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June 8, 2012

Ms. Colleen Casey
Materials Licensing Branch
US Nuclear Regulatory Commission, Region III
2443 Warrensville Rd., Suite 210
Lisle, IL 60532-4352

Reference: License Number 24-00513-39
Docket Number 030-32695
Control Number 577642

Dear Ms Casey,

The following additional information is being provided at your request based on your Conversation Record Transmittal dated June 5, 2012 regarding the request to add 0.5 grams U-235 (1.07 E-6 Ci; Uranium enriched to < 20% U-235) as indicated in my previous letter dated May 31, 2012 . I am answering your questions sequentially to ensure that I am providing all of the answers your questions and to provide as much information as possible to ensure your complete understanding of this project and a timely completion of this action.

1. The equation used to convert grams to activity can be found in the Radiological Health Handbook, 1970 Edition, US Department of Health Education and Welfare, Public Health Service, page 103, Equation 5. (See attached)

2. Concentrated Nitric Acid is normally considered to be 15 Molar, by definition. This is what will be used to dissolve the U_3O_8. **This portion of the procedure will be performed under the University of Missouri Research Reactor License No. R-103 in the reactor laboratory building.**

3. The chemical conversion will be performed by Dr. John Brockman or an individual under his direct supervision under license R-103. Dr. Brockman has a Ph.D. in Chemistry and is a current member of our Radiation Safety Committee. He is an authorized supervisor or user on several projects at the Research Reactor both under the Reactor License and the Type A Broadscope License. **The students attending the Summer School will**

not participate in the dissolution of the U_3O_8 but will only handle the initial stock solution 1000 µg/g and the tubes containing 100 ng uranium (2.16 E-7 µCi) per tube intended for final analysis on the Mass Spectrometer. This work will also be done under the reactor license R-103. The purpose of this amendment is to allow the transfer of U-235 from the Reactor License (R-103) to the Materials License (24-00513-39) in its final diluted form. Thus the Radiation Safety Committee will only review the final use of the U-235 solution for this particular project. The Isotope Use Subcommittee of our Reactor Advisory Committee will be charged with reviewing the chemical conversion and subsequent dilutions of the U-235. The subcommittee's duties and responsibilities originate from Section 12 the Hazard Summary Report for License No. R-103. We do however wish to have the flexibility to use U-235 in the future under the Type A Broadscope License for other projects which may come our way to support other research efforts and meet the definition of Research and Development as defined in 10 CFR 30.4. These additional and as yet unforeseen projects will be under the control of the Radiation Safety Officer and the Radiation Safety Committee as stated in earlier submittals. This is why we are requesting 0.5 grams of material; an amount consistent with other SNM already present on our Broadscope Type A license, specifically Pu-239/240.

4. Attachment 1 which was provided in our last correspondence will be provided to the Radiation Safety Committee and Isotope Use Subcommittee of License R-103 for evaluation. **Only the transfer and use of the final diluted product has relevance to license No. 24-00513-39 as it is the only material that will be transferred to that license.** The entire contents of Attachment 1 will be provided to the Radiation Safety Committee to give them a better understanding of the entire project; however they will only be reviewing the transfer and final use of the diluted material to a project authorized under the Broadscope License.

For your information and to help you better understand the project, use of concentrated nitric acid will be performed in a laboratory fume hood for the initial dissolution of the U_3O_8 starting material. Once the original solution and uranium are dissolved and diluted, they can be moved out of the fume hood for further use. Due to the small amount of activity of U-235 in the initial preparation of the 1000µg/g stock solution (1.07E-1 µCi), special radiation protection requirements will not be necessary. Normal whole body dosimetry will be provided to workers working with the project during the initial phase of the stock solution preparation as U-235 is primarily an alpha emitter with small emissions of beta particles and associated daughter gamma rays. Bioassays will not be required due to the extremely small amounts of materials that will be handled, the density of the material

(thus minimizing the likelihood of airborne particles) and due to the fact that the uranium will mostly be in solution, thus minimizing any potential for airborne activity to occur. Normal laboratory practices (gloves, safety glasses, lab coats) will be utilized with regards to handling of acids and the uranium during the initial preparation of the stock solution. A gas flow proportional counter will be used to detect any alpha contamination that may occur during the handling and processing of this material.

The above portion of the review will be conducted by the Isotope Use Subcommittee under the Radiation Protection Program of License R-103 and will occur under Reactor License R-103. The procedure submitted previously has not yet been by the IUS or RSC; however I am planning on submitting the material to them the week of June 11, 2012 for review and approval. I do not expect any substantial questions from the committees as this project is well within our facility's capabilities and expertise.

