SEP 14 1984

MEMORANDUM FOR: William J. Adam
Materials Licensing Section
Division of Radiological & Material Safety Programs
Region III

FROM: James E. Ayer
Advanced Fuel and Spent Fuel Licensing Branch
Division of Fuel Cycle and Material Safety, NMSS

SUBJECT: CESIUM SOURCES IN THE FORM OF WESF CAPSULES IN DRY IRRADIATION--WET STORAGE FACILITIES

Re: Letter to Radiation Sterilizers, Inc. from William J. Adam dated May 29, 1984.

The purpose of this memorandum is to inform you of our progress and intent relative to authorizing the use of cesium sources in the form of WESF capsules in dry irradiation--wet storge facilities.

On October 6, 1983, the Department of Energy (DOE) requested certification of WESF capsules for use in irradiators. The WESF capsule has an activity level so high that ANSI N542 recommends an evaluation of fire, explosion, or corrosion probability and a separate evaluation of the specific source usage and source design. The currently-used WESF capsule was designed for water basin storage of cesium chloride as a waste material. Furthermore, the number of WESF capsules available is insufficient to satisfy the orders of three potential users. For these reasons, among others, NRC decided not to register the WESF capsules as sealed sources. Instead, NRC in a letter dated April 3, 1984 agreed to assist in the evaluation of demonstration facilities and to review license applications for demonstration projects sponsored by the DOE.

The DOE has completed extensive mechanical testing of WESF capsules and compared the results with ANSI N542 Class 6 Test Conditions. The results of testing are discussed in PNL-5170, "A Review of Safety Issues That Pertain to the Use of WESF Cesium Chloride Capsules in an Irradiator," a copy of which is enclosed. The WESF capsules comply with the test conditions of ANSI N542 Class 3 and, with the exception of external pressure tests comply with the most severe conditions designated as Class 6. Capsule samples have been tested for the effects of impact, percussion, and fire, with no visible evidence of capsule failure. On this basis, it is our judgment that the WESF capsule has mechanical properties sufficient to meet the American National Standard for Sealed Radioactive Sources for Use in Category III and IV Gamma Irradiators. There remains the open question of corrosion probability.

The 30-year half-life of Cs-137 is an incentive to use the WESF capsule for periods of time greatly exceeding those experienced with isotopes of much shorter decay rate, such as Co-60. Therefore, corrosion effects over extended periods of time are important to an understanding of the risk associated with WESF capsule use. The DOE has an extensive program of corrosion testing that is still in progress. Corrosion rates on capsules held at an estimated interface temperature of about 150° C. for up to six years show insignificant attack on the inner capsule at the CsCl-316 interface. Experiments on capsules held at an interface temperature of about 450° C. for up to two years show variable but significant corrosion rate at the CsCl-316 interface. These findings are in the absence of long-term thermal cycling that would take place in the (Category IV) dry-irradiation/wet storage mode.

Efforts to ensure the use of reliable sources notwithstanding, the effects of loss of capsule integrity can be significant due to the solubility of CsCl and the specific activity of Cs-137. At about 30° C. the solubility of CsCl is 200 grams per 100 grams of water. Less than 0.003 mg. of Cs-137 will contaminate a 30,000 gallon storage pool to levels beyond those permitted by 10 CFR 20 for release to an unrestricted area. Furthermore, if a resin column is considered a point source, about 4 mg. of adsorbed Cs-137 would result in a gamma radiation level of 1 R/hr. at 1 meter.

Recognition of the unique properties of Cs-137 chloride, the results of the experimental program being carried out by DOE, and of meetings and discussions with DOE has led to the following conclusions relative to WESF capsule use in Category IV gamma irradiators.

- We would consider the first user of WESF capsules to be the "demonstration" facility for a particular process.
- The demonstration must include periodic sampling and destructive testing of WESF capsules including:
  1. An approved sampling plan,
  2. A commitment to test both inner and outer capsules for the effects of corrosion and to report test results,
  3. An approved action plan and action levels based on test results.

- The demonstration must include proof of operation of capsules at < 300° C. operating surface temperature at the most restrictive location with a thermal cycle limit of 12,000 cycles air-to-water over the lifetime of the capsule.

- The demonstration must address the ultimate disposition of the spent capsules including:

  1. A commitment to transport from location of use to location of receipt,

  2. A commitment to receive spent capsules.

- The demonstration must address emergency procedures and systems including:

  1. Impervious water storage pool liner,

  2. A storage pool cleanup system with provisions for shielding,

  3. Continuous monitoring of gamma radiation emanating from cleanup resins,

  4. A plan for disposal of contaminated resins,

  5. Procedures for operation of cleanup systems under contaminated conditions.

We intend to proceed with licensing actions involving WESF capsules on the above bases. If you have questions regarding the above, please contact me at (301) 427-4205.

