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INDIANA UNIVERSITY
Student Health Service
600 North Jordan Avenue
BLOOMINGTON, INDIANA 47401
Environmental Health and Safety

TEL. NO. 812—337-6511

July 7, 1978

Michael A. Lamastra
Radioisotopes Licensing Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Lamastra,

Re: Proposed Amendment to Indiana University (Bloomington) License 13-00108-05, Control No. 94574

In response to your letter of June 14, 1978 and your conversation with Michael Kovosh on July 6, 1978, enclosed are three documents addressing the questions raised by your office.

The vacuum pumps are all vented, through pipes, to a 6½' x 4' building exhaust tunnel. Air flow measurements were made in this tunnel to obtain dilution air flow rates with velocities ranging from 700 to 800 feet per minute. Access to the tunnel is in a controlled area inside the building. The building exhaust is carried to a pit, vented to the outside, at ground level in the rear of the building inside the fenced area. (It was incorrectly stated in the original application that the building vent was at roof level). The calculations show that released tritium in the dilution air will be well below usual detection limits.

Our Radiation Safety Committee has reviewed the proposal and has given approval for the experiments during their regular meeting on June 14, 1978. We trust that the enclosed information enclosures will be satisfactory.

Very truly yours,

Henry C. Briggs

Henry C. Briggs,
Radiation Safety Officer

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HANDLING PROCEDURES FOR 10 CURIE TRITIUM FOIL TARGETS

Indiana University Cyclotron Facility

1. The package containing tritium sources will be placed, on receipt, in the hood in room 19. Prior to opening, the outside surface will be checked with a tritium sniffer and approval to go ahead will be issued by the Cyclotron or University Health Physicist.

2. Initial opening of the package and transfer of the sources will be done in the presence of the Cyclotron or University Health Physicist. Double gloves will be worn and changed frequently for all handling operations.

3. The sources will be stored, in the hood, in a dessicator or in the target ladder assembly, under partial vacuum.

4. When a source is to be used, it will be mounted on the target ladder assembly in the hood. A plastic bag will be used to contain the source while transporting and inserting it into the target holder. Bagging procedures will be used to provide a seal between outside air and the source during all operations in which the source is out of the hood or target assembly. The techniques will be practiced with a spare target ladder prior to using the target. The transfer operation should take less than one minute.

5. The source will be moved to and from the target area only while inside the sealed target ladder assembly. The assembly will be completely sealed prior to opening the system to the Cyclotron vacuum.

6. All pumps and nearby beam lines will be labeled with instructions to open during the first disassembly, only with Health Physics approval. All disassembly operations will be monitored by Health Physics personnel with appropriate handling techniques, bagging and ventilation being provided as indicated by monitoring results. Appropriate decontamination will be performed, if necessary under Health Physics supervision prior to removal of above labels. Pump oil will be handled as radioactive material under Health Physics supervision.

7. Personnel performing the target transfers or vacuum pump maintenance will provide urine or breath samples at least 6 hours following the potential exposure. These samples should be provided within 48 hours and shall be provided within 7 days for analyses by Health Physics. Analyses will be performed once each week for continuing experiments.

Date 7 July 1978

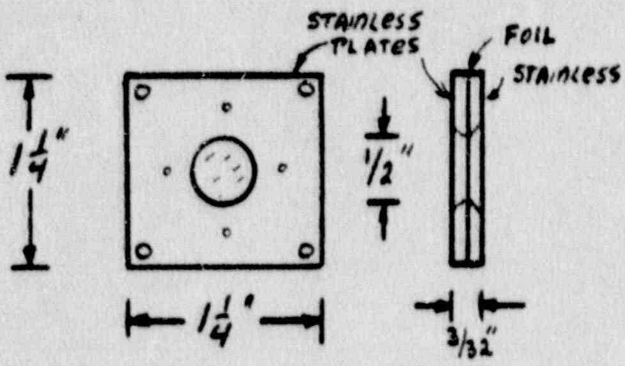
Signed [signature] — Henry C. Briggs

Director, I.U. Cyclotron Facility — Radiation Safety Officer

DESCRIPTION OF TARGET FOILS

Members of the Ohio State University Van de Graff Laboratory have recently begun a series of radiative capture experiments at the Indiana University Cyclotron Facility in Bloomington. As part of these experiments they plan a measurement of the cross section and analyzing power for the reaction $T(p,\gamma)^4He$. The tritium targets to be used for these measurements have been fabricated by the Oak Ridge National Laboratory, purchased by Ohio State University under their license, and presently reside in Columbus awaiting approval to utilize them for the experiment at the Indiana Cyclotron.

Two identical targets were made - both by the Isotope Sales department of Oak Ridge National Laboratory, using their standard fabrication techniques of the past 20 years. These targets are foils, prepared by heating a .0002" thick titanium foil and exposing it to a tritium atmosphere. The tritium forms a chemical bond of 1:1 to 2:1 to the titanium atom, in the present case to form targets of ~ 10 Ci each. The foils were then clamped by ORNL between two stainless steel plates, each containing a 1/2" diameter hole, to allow for particle bombardment in this area. The foils are sketched below.



