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SAFETY ANALYSIS REPORT FOR PACKAGING THE ORNL HFIR UNIRRADIATED FUEL ELEMENT SHIPPING CONTAINER VOLUME 2

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Summary of Revision 13 Changes

Volume 2

Changes incorporated in Volume 2 are summarized in the revision log included in Volume 1 of this document

6.2 Package Fuel Loading

The maximum contents for each type of container (Inner and Outer) is provided in Table 6.2 for Fissile Class I packages.

Table 6.2

Maximum Contents for Fissile Class I Packages

Inner HFIR Unirradiated Fuel Element Shipping Container

Less than 2.63 (rounded up from 2.62174) kg U-235 as U_3O_8 – Al – B_4C cermet, having a density of 3.33 g/cm^3, enriched to 93.15 wt% U-235 and clad with 0.010-in. thick aluminum into 171 individual fuel plates, formed into involutes, and assembled into two concentric aluminum side plates. See Figure 1.7 for dimensions of inner elements. The inner element weighs about 103.5 lbs (46.95 kg).

Outer HFIR Unirradiated Fuel Element Shipping Container

Less than 6.88 (rounded up from 6.8724) kg U-235 as U_3O_8 – Al cermet, having a density of 3.33 g/cm^3, enriched to 93.15 wt% U-235 and clad with 0.010-in. thick aluminum into 369 individual fuel plates, formed into involutes, and assembled into two concentric aluminum side plates. See Figure 1.8 for dimensions of outer elements. The outer element weighs about 205 lbs (92.98 kg).

6.3 Model Specification

Both of the HFIR element packages (inner and outer) were modeled similarly with only appropriate dimensional and fuel element differences included. Figures 6.1.a and 6.1.b provide the basic dimensional specifications and Table 6.3 provides the basic material descriptions of the computational models for the Inner HFIR Element Package and the Outer HFIR Element Package, respectively. Figures 6.2 through 6.9 provide computer pictures of the basic components and array configurations considered in the analysis. Close comparisons between these figures and the engineering drawings of the containers and actual elements will reveal subtle differences from the actual packages and their contents. The differences between the actual packages and the computational models are listed below.

6.3.1 Description of Calculational Model

Figures 6.1.a and 6.1.b are dimensioned vertical cross sections through the center line of the calculated geometric models used in the analyses.

Comparisons between the actual packages and the computational models for each package demonstrate that the computational model

7. OPERATING PROCEDURES

This chapter complies with the operating procedure requirements specified in subpart D to 10 CFR Part 71 and also demonstrates that the operating procedures used will ensure that occupational radiation exposures are maintained as low as reasonably achievable as required by paragraph 20.1 (c) of 10 CFR Part 20.

7.1 Procedures for Loading Packages

Each container must first be inspected and discrepancies corrected before being selected for use, as per Chapter 8 of this SARP. Only one fuel element, either inner or outer, is loaded at a time using the following generic sequence:

1. Inspect the container per the requirement of Table 8.1. If the container is acceptable for transportation, proceed with procedure; otherwise obtain another container.

   Note: Containers that are not acceptable for use will be returned for maintenance per Chapter 8.

2. Verify that the Certificate of Compliance is current for the required shipping period and the contents of the container will be in accordance with the licensed contents of the container.
3. Move container to loading area using a fork lift under the container.
4. Remove the bolts from the container lid and then unbolt and remove the lid-lifting blocking device. Remove the lid with an approved lifting assembly at the user facility.
5. Perform verification of the contamination level for the exterior surface of the fuel element. Record external contamination level and verify level is less than the allowable limit of 1000 cpm. If level is greater than 1000 cpm, contact Health Physics personnel and STOP all shipment activity.
6. Place fuel element in polyethylene wrap or bag (0.004 in. nominal thickness) and load the applicable fuel element (inner fuel element into the inner fuel element container and outer fuel element into the outer fuel element container) into the container if the contamination level is within the allowable range.

   NOTE: The outer fuel element will not physically fit within the inner container and an off center

8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAMS

This chapter discusses the acceptance test and maintenance program to be used on the packaging in compliance with subpart D of 10 CFR Part 71. Maintenance of the HFIR fuel is not addressed in this section. After initial fabrication and testing, no maintenance is performed. Acceptance tests are performed on the fuel during fabrication. These tests are discussed in Chapter 4, Section 4.1.4, and will not be discussed in this chapter.