Original Signed by
James E. Ayer

James E. Ayer
Advanced Fuel and Spent Fuel
Licensing Branch
Division of Fuel Cycle and
Material Safety, NMSS

Enclosure: PNL-5170

cc: R. E. Cunningham, FC
B. Singer, FC
J. Jicha, DOE
R. Woodruff, Region II
D. A. Nussbaumer, SP

APPENDIX

A. This listing is provided as an example of changes necessary to your current applications.

1. The following items and sections in the applications constituting a part of License No. 04-19644-01 are restrictive to the use of cobalt-60. They should be expanded to recognize the use of cesium-137.

Item 8 A-D

"The only isotope to be used in this facility is cobalt-60."

Section 1, 1st paragraph

"The facility is designed .... utilizing a controlled cobalt-60 source."

Section 1, 3rd paragraph

"The cobalt-60 source elements are generally .... delivered to the RSI facility in DOT approved lead casks from the isotope suppliers."

Section 5, 6th paragraph

"The following assumptions were made for these calculations:

"1. The Co-60 activity will be 10^7 curies or less.

"2. A nominal exposure rate of 1.2 R/hr. at one meter per curie of activity has been used. For shielding calculations, ...

"3. etc."

"Source Break in Pool

If a source ruptures due to any reason, the cobalt pellets ... could be removed with magnets ... and returned to the vendor ...."

2. The following items and sections in the applications constituting a part of License 04-19644-01 are restrictive to source loadings that are typical of Co-60. If the license is to be amended to permit possession of 30,000,000 curies of Cs-137 and 5,000,000 curies of Co-60, they should be expanded to recognize this increase in source loading.

Item 13a

"We do not expect the maximum source loading to exceed 5 MCi (5 megacuries)."

Item 13c

"The maze was designed to have less than 0.25 mR/hr. flux at the entrance for a 10 MCi source loading."

Item 13j

"The shielding has been designed to provide less than 0.25 mR/hr. at all external surfaces with a 10 MCi source loading."

Item 14

"Our source racks have been designed for over 30 years of operation before their capacity is reached. ...Since each new module represents about 100,000 curies (10 elements each of 10,000 Ci), they will have slightly over 3,000 curies after 30 years, the half-life of cobalt being roughly 5.25 years. AECL has agreed to dispose of any decayed isotope."

Section 1, 2nd paragraph

"The biological shield is designed ... emission rates less than 0.25 mR/hr."

Section 5, 1st paragraph

"The biological shield for the RSI Schaumburg, Illinois facility was calculated .... with a 10 megacurie source loading. During operation, the sources, ... in the 12' x 29' x 54' gamma cell." (12'8" x 23' x 43' gamma cell)

Section 14, paragraph 10
Water Treatment System

"Water Chillers shold be considered when isotope loading approaches two megacuries...."

3. The following items and sections in the application constituting a part of License 04-19644-01 reflect designs based on the use of cobalt pencils as sources. They, as well as drawings that are a part of the application, should be revised to recognize the comingling of WESF capsules and cobalt pencils.

Item 13d

"Source elements are loaded into standard modules, which hold 10 elements in a flat array, when received."

Item 13e

"The source elements are placed into stainless steel modules, which are subsequently placed into a stainless steel source rack.... A steel cage is build around the source racks to protect them from the product carriers. The distance between our source rack and the cage is approximately 12...."

Section 1, 5th paragraph

"Up to ten source elements are loaded into each module ... 15 feel long, 8 feet high, and 2 inches thick."

Section 8, 2nd paragraph

"... ten sources are placed into one of our (the) source modules ... in a flat array."

Section 8, 4th and 4th paragraphs

"... Our (the RSI) system utilizes two source racks with each rack containing 32 (26) module channels. ... designed to contain three modules stacked.... The total capacity of our system ... 1920 (1560) capsules."

Source Control Procedure - 3rd paragraph

"Modules will be filled ... 96 (78); module positions in each source rack."

Source Control Procedure - 5th paragraph

"Each source rack contains 32 (26) channels to hold the source modules."

New

It is our impression that Radiation Sterilizers, Inc. (RSI) intends to comingle WESF capsules with cobalt pencils. If this is so, please provide in your application a source management plan showing the distribution of WESF capsules among the cobalt pencils. This plan should address changes of distribution with time, storage locations, and number in storage, as well as other data that describe a considered source management plan.

4. The following section in the applications constituting a part of License 04-19644-01 is specific to AECL source rods and unloading/loading procedures. It should be revised to reflect procedures specific to WESF capsules and the casks in which they are transported.

Section 8, paragraph 1

"The basic source element in this system typified by the AECL C-188 source rod ... each element ... identified with a serial number...."

