-7004, Naval Reactor Branch, USAEC, (1956)

3. H. E. Johns and J. R. Cunningham, Physics of Radiology, 4th Edition, (1983)

3. Please provide more detail about the fire-fighting equipment in the reactor room and nearby areas (question 6 of the May 1987 submittal).

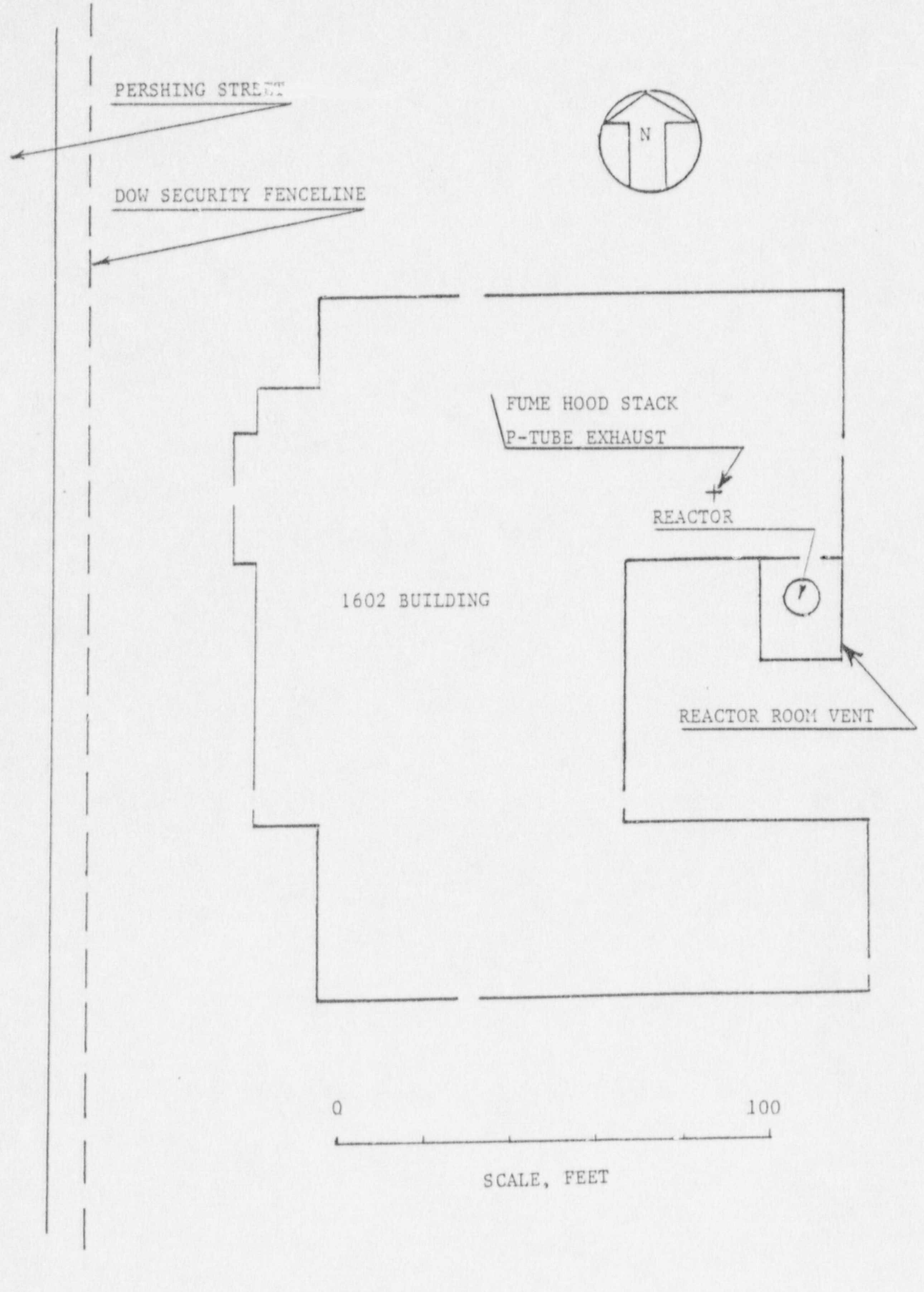
One 10-pound CO_2 fire extinguisher is located about 12 feet from the console in Laboratory 30 and another is located in contiguous Lab 31. Other fire extinguishers are located in adjacent areas.