During use, these foil assemblies will be mounted (singly) on a target ladder and quickly placed under vacuum. The expected release of tritium gas under particle bombardment, as discussed in another section of this response to the NRC information request of June 14, 1978, is calculated to be below detectable levels.

Foils of similar design and activity have been in use by the Ohio State experimentalists at the OSU Van de Graff accelerator laboratory for over nine (9) years. Their considerable experience with these foils under proton and deuteron bombardment with beam currents of 10μA at energies up to 6 MeV (where all of the beam energy is deposited in the target) has shown no detectable level of tritium release into the scattering chamber and associated apparatus. Minimal levels were detected in vacuum pump oil and were disposed of properly. These tests were performed by an agent of the Ohio State University Office of Radiation Safety.

CALCULATION OF ^3H LOSS FROM A 10 CURIE TARGET

Indiana University Cyclotron Facility

1. Steinberg and Alger (1) show an initially exponential loss of ^3H from a tritium target irradiated with protons. The straight line portion (steepest slope) drops from 30,000 to 1000 cpm in a 220 minute period (extrapolated) or $1000 = 30{,}000\, e^{-220k}$, with $k = 0.01546\ \text{min}^{-1}$ with 120 kV protons, a beam current of 0.5 mA (500,000 nA) and a target area containing 0.589 Ci of ^3H (0.62 Ci/cm^2). This is remarkably close to a value of 0.01528 min $^{-1}$ derived from data given on page 45 of a publication by Nellis et al. (2) which states that roughly 1 tritium atom is lost per bombarding particle or about 0.3 Ci/coulomb.

2. Our beam will average about 10 nA with a total of 200 keV of energy deposited in the target. Our target concentration will be about 10 Ci/in^2 (1.55 Ci/cm^2).

3. Assume ^3H release will be proportional to beam current, energy deposited and target concentration. This assumption assumes ^3H is released based on ionization density available to affect ^3H and not on temperature effects. Thus, the difference in heating a target using 500,000 nA and 10 nA is not taken into account. This represents a considerable safety factor in the calculations.

$$0.01546 \times \frac{10}{500{,}000} \times \frac{200}{120} \times \frac{1.55}{0.62} = 1.288 \times 10^{-6}\ \text{min}^{-1}$$

4. Loss of activity can be based on the experimental beam spot size of 0.95 cm^2 (ref. 1) since increasing the size will lower the current per square centimeter.

$$0.95\ (\text{cm}^2) \times 1.55\ (\text{Ci/cm}^2) \times 1.288 \times 10^{-6}\ (\text{min}^{-1}) =$$

1.9×10^{-6} Ci/min. initial loss rate (2.7 mCi/day or 0.14 mCi/day in vacuum pump exhaust assuming 5% lost from system)

5. Assume 5% is released in exhaust as HTO (page 9, ref 1). Max Permiss conc = 2×10^{-7} uCi/cm^3 to environs. We measured the air flow in the exhaust tunnel of the building (the location that the vacuum pump exhaust pipe discharges) at 19,930 ft^3/min.. This discharges at ground level adjacent to the building inside a fenced area.

$$\frac{1.9 \times 10^{-6} \times 0.05\ (\text{Ci})}{(\text{min})} \frac{(\text{min})}{19{,}930\ (\text{ft}^3)} \frac{(\text{ft}^3)}{[12 \times 2.54]^3\ (\text{cm}^3)} \times$$

$$\frac{10^6\ (\text{uCi})}{(\text{Ci})} \frac{(\text{cm}^3)}{2 \times 10^{-7}\ (\text{uCi})} = 8.4 \times 10^{-4} \text{ of MPC value}$$

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6. If 10 Ci were released (entire target) during a 24 hour period (incident reporting criteria):

$$\frac{10\ (Ci)}{(day)}\ \frac{(min)}{19{,}930\ (ft^3)}\ \frac{(ft^3)}{[12 \times 2.54]^3\ (cm^3)}\ \frac{(day)}{1440\ (min)}\ \frac{10^6\ (uCi)}{(Ci)} \times$$

$$\frac{(cm^3)}{2 \times 10^{-7}\ (uCi)} = 61.5 \text{ times MPC value}$$

This would not be a reportable incident under 10CFR20.403 nor 20.405 since averaging can be performed over 13 weeks for restricted areas (with a higher limit of 5×10^{-6} uCi/cm^3) and one year for unrestricted areas.

REFERENCES:

1. Steinberg, R. and Alger, D.L.. "A New Pumping System for a 150 kilovolt Neutron Generator to Reduce the Present Tritium Hazard," DHEW Publication No. (FDA) 73-8011 (1972).

2. Nellis, D.O. et al.. "Tritium Contamination in Particle Accelerator Operation," Public Health Service Publication No. 999-RH-29 (1967).