Section 8, paragraph 6

"... The following procedure will be generally followed.

"1. .....
(through)
38. ....."

B. The NRC has agreed to assist in the evaluation of demonstration facilities and to review license applications for demonstration projects. We will consider the first user of WESF capsules to be the demonstration for a particular process, in this case dry-irradiation/wet storage. As you suggested in your letter of July 23, 1984 to Nathan Bassin, a capsule monitoring program is in order to "give early warning of a potential long-term problem." Thus, your application for license amendment to use WESF capsules in your facilities should include a plan for periodic sampling and destructive testing of WESF capsules. The plan should include:

1. Proof of operation of capsules at CsCl-316L interface temperature $\leq$ 200° C.,

   In your July 23, 1984 letter to Nathan Bassin you claimed that, "The interface temperature in my application is not expected to exceed 200 degrees Centigrade." Please indicate in your plan how you will monitor the temperature of the WESF capsule that resides in the most restrictive location in the source array. The most restrictive location is construed as the site of the capsule that is at the highest temperature. If the surface temperature of the outer capsule is measured, please show by calculation the relationship between outer capsule temperature and CsCL-316 L interface temperature. A plan for recording the daily maximum temperature during the dry irradiation cycle should be included in the plan.

2. A limit of 12,000 cycles between dry-irradiation and wet storage,

   In the July 23, 1984 letter you stated that, "Our estimated 30 year operation would result in about 12,000 cycles ...." Please include in your plan the records to be kept that would provide a history of the cumulative cycles of capsules between irradiation and storage. The plan should address, particularly, the cycling history of those capsules that are selected for destructive testing.

3. The frequency of testing, rationale for selection of capsules to be tested, the analyses to be carried out, and test reporting procedures,

   In the July 23, 1984 letter you stated that you are in full agreement with the approach of "a capsule monitoring program whereby periodically a capsule would be removed and returned for analysis ...." Accordingly, the testing plan should include a rationale, on a statistically supportable basis, for the selection of the WESF capsules to be tested. The Department of Energy (DOE) has suggested that a capsule would be removed annually and subjected to destructive evaluation. We agree that annual testing is important for the first five years of operation. Thereafter, frequency of testing should be predicated on the results of destructive analysis. Thus, the testing plan should include a sampling frequency that "ensures early warning of a potential long-term problem." The plan should be re-evaluated every five years to coincide with the five-year license renewal process. The plan should also identify both the destructive and non-destructive analyses to be carried out. As a minimum, the analyses should be equivalent to those described in PNL-4847, "Cesium Chloride Compatibility Testing Program Annual Report - Fiscal Year 1983," by G. H. Bryan. The test results should be made available in a letter report to NRC. The test plan should include the reporting procedure by which RSI will inform NRC in a timely manner of the results of these periodic analyses.

4. An action plan and action levels based on test results,

   The purpose of the testing program is to anticipate problems related to the use of WESF capsules. Therefore, the plan should include the identification of a threshold or level of corrosion effects that limit the useful life of the capsules. The plan should also describe the disposition of capsules if, and when, the threshold has been reached.

5. Documentation of a commitment to test capsules according to the subject testing plan.

   RSI shall provide NRC with a copy of a letter, signed by a responsible authority, that commits to the long-term testing of WESF capsules in accordance with the above plan.

C. The effects of loss of capsule integrity can be significant due to the solubility of CsCl and the specific activity of Cs-137. Therefore, the application must address emergency procedures and systems that anticipate this unlikely occurrence. These shall include:

1. A storage pool cleanup system, including shielding, that is capable of removing cesium from pool water,

2. Continuous monitoring of gamma radiation emanating from cleanup resin columns,

3. A plan for disposal of contaminated resins,

4. Procedures for operation of cleanup systems under radioactively contaminated conditions,

5. Procedures to be followed in the event that monitored capsules exceed CsCl-316 L interface temperature of 200°C.

D. The application must address the ultimate disposition of spent WESF capsules. This address must include:

1. Documentation of a commitment to transport spent capsules from the location of use to the location of the ultimate receiver,

   At the end of life, as determined by the corrosion threshold, limited radioactivity or other causes, the capsules must be transferred to the point of ultimate disposal. In addition to the applicant's plan for this disposition, we require a copy of a letter, signed by a responsible authority, that commits to the transport of spent capsules from the point of use to the location of ultimate disposal.

2. Documentation of a commitment to receive, store, and/or otherwise dispose of spent WESF capsules.

   The NRC requires a copy of a letter, signed by a responsible authority, that commits to the reciept, storage, or other disposition of spent WESF capsules. If the commitment is made on the part of DOE, we will consider a commitment to receive at a DOE-controlled site as a commitment to disposal.

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