71-9315

Department of Energy
Washington, DC 20585

JAN 3 1 2007

ATTN: Document Control Desk,
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Document Control Desk:

The U.S. Department of Energy (DOE) requests an Amendment #3 to the Certificate of Compliance (CoC) USA/9315/B(U)F-96, model number ES-3100 shipping container. The following items are included in this amendment request for the consideration by the U.S. Nuclear Regulatory Commission:

- Revised definition of pyrophoricity as it applies to small uranium metal pieces shipped in the ES-3100,
- Addition of air transport capability for the ES-3100,
- Revised criticality safety calculations for all the authorized contents of the ES-3100,
- Revised Criticality Safety Index for the ES-3100,
- Revised quantity of off-gassing material that can be transported as packing material within the ES-3100 containment vessel, including adding a Teflon bottle as a convenience container for the uranyl nitrate crystal,
- Revised concentration of carbon in uranium shipped in the ES-3100,
- Revised concentration of the neptunium-237 in uranium shipped in the ES-3100,
- Specification of uranium alloyed with aluminum and molybdenum as contents of the ES-3100,
- Addition of uranium zirconium hydride as a specific content of the ES-3100, and
- Revision of the manufacturing specification for the neutron absorber material (277-4).

NM3501

DOE requests an expedited review of this amendment because the ES-3100 packaging will not be used until the new criticality safety analysis is approved, which is a large part of this amendment request.

This letter has two attachments. The first provides a detailed background for each of the items in this request. The first attachment also gives the location in the Safety Analysis Report (SAR) where each of these technical items is addressed. The second attachment is the ES-3100 SAR. This SAR version is Revision 1. Revision 1 incorporates the previous five series of change pages and also adds the information for this latest amendment. The information pertaining to this amendment request is highlighted in the text of the SAR. The original copy of this letter, without attachments is being sent to the Document Control Desk. Ten copies of the this letter with attachments, will be hand delivered to Kimberly J. Hardin, Project Manager, Licensing Branch, Division of Spent Fuel Storage and Transportation, Office of Nuclear Material Safety and Safeguards by a team from BWXT Y-12 shortly after this letter is sent.

If you have any questions, please contact me at 301-903-5513.

Sincerely,

James M. Shuler

James Shuler
Manager, Packaging Certification Program
Safety Management and Operations
Office of Environmental Management

Enclosure

cc:
Robert George, NA-261
Dana Willaford, DOE ORO
Steve Sanders, BWXT Y12
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ATTACHMENT 1

SUMMARY OF THE AMENDMENT 3 REQUEST USA/9315/B(U)F-96

UPDATE THE DEFINITION OF PYROPHORIC URANIUM

Section 1.2.3 (*HEU Metal and Alloy*) defines the minimum size limits for small pieces of broken uranium metal that can be safely transported in the ES-3100 without the possibility of a pyrophoric event occurring. The users of the ES-3100 asked that the definition of pyrophoric uranium in the ES-3100 SAR be reviewed and updated. Thus, an investigation into the pyrophoric properties of uranium metal was conducted to determine a more up-to-date safe size limit for shipment of small pieces of metallic uranium. Discussions with the NRC and others led to the following new definition:

> *1. Uranium metal and alloy (broken) pieces must have a surface-area-to-mass ratio of not greater than 1 cm^2/g or must not pass through a 1/4-in. mesh sieve.*
>
> *2. Incidental small pieces which do not pass the size restriction tests in #1, and powders, foils, turnings, and wires, are not permitted unless they are either in a sealed, inerted container or are stabilized to an oxide prior to shipment.*

In Revision 1 of the SAR, an updated definition of pyrophoric uranium metal is given in Section 1.2.3 (*HEU Metal and Alloy*) and 1.2.3.8 (5). Also, Appendix 1.4.10 has been added with the details of the pyrophoric investigation and justification for the revised definition.

ADD AIR TRANSPORT TO THE ES-3100

There is an overwhelming need to ship HEU via air transport. The ES-3100 is considered a viable container for air transport use. The ES-3100 design agency (BWXT Y-12) and NRC discussed (during a teleconference) how this package may meet the requirements for air transport. In lieu of Type C testing, the NRC suggested qualification for air transport by using conservative criticality safety calculations.

Using this approach, the ES-3100 SAR, Chapter 6, now contains a section of calculations specifically focused on air transport. Subcriticality is shown under conservative assumptions of the package materials being either present or absent, depending on their contribution to criticality safety. As a result of the conservative approach, fissile loading is greatly reduced for air transport scenarios over that for road transport. As specified in Chapter 1, HEU contents for air transport include HEU broken metal, solid geometric shapes, and Test, Research, and Training General Atomics (TRIGA) fuel elements.

In Revision 1 of the SAR, air transport is discussed in Section 1.2.3 and Chapter 6.

REVISED CRITICALITY SAFETY EVALUATION

Commercial product Cat. No. 277-4, the neutron absorber documented in Revision 0 of the SAR, is a proprietary mixture made by the Thermo Electron Corporation. This material combines high alumina cement and boron grit. During the RAI process prior to issuing the CoC (round 2, dated November 18, 2005), a question about process control of the Cat. No. 277-4 material required that DOE replace the Cat. No. 277-4 with a new formulation (designated just "277-4"). The new formulation was to be produced during ES-3100 manufacture by a two-part system of dry-blend components. The two-part system combined Thermo Electron Corporation's proprietary high-alumina cement without boron grit (Cat. No. 277-0) with nuclear grade boron carbide (B_4C). This mixture was to be produced by the ES-3100 manufacturer under strict quality controls. The new compound, 277-4, was detailed in SAR change pages prior to the CoC (specifically, Equipment Specification JS-YMN3-801580-A005, Rev D - Appendix 1.4.5 of the SAR). The manufacturing of 277-4 by a controlled process ensured consistency of the 277-4 among lots and generates the details necessary for accurate material characterization.