4. Please review Reg Guide 8.10 and provide more comments on the ALARA program at the Dow TRIGA Research Reactor facility (question 8 of the May 1987 submittal).

The Dow Chemical Company ALARA policy is expressed in the Policy Statement (question 1, above). This statement has been circulated to the reactor staff and is posted in the facility. Members of the reactor staff receive annual training in radiation protection and the implications of the ALARA policy.

The Reactor Operations Committee takes a proactive stance with respect to the evaluation of the facility through the required audits (see the Technical Specifications) under the direction of the Radiation Safety Officer, who is administratively separated from the facility staff.

5. Please provide a copy of the diagram showing the relationship between the reactor room and areas of unrestricted access, adding scaling information and indicating the points of release (question 13 of the May 1987 submittal).



PERSHING STREET
DOW SECURITY FENCELINE
N
FUME HOOD STACK
P-TUBE EXHAUST
REACTOR
r
1602 BUILDING
REACTOR ROOM VENT
0
100
SCALE, FEET

6. Please provide a detailed analysis of the temperature rise expected in the aluminum-clad fuel element to reactivity insertions of 0.021 $\delta k/k$ ($3.00) (question 19 of the May 1987 submittal).

Inadvertent transients have been analyzed in the report of Hawley and Kathryn (S. C. Hawley and R. L. Kathryn, Credible Accident Analyses for TRIGA and TRIGA-Fueled Reactors, NUREG/CR-2387, PNL-4028 (1982)), based upon the detailed analyses reported by West et al (G. B. West et al, Kinetic Behavior of TRIGA Reactors, GA-7882, General Atomic, San Diego, California (1967)). West et al used a Fuchs-Nordheim point kinetics model, considering both constant and temperature-dependent heat capacities of the fuel elements. Hawley and Kathryn used a simpler equation which assumes a constant heat capacity (pp 18,19; Table 3, Reactivity-Temperature Relationships), since this method predicts a greater mean temperature rise for a given reactivity insertion and is thus more conservative. Hawley and Kathryn calculated (Table 3) a mean temperature rise of 300 C for a core of aluminum-clad fuel elements with H:Zr ratio of 1.1, a β_{eff} of 0.0073, a prompt negative temperature coefficient (α) of 10^{-4}, and insertion of 0.0225 $\delta k/k$ ($3.08) reactivity. Using their equation

$$\Delta T = ((\delta k/k)(1-\beta_{eff})-\beta_{eff})*2/\alpha$$

for the Dow TRIGA Research Reactor where the value of β_{eff} is 0.0070 (due to the stainless-steel-clad fuel elements), the value of the prompt negative temperature coefficient α is $1.2*10^{-4}$, and the maximum available excess reactivity will be .021 $\delta k/k$, we calculate the corresponding temperature increase to be

$$\Delta T = 231 \text{ C}$$

and if the initial temperature of the fuel is about 30 C then the final mean temperature of the fuel is expected to approach 261 C, well below the proposed Safety Limit (500 C) and even more below the temperature associated with phase changes expected in the H:Zr 1:1 aluminum-clad fuel element (535 C).

In the Advanced TRIGA Prototype Reactor (ATPR) used by West et al the measured temperatures were peaked in the B-ring and were found to be considerably lower than calculated (Table VIII, page 33), with a peak fuel temperature of 405 C (measured) for a $3.00 reactivity pulse. The aluminum-clad fuel element in the Dow TRIGA Research Reactor will be positioned in either the E- or the F-ring, far from the peak power area of the B-ring, in order to be even more conservative with respect to the operation of this one fuel element.