8.1 ACCEPTANCE TESTS

Original acceptance tests for the inner and outer HFIR fuel element containers were made during 1965 (first six sets of containers) and in 1976 (the most recent set of containers fabricated). These tests involved a dimensional comparison with the fabrication drawings and an operational verification when the containers were originally loaded. The operational verification was a "fitness for use" test which has been verified by the 20 years of use of these containers in normal transportation conditions.

8.1.1 Visual Inspection

A visual inspection was performed to verify that the fabricated containers were in accordance with the drawings. Initial inspections were performed in 1965 and 1976, and no additional information is available on the initial requirements.

8.1.2 Structural and Pressure Tests

Only a dimensional inspection of the structural containers were performed. The ability of a container to hold a fuel element and have the lid closed on the container was verified according to operational practices at ORNL in effect during 1965 and 1976. The container had no pressure boundary. Therefore, no tests were required.

8.1.3 Leak Tests

The package was not designed to be leak tight. Therefore, no leak tests were performed. The containment of the fuel plates was established by the initial fabrication techniques used for HFIR fuel elements.

8.1.4 Component Tests

No component test besides the visual and operational tests were performed on the HFIR unirradiated fuel element containers in 1965 and 1976. Therefore, the requirements of this section are not applicable.

TABLE 9-1

Q-List
Outer HFIR Element Shipping Container

Neoprene gasket	QA Level C
Plywood disks	QA Level C
Plywood rings	QA Level C
Reinforcing angles	QA Level C
2x2x1/4-in. stiffening angles	QA Level C
11-Ga HR steel	QA Level C
3/8-in. steel bolts	QA Level C
Polyethylene foam	QA Level C
Fuel Element (Outer)	QA Level A

TABLE 9-2

Q-List
Inner HFIR Element Shipping Container

Neoprene gasket	QA Level C
Plywood disks	QA Level C
Plywood rings	QA Level C
Reinforcing angles	QA Level C
2x2x1/4-in. stiffening angles	QA Level C
11-Ga HR steel	QA Level C
3/8-in. steel bolts	QA Level C
Polyethylene foam	QA Level C
Fuel Element (Inner)	QA Level A

9.3.2.1 Personnel Training. Individuals who perform specific functions related to either the container or the fuel fabrication must be trained to ensure that personnel can fulfill fabrication, inspection, maintenance, and operation requirements.

9.3.3 Design Control

The ORNL HFIR unirradiated fuel element shipping containers (inner and outer) were designed and fabricated by ORNL Engineering in 1965. The fabrication work on these containers was performed prior to the requirements for a formal quality assurance program. At the time of fabrication, the containers were inspected by ORNL shop inspectors and were found to be acceptable.

As part of the SARP revision process, an extensive reinspection of all containers was performed in 1989 by qualified quality assurance inspectors. The drawings included in the SARP reflect an accurate "As-built" condition of the containers.

Any changes or modifications to the package that varies from the approved licensed configuration or specifications are PROHIBITED. The statement, "Licensing Restrictions Apply" has been placed on the package drawings (refer to Chapter 1, Figures 1.3 through 1.8) to prevent revisions from being made to the drawings without the proper approval. Revisions are not to be made to the drawings without appropriate reviews and approvals (to include NRC).

Specifications for the HFIR fuel are controlled under the RRD Configuration Management Program. The fuel fabrication process has not been altered significantly in over 45 years of HFIR operations and it is not anticipated that the fabrication process will vary significantly in the future. When appropriate, revisions to the fuel specification may be made under the RRD configuration management program. Such revisions are made consistent with QA level A and include appropriate reviews for potential impacts on the evaluations presented in this SARP.

The following activities are representative of the design control process that would affect the existing and future containers.

Design Control on Existing Containers

1. Identification of a needed modification to the container packaging that would affect the approved licensed configuration. Initial notification must be given to NRC that a change is required for a specific reason.

2. Identification of applicable design codes and standards pertinent to modifications or additions to be made to the HFIR unirradiated fuel casks. Review and approval by both RRD and NRC must be requested and received for each revision that affects the approved licensed configuration.