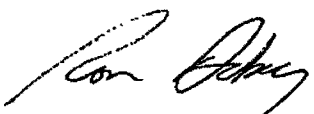
5. Dr. John Brockman, as noted in response 3 above, will be the Authorized Supervisor for this experiment. He has a Ph.D. in chemistry, is a member of our facility's Radiation Safety Committee and is an Authorized Supervisor under multiple projects both under the Type A Broadscope License and the Reactor License.

6. I am requesting completion of this action by June 15, 2012.

It should be noted that the University of Missouri Research Reactor Radiation Safety Committee could change some or all of the requirements for this project and procedure as is their duty as a committee under the provisions of a Broadscope Type A license such as ours, 24-00513-39.

Should you have any additional questions regarding this submittal, please do not hesitate to contact me.

Sincerely,



Ronald J. Dobey, Jr., CHP
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Attachments

ACTIVITY MASS RELATIONSHIP - SPECIFIC ACTIVITY

The specific activity (SpA) of a radioactive nuclide (disintegrations per unit time)/(unit mass), is calculated from the basic equation:

$$SpA = \lambda N = \frac{(\ln 2)\ N}{T_{\frac{1}{2}}} .$$

Where: N = number of radioactive atoms per unit mass, and

$T_{\frac{1}{2}}$ = half-life.

This basic equation can be transformed as follows:

by definition: $N = 6.0225 \times 10^{23}/\text{atomic mass}$

$Ci = 3.7 \times 10^{10}$.

Substituting : $SpA = \frac{0.69315\ N}{T_{\frac{1}{2}}\ (\text{secs})} = \frac{0.69315}{T_{\frac{1}{2}}} \times \frac{6.0225 \times 10^{23}}{\text{atomic mass}} \times \frac{1}{3.7 \times 10^{10}} = \text{Ci/gm.}$

This equation is satisfactory when the half-life of the nuclide is expressed in seconds. If, however, the half-life is expressed in other units (such as minutes, hours, days, or years), a separate time conversion is required for each. By substituting the appropriate time conversion factors the following five equations can be obtained.

$$\text{curies/gram or SpA } (T_{\frac{1}{2}} \text{ in secs}) = \frac{1.128 \times 10^{13}}{(T_{\frac{1}{2}})(\text{atomic mass})} \quad (1)$$

$$\text{curies/gram or SpA } (T_{\frac{1}{2}} \text{ in mins}) = \frac{1.880 \times 10^{11}}{(T_{\frac{1}{2}})(\text{atomic mass})} \quad (2)$$

$$\text{curies/gram or SpA } (T_{\frac{1}{2}} \text{ in hrs}) = \frac{3.134 \times 10^{9}}{(T_{\frac{1}{2}})(\text{atomic mass})} \quad (3)$$

$$\text{curies/gram or SpA } (T_{\frac{1}{2}} \text{ in days}) = \frac{1.306 \times 10^{8}}{(T_{\frac{1}{2}})(\text{atomic mass})} \quad (4)$$

$$\text{curies/gram or SpA } (T_{\frac{1}{2}} \text{ in yrs}) = \frac{3.578 \times 10^{5}}{(T_{\frac{1}{2}})(\text{atomic mass})} \quad (5)$$

Example: Calculate the specific activity of ^{131}I whose half-life is 8.05d. Using equation (4) and the mass number as the atomic mass, make the appropriate substitutions:

$$SpA = \frac{1.306 \times 10^{8}}{8.05 \times 131} = 1.24 \times 10^{5}$$

The following specific activities were calculated from the above equations, using half-lives from The Table of Isotopes.[1] Integer mass numbers were used rather than actual masses, except for ^{3}H where the exact mass was used. (It should be noted that these specific activities are for pure forms of the nuclides only.) More extensive tables of specific activities are available.[2]

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[1] Lederer, C. M., Hollander, J. M., and Perlman, I., The Table of Isotopes, (6th ed.; New York: John Wiley & Sons, Inc., 1967).

[2] Goldstein, G., and Reynolds, S. A., "Specific Activities and Half-Lives of Common Radionuclides," Nuclear Data A, Vol. 1, No. 5 (July 1966), pp.435-452.

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Casey, Colleen

From: Dobey, Ronald J. [DobeyR@missouri.edu]
Sent: Monday, June 11, 2012 4:58 PM
To: Casey, Colleen
Subject: RE: I do not have your response yet, FYI
Attachments: NRC 61112 Ltr.pdf

Let's try this again.

Ron Dobey, CHP
Manager, Reactor Health Physics
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From: Casey, Colleen [mailto:Colleen.Casey@nrc.gov]
Sent: Monday, June 11, 2012 1:41 PM
To: Dobey, Ronald J.
Subject: I do not have your response yet, FYI

Dear Ron,

Just following up on what we talked about Friday. I do not have your response yet, in case you transmitted it and I have not received it.

Thanks.

Colleen

Colleen Carol Casey
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