.kms fusion inc. A Subsidiary of KMS Industries, Inc.
3621 South State Road, P.O. Box 1567, Ann Arbor, Michigan 48106-1567 313/769-8500

May 9, 1985

REF: RSO-429-JCW

U. S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Dear Sirs:

Please refer to control number 75962. Additional information requested by your office, in support of our request for renewal of byproduct material license 21-15446-01, is provided herein following the numbering system of your letter of February 25, 1985.

1. Minor changes have been made to procedure SPC-012. The revised version, RSC-012, is enclosed. This procedure applies equally to operations using tritium and operations involving other radionuclides. While we recognize that different radionuclides are of different radiotoxicity, it is customary to lump all beta-gamma emitters together. This has been done, in fact, in the Ionizing Radiation Rules of the State of Michigan.

   Procedure RSC-012 is intended to apply only to surveys of surface contamination, and does not specify other surveys which may be required. Other surveys are required and specified in procedures submitted by, and approved for, users. The only laboratory other than those involving high-level tritium operations, which has operations sufficiently hazardous to justify surveys in addition to contamination control is our subsidiary, Covalent Technology Corporation (CTC), in Building 1 at 3941 Research Park Drive. CTC normally uses only microcurie quantities of tritium and iodine-125 for in-vitro testing. CTC is presently approved, however, to do radioiodinations with quantities of I-125 up to 2 millicuries. These radioiodinations are done rarely. When they are done, our unnumbered procedure "Radiation Safety Procedures for I-125 Radioiodinations" specifies that a personal breathing zone air monitor will be used, and the approved user's operating procedure specifies that a general purpose GM monitor with a pancake probe will be used to promptly assess surface contamination. Action levels for surface contaminations are given in RSC-012; any detectable activity measured by the air monitor would be investigated, and if an quality greater that 0.1 MPC-week were measured, corrective action would be taken.

With the exception of two neutron sources licensed under SNM-1341, KMSF does not presently use radioactive sources which generate significant external fields. These sources are used by qualified individuals with portable survey meters to measure radiation fields.

The radiation safety department consists of the RSO and one health physicist. The health physicist performs surveys; the RSO evaluates them. Wipe test surveys are done at least weekly, or more often as the RSO deems necessary.

2. Please amend our license application to specify a calibration interval of 12 months for survey instruments 4, 7, 8, 9, and 10 in item 10 of our renewal applications.

3. Refresher training is provided at approximately eighteen month intervals.

4. Information contained in KMS letters dated January 18, 1982, February 10, 1982, and June 25, 1982 is still applicable. These letters may be incorporated into our license renewal.

5. In this section, I will first provide the specific information you request, then provide some background information and justify our procedures in subparagraphs (c) and (d).

   (a) A floor plan of the laboratory at 3621 South State Road (Building No. 2) is enclosed. Fusion experiments are done in room 68 "TBIS BUNKER TARGET ROOM." The target chamber is located at the approximate center of this room which is rectangular, 33 x 28 feet, in dimensions. There are no special features incorporated into this room, therefore, a more detailed drawing is unnecessary.

      1. There is no radiation shielding used in the room.

      2. The fusion chamber is connected to a vacuum pump which exhausts, via piping, to the atmosphere outside of the building on the roof. There is no monitoring equipment on the effluent released to the environment by this route.

      3. The room air handling system is ordinary. Air enters the room via ducts in the ceiling and returns via the hallway.

   (b) Multi-level sonic sirens, warning lights, and a countdown on a public address system are used as warnings prior to a target shot (fusion reaction). There are no interlocks to prevent access to the area. The area is access-controlled, however, as it is under surveillance by a number of trained personnel when a target shot is pending. A target shot requires the coordinated efforts of numerous people and there is a method in effect which assigns responsibility to individuals to ensure that the area is clear prior to the shot. Our concern here is not the radiation which might issue from the fusion reaction, but instead the protection of individuals to the optical radiation from the powerful laser.

(c) There is very little radiation emitted by target shots. Radiation generated can be 14 MeV neutrons, alpha particles, and soft x-rays. Personnel involved are monitored for photon and neutron radiation. Several area monitors (photon and neutron) are also used, including one attached to the target chamber itself. These routinely show no detected radiation.

The problem with fusion, of course, is that it doesn't work very well yet. The laser at KMS is not comparable to those at the national laboratories; we are now aware of the fact that we cannot induce much fusion with our present laser. Our experimental program is presently geared towards providing support physics data which can be used by national laboratories. In fact, most of our target shots in the recent past have not involved the use of tritium and hence produced no fusion. The maximum number of neutrons ever generated in a target shot at KMS is about 10^9. However, KMS has conducted no target shots in more than two years which have generated neutrons.