The material characteristic data for Cat 277-4 generated by Thermo Electron Corporation were used in the original criticality evaluation (February 2005 SAR). Since this data appeared to be slightly non-conservative as a basis for criticality safety, Revision 0 of the SAR used a set of "CSI dependent reduction factors" as a means of addressing this apparent non-conservatism.

Detailed characteristic data for the controlled mixture of 277-4 were made available in January 2006. This data is a great improvement over the Thermo Electron Corporation's data, and eliminated the need for the bias correction factors. So, for Revision 1 of the SAR, the criticality evaluation was revised using DOE's much improved material properties for the 277-4 neutron poison and no correction factors.

Revision 1 of the SAR includes a new version of Chapter 6 that details the updated criticality safety calculations.

ADD CSI OF 3.2

In the original CoC, CSIs of 0, 0.8, and 2.0 where specified. Some shipping scenarios can use a higher CSI. So a CSI of 3.2 was included in the revised criticality safety evaluations.

The revised Chapter 6 specifies a CSI of 3.2. Table 1.3 in Revision 1 of the SAR has been modified to include the fissile loading limits for a CSI of 3.2.

INCREASE MASS OF OFF-GASSING MATERIAL IN CONTAINMENT VESSEL

The original ES-3100 SAR analyzed up to 500 g of "off-gassing" packing material in the containment vessel (CV) (SAR Section 1.2.3.6). This type of material included polyethylene bottles and bags, silicone rubber pads, and any other material that is subject to off-gassing at elevated temperatures. The licensee now wants to add Teflon bottles as an authorized

convenience container for HEU uranyl nitrate (UNX) contents. These bottles would increase the limit of this material in the CV to 1500 g.

Calculations were performed to determine internal pressure of the CV when loaded with Teflon bottles (during NAC and HAC). The calculations can be found in SAR Appendices 3.6.4 and 3.6.5. The calculations show that the pressures internal to the CV, resulting from off-gassing of Teflon bottles, polyethylene bags and bottles, and silicone rubber at elevated temperatures (under normal and accident conditions), are well below the code allowable pressures. A new limit of 1500 g of "off gassing" material in the CV has been justified.

Revision 1 of the SAR includes the required changes in Sections 1.2.3.4, 1.2.3.6, 1.2.3.8, 3.6.4, and 3.6.5.

INCREASE CARBON CONTENT IN HEU

Increased carbon content in HEU was investigated by the criticality safety analyst. Various actual samples were included in the analysis, and qualified for shipment in the ES-3100. Maximum carbon content requested is 171,000 µg C/g U.

The revised carbon concentration is given for Group 7 oxide in Section 1.2.3 (HEU Oxide) of Revision 1 of the SAR. Analyses are provided in Section 6.9.3 (Table 6.9.3.1-3) of Revision 1 of the SAR.

INCREASE NP-237 CONTENT IN HEU

An increased Np-237 concentration of 2.5 wt% in HEU was investigated by the ES-3100 shielding analyst. Results indicated that Np-237 of this concentration can be shipped without dose rates exceeding the DOT limits.

The analysis is detailed in Section 5.0 of Revision 1 of the SAR.

VERIFY THAT U/AL AND U/MO ALLOY INGOTS ARE COVERED BY AUTHORIZED CONTENTS

The ES-3100 criticality safety analyst verified that alloys of uranium with aluminum and molybdenum can be shipped under the broken metal category using the same fissile loading limits as uranium metal (Table 1.3).

Descriptions of these alloys are given in Section 1.2.3 (HEU Metal and Alloy) and Section 6.4 of Revision 1 of the SAR.

ADD URANIUM ZIRCONIUM HYDRIDE COMPOUND AS A CONTENT

Fuel elements from Training, Research, Isotopes, and General Atomics (TRIGA) reactors have been analyzed as contents of the ES-3100. These fuel elements are unirradiated. The fuel material is uranium zirconium hydride ($UZrH_x$), where $x \leq 2$. TRIGA fuel is shipped as either

intact fuel elements or disassembled fuel pellets. The maximum loading per ES-3100 was determined to be 921 g ^{235}U.

A typical shipment of TRIGA fuel element or elements will be bundled together with polyethylene bagging and aluminum tape. If the fuel is disassembled, fuel pellets will be packed in convenience cans. A single ES-3100 convenience container will hold one TRIGA fuel element. Analysis determined that three convenience containers can be shipped per ES-3100, subject to the fissile limit of 921 g ^{235}U.

Revision 1 of the SAR provides details of this content in Sections 1.2.3 (TRIGA Fuel Elements) and 6.2.1.

REVISE THE 277-4 MATERIAL SPECIFICATION

During the manufacture of the ES-3100, it was noted that the acceptable Loss on Drying percentage (LOD) characteristic of the neutron absorber (277-4 material) is actually a function of the final cured density of the material. Therefore, the specification for this material found in Appendix 1.4.5 of the SAR (JS-YMN3-801580-A005) was revised to show a range of acceptable LOD values as a function of cured density. These values are supported by the calculations in Design Analysis and Calculation in Appendix 1.4.9 of the SAR (DAC-PKG-801624-A001).

In Revision 1 of the SAR, the 277-4 specification JS-YMN3-801580-A005 (Appendix 1.4.5) was modified (became Revision F) and the supporting Design Analysis and Calculation DAC-PKG-801624-A001 (Appendix 1.4.9) was modified (became Revision B).

ATTACHMENT 2

ES-3100 SAFETY ANALYSIS REPORT

[Y/LF-717, Rev 1]