3. Documentation of the design/modification process. All design calculations must be documented and reviewed by an individual who is independent from the design process.

4. All modifications must be reflected in the SARP.

Design Control on Future Containers that May be Fabricated:

1. Project engineer is selected to coordinate communications on design activities; to include interfaces among RRD groups, ORNL Divisions and Departments, suppliers, and DOE.

2. Project engineer reviews the SARP to identify design criteria, specifications, drawings, procurement specifications, and procedural documents required for container fabrication.

3. Project engineer ensures that the necessary documents are prepared for fabrication to include procurement documents, work orders, and quality assurance inspection requirements and requests.

4. Project engineer ensures that appropriate fabrication verification is performed; to include quality assurance inspections as required. Also, verifies that the container was fabricated according to the conditions of the certificate of compliance.

5. Project engineer ensures that design documentation and QA records are developed and maintained.

6. Project engineer ensures that adequate controls are placed on the fabrication process to attain the required quality and verification of quality.

9.3.2.1 Procurement Document Control

9.3.4.1 Packaging Procurement. The packaging procurement is divided into three components; packaging procured prior to 1980, those containers to be fabricated, and the fuel elements. The casks were originally fabricated at ORNL. Therefore, no supplier certificate of compliance documents are available. However, other documents such as signed inspection checklists and as-built drawings are available as documentation of verification activities conducted during fabrication, use, and maintenance of the casks.

9.3.4.2 Replacement Parts Procurement. All replacement parts will be based on a one-for-one replacement. No substitutions are to be made to the container parts without the documented approval of NRC and a corresponding revision made to the SARP specifications. The procurement of replacement parts important to safety are reviewed by QA personnel to ensure that appropriate technical and QA requirements are included in purchase orders. Purchase orders are placed with qualified vendors. RRD will assure itself that the replacement parts meet requirements as defined by this SARP.

9.3.5 Instructions, Procedures, and Drawings

Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Appropriate quantitative or qualitative criteria for determining that important activities have been satisfactorily accomplished must also be documented.

Current specifications for the HFIR fuel are contained in the controlled document *Specification for High Flux Isotope Reactor Fuel Elements*, RRD-FE-3.

The fuel fabricator must implement a program that contains appropriate instructions, procedures, and drawings to comply with the specifications document, RRD-FE-3.

9.3.6 Document Control

All documents used to accomplish and/or verify quality-related activities are controlled. The controlled documents used in transportation activities include (but are not limited to) the following: this QAPP, Research Reactors Division Procedures, fuel fabrication procedures, and *Specifications for the High Flux Isotope Reactor Fuel Elements*, RRD-FE-3.

Control of Processes Affecting the Fuel Elements:

Welding performed on the fuel elements in accordance with the specifications identified in the controlled document *Specification for High Flux Isotope Reactor Fuel Elements*, RRD-FE-3.

In general, all welds must be made only by qualified welders or welding operators. Work must be performed in compliance with approved procedures that have been qualified in accordance with the fuel specification document. The fuel fabricator must submit for approval by RRD, prior to the start of fabrication, detailed welding procedures that conform to requirements of the fuel element specification.

9.3.10 Inspection

Inspections will be performed to verify conformance of a HFIR cask-related item or activity to identified standards and requirements. These inspections are categorized as in-process, final, and inservice.

In-process and final inspections of HFIR cask-related items produced by ORNL for the Research Reactors Division will be performed to demonstrate item conformance and acceptance. Additional modifications, repairs, or replacements of cask items require reinspection to verify acceptability.

An inservice inspection is performed to ensure adequate operation and maintenance of packaging. This inspection is performed during fuel shipments to the HFIR by certified quality assurance inspectors.

Items verified prior to a shipment include the following:

- Packages are properly assembled
- All shipping papers are properly completed
- Packages are conspicuously and durably marked as required by DOT regulations
- Measures are established to ensure that an individual designated by the user of the packages signs the shipping tags or indicators before authorization for shipping.

Visual inspections are conducted as part of the preparation process for shipping unirradiated fuel. These inspections include the following: a visual inspection of the inside of the container, a visual inspection of the outside of the container, a check for contamination, a verification that all lid bolts are present, an inspection of the gasket surface and replacement if signs of degradation are observed, and an inspection of the lid-lifting blocking device to insure all parts are in place and in working condition.