I am informed by our experimentalists that an experimental campaign will be conducted in the forthcoming year which may involve 200 shots which are expected to produce about 10^6 neutrons each. At a distance of 1 meter, this is only 8 neutrons/cm^2 per shot, assuming no absorption in the target chamber. This is an inconsequential number. At the room boundaries, it is only 0.4 n/cm^2 per shot, equivalent to about 5 mrem for the 200 shots. X-rays and alpha particles are absorbed by the walls of the target chamber. It is now clear why shielding is unnecessary.

(d) Fusion experiments are conducted in the target chamber, which is vented directly to the atmosphere outside the building. Experiments are done on a variety of gas mixtures. Tritium, when used, is in the form of elemental gas. We estimate that targets used in the forthcoming experimental campaign will contain a maximum of 500 microcuries per target, and an average of 100 microcuries per target. Thus, the entire campaign might release 20 millicuries to the environment over the period of one year. This is a small quantity, and is well-estimated without monitoring by knowledge of the tritium content of the targets. Only trace quantities are released into the working environment in the building, as the target chamber is opened. Because the area is large and well-ventillated, and because quantities released into the room are in the unoxidized form and in only trace quantities, room air monitoring is not deemed necessary. Surface contamination surveys and bioassay are performed when appropriate.

6. Sample copies of information sent with tritium targets are enclosed. This information comprises unpacking and handling instructions, as well as a cover letter specifying limitations on the uses.

KMS will verify that the prospective recipient of radioactive materials is authorized to possess such materials prior to shipment. The verification will be effected by one of the following two methods:

(a) We will obtain a copy of the NRC or Agreement State Specific License of the prospective recipient and verify that possession is authorized.

(b) We will obtain from the prospective recipient a written certification that the recipient is authorized, by license or registration certificate, to receive the type, form, and quantity of byproduct material to be shipped. The proposed recipient must specify the license or registration certificate number, issuing agency and expiration date.

Sample copies of instructions to customers regarding unpacking and use are enclosed. The following paragraph delimiting use is enclosed with every shipment.

> The materials referred to in this correspondence are being provided under Contract No. DE-AC08-82DP40152 between KMS Fusion, Inc. and the United States Department of Energy. The use of these materials is limited to projects and programs as defined within this contract and performed on-site at your laboratory as part of the National Inertial Fusion program. Any diversions of these materials must first be approved through KMS Fusion, Inc. and by the United States Department of Energy. The glass Microshell® containers are covered by U. S. Patents #4,017,290, #4,021,253, #4,340,407, and #4,432,933.

It should be borne in mind that recipients are highly-educated scientists already intimately familiar with the properties and applications of the targets provided by KMS.

KMS has acquired new space in a third building, at 3850 Research Park Drive, Ann Arbor, Michigan, 48104. We wish to move our Shipping and Receiving Department, presently located in the building at 3941 Research Park Drive, to the new building.

We request, therefore that condition 15 be amended to include the proviso that licensed material may be received and shipped from the building at 3850 Research Park Drive.

Licensed material will only be handled at the 3850 Research Park Drive facility in unopened DOT-approved packages. Outgoing packages will be sealed before being taken to the new building for shipment; incoming packages will be promptly delivered unopened to our laboratories at 3621 South State Road or 3941 Research Park Drive.

KMS Fusion, Inc. desires to distribute inertial confinement fusion (ICF) targets to other institutions in support of the national ICF program. These targets will be hollow glass or plastic spheres (shells) containing tritium and usually other gases such as deuterium. The targets are typically 100 to 200 micrometers in diameter (sometimes larger) with a wall thickness of a few micrometers. These targets are designed to be destroyed in ICF experiments. The pressurized gas within tends to keep

the target spherical, and although the targets are glass and the walls are thin, the targets are not exceptionally fragile.

The information provided below follows the format of Appendix A provided by your office.

A. Supplier

The supplier will be KMS Fusion, Inc., 3621 South State Road, Ann Arbor, Michigan 48106.

B. Identification

Targets provided to customers will be characterized by size, gas composition and pressure, composition of the wall material, and total activity.

Internal records maintained by KMS will include:

(1) The tower run (shell manufacture) number

(2) The permeation fill number

(3) Data describing quality control tests which may have been made, such as shell wall thickness, uniformity, sphericity, pressure verification, etc.

KMS has registered the name "Microshell" with the patent and trademark office, to describe these targets.

C. Radioactive Material

(1) Tritium

(2) Targets are typically 100 μm to 200 μm diameter at 20 to 100 atmospheres of 50% tritium.

The maximum activity target which we envision shipping is 800 μm diameter at 200 atmospheres pressure.

The activities of these targets is:

125 μm diam 50 atm = 61 μCi
800 μm diam 200 atm = 65 mCi

The quantities of targets shipped at any time varies from a minimum of several carefully selected shells to a maximum of thousands of uncharacterized shells as a bulk product. The maximum activity shipped at any one time would range from a few millicuries to perhaps 20 curies if bulk product is shipped.

(3) Tritium is contained within the targets as elemental gas.

(4) Tritium is introduced into the target microshell® by a patented permeation process described in detail in procedure RSC-005. Briefly, the hollow glass shells are manufactured in a tower electric furnace. These shells are subsequently heated to 350 to 400 degrees celsius. At this temperature, the deuterium-tritium mixture permeates through the walls of the shell until equilibrium with the external pressure (e.g., 50 atm) is achieved. The shells are then cooled and the external pressure removed. The glass, permeable to hydrogen at 350° C, is quite impermeable at room temperatures. The hydrogen is thus trapped inside.

D. Construction

Targets are hollow spherical shells containing, typically, deuterium and tritium in equal amounts. The shell material is borosilicate or calcium borosilicate glass, or fused quartz, or a relatively impermeable plastic such as polyvinyl alcohol, polystyrene or acrylonitrile polymer.

Targets may be shipped individually mounted on fibers, mounted on microscope slides, or in bulk in a capped vial.

We have no engineering drawings of our targets shells. Such a drawing would consist of nothing more than two concentric circles. We have enclosed a photocopy of a photograph of a target shell (approximately 125 μm diameter) mounted on a glass fiber post (approximately 5 μm) in diameter.

Whether shipped on microscope slides, or shipped individually packaged in a holder ("eggcrate") these methods are simply packaging methods and are not an integral part of the source.

E. Labeling

The targets are much too small to be individually labeled. The container in which they are shipped bears the phrase

"CAUTION-RADIOACTIVE MATERIALS"

as well as a statement of the radionuclide identity, chemical and physical form, activity, date, and the radiation symbol.

F. Source Assay

The principal method, by which the activity of the deuterium-tritium gas in the targets is known, is by measurement of the pressure at fill time, and by the use of several known calibration volumes. The method is described in procedure SPC-005, but will be briefly reviewed here. Refer to the diagram on page 25 of SPC-005. Tritium is evolved from the uranium beds by heat, into the calibration volume possibly augmented by one or more auxiliary calibration volumes. The tritium is then condensed in the condensation tube, and the mass is known by the pressure loss in the calibration volume and the volume

itself. The target fill pressure is then calculated by the known mass and the known volumes of the condensation and contact tubes. Volumes are calculated by measured dimensions. Pressures are measured by a precision gauge with calibration traceable to the National Bureau of Standands, and verified periodically by a mercury barometer. In addition, target pressures are verified on statistically-selected samples by the GEVF (gas entrapment in a viscous fluid) method described in procedure RSC-0030. This is an absolute method, which does not require traceability to a national standard. Briefly, the size of shells is measured (with a microscope) when immersed in a fluid such as glycerine. The shells are then broken, and the size of the resultant gas bubble is measured. The target shell pressure is easily calculated by the ratio of the diameters, before and after breaking, and the ambient pressure as measured by a mercury barometer. Two other independent assay methods are available and are used occasionally for verification. One is based on measurement of bremsstrahlung x-rays produced by tritium beta particles; the other is based on the change in refractive index of shells which contain tritium, as measured by an interferometer.

G. Quality Control

Quality control procedures performed on targets are appropriate for the intended use, and are as elaborate as the customer wants. The minimum tests performed are those necessary to verify the gas pressure and hence the activity assay. Other tests which maybe performed include shell characterization, such as surface finish, sphericity, eccentricity, size measurements, etc.

These measurements are to assure that the product is fit for its intended purpose, not to assure freedom from leakage. In fact, the targets can leak, and sometimes break. This is understood by the recipients; both KMS and recipients handle the targets as unsealed radioactive material.

Packaging is provided as is required by the task. Millicurie quantities need no special packaging, as there is no realistic prospect of exceeding maximum permissible air concentrations for members of the public. Larger, more hazardous, quantities are packaged and shipped in an aluminum tube sealed with a metal-to-metal hermetic seal.

Sincerely,

John C. Widman

John C. Widman,
Chairman, Radiation
Safety Committee

JCW:gdf

Enclosures