SUMMARY OF SAR CHANGES
ORNL/TM-V11656/V1 & V2
Rev. 13

Chapter 1, *General Information,* provides an overview of the packaging and its contents (HFIR unirradiated fuel elements). The changes to this chapter include editorial corrections, replacement of several detailed fuel fabrication drawings with two drawings showing technical content pertinent to evaluations in the SAR, and clarifications to the contents in Section 1.2.3. Note that the changes to Chapter 1 are not a result of physical changes to the HFIR fuel elements or other package content changes.

Chapter 2, *Structural Evaluation*, incorporates key fuel element dimensions in its structural model; these dimensions are shown on the simplified drawings (Figures 1.7 and 1.8) which have replaced the detailed fabrication drawings. The container designs have not changed and are not affected by the removal of the fuel fabrication drawings or the Fuel Specification.

The text states in Section 2.1.2 that the regulatory requirements of 10 CFR 71.73 are met so long as the fuel does not melt or fracture into numerous small pieces. These are conservative acceptance criteria since the fuel material is interspersed in an aluminum matrix and clad with aluminum and therefore would be difficult to release—even if broken into many pieces—in such a manner and in quantities which would pose a significant hazard to the public.

Other conservative assumptions are made in the structural analysis, including that the fuel plates attached to the outer side plate are "clamped" in place, while those on the inner side plate are not. The HFIR Fuel Specification requires that fuel plates be welded to both inner and outer side plates, as indicated on the simplified drawings added to Chapter 1. Furthermore, ORNL has defined "critical attributes" for fuel element assembly which are intended to, among other things, ensure that the necessary weld penetrations are achieved to attach the fuel plates to the side plates. The identified "critical attributes" are verified prior to accepting the element for use in the reactor. Thus, proper welding of the fuel plates to the side plates is a fundamental requirement in HFIR fuel manufacturing which has not changed.

Appendix B of Chapter 3, *Thermal Evaluation*, determines the minimum amount of fuel bearing material which would need to be exposed for it to be possible to release an A_2 quantity of radioactive material; that analysis disregards the protection the packaging provides to the fuel. The salient features of the fuel which affect this analysis (and other Chapter 3 analyses) include various fuel dimensions and configuration (e.g., cladding and side plate thicknesses), materials of construction, and amount and type of nuclear material. These features have not been changed and are shown on the simplified drawings included in Chapter 1. If changes were to be proposed for these features, significant internal and regulatory reviews and necessary approvals (including the NRC, the licensing authority for the shipping package) would be required prior to implementing the changes. The container designs have not changed and are not affected by the removal of the fuel fabrication drawings or the Fuel Specification.

The radioactive contents of HFIR fuel are contained in a fuel matrix composed of U_3O_8 interspersed in an aluminum filler and clad in 6061 aluminum, which together provide a containment that withstands the combined effects of the structural and thermal tests for normal and hypothetical accident conditions when transported in the HFIR unirradiated fuel element container. Chapter 4, *Containment*, credits these features as providing the primary boundary or containment. The containment boundary (i.e., the cladding and fuel matrix) has not changed, and if such changes were proposed, significant scrutiny (including NRC review) would be required. Furthermore, there are multiple in-process and acceptance tests and inspections completed during the fuel fabrication process; Chapter 4 provides a subset of these tests and inspections as evidence that the containment boundary of the completed fuel element will be as assumed in the SAR. The description of one such test (i.e., destructive testing) is being changed to state that the frequency and sample size are determined based on trending data. This is a clarification and does not represent a change in the testing.

Chapter 5, *Shielding Evaluation*, states that "radiation emitted by the unshielded and unirradiated HFIR fuel assembly…is well below the levels specified in the regulations per 10 CFR 71 for shipment of radioactive materials." A change to the amount and type of radioactive material shipped in the 5797 container is not proposed. Chapter 5 will therefore not be affected by the removal of the Fuel Specification or fuel fabrication drawings.

It is stated in the criticality analysis in Chapter 6 that the significant features of the package for criticality safety include the steel outer container wall, wood insulation, separation of the containers, and the form and composition of the fissile materials within each element. The controlled container drawings are not proposed to be altered or removed from the SAR. The salient features of the fuel elements, including the key dimensions and form and composition of the fissile material, have not changed. These features are described in detail in Chapter 4 and are also provided on the simplified fuel drawings which have been added to Chapter 1, as well as the figures provided in Chapter 6.

Chapter 7, *Operating Procedures*, provides guidance for safely loading, unloading, and preparing an empty 5797 package for shipping. Removal of the Fuel Specification has necessitated the addition of a step in Section 7.1, *Procedures for Loading Packages*, which prompts the user to place the fuel element in a protective polyethylene bag or wrap. This is not a content change as the Fuel Specification requires the elements to be placed in a protective polyethylene bag or wrap prior to shipping. This chapter is otherwise unaffected by the changes made in SAR Revision 13.

Chapter 8, *Acceptance Tests and Maintenance Programs*, discusses the acceptance test and maintenance program to be used on the 5797 packaging, in compliance with Subpart D of 10 CFR Part 71. Sections 8.2.2, *Leak Tests*, and 8.2.3, *Subsystems Maintenance*, refer to the containment boundary provided by the fuel plates. These sections defer to the Chapter 4 analysis which describes the verification of the containment integrity by destructive and non-destructive testing. Changes proposed to Chapter 4 would not affect these sections since the containers are not leak tight and since the maintenance tests in Chapter 8 are not intended to address

maintenance of the HFIR fuel, as the fuel material is enclosed in an aluminum matrix and cladding.

Chapter 9, *Quality Assurance*, focuses heavily on quality assurance aspects germane to the fuel production and inspection processes since the fuel elements are considered the most critical part of the package. The changes to this section predominantly reflect the removal of the fuel fabrication drawings from Chapter 1 and the removal of the Fuel Specification from Chapter 4, Appendix C. The simplified fuel drawings added to Chapter 1 provide the salient features of the fuel which are necessary to demonstrate compliance with applicable regulations. Design control for these critical aspects of the fuel elements is provided by controlling these drawings with a "licensing restrictions apply" stamp which will require that any changes be appropriately reviewed by certifying officials.

Several editorial-type changes have been made to both volumes of the SAR. Such changes include correcting minor errors, clarifications, and rearrangements of material. These changes do not affect the conclusions of the evaluations in the SAR.

Previously fabricated elements currently in inventory have been tested, inspected, and accepted for use in the reactor and could have been shipped under previous revisions of the CoC. The fabrication and acceptance processes have been enhanced as a result of lessons learned from a 2018 fuel degradation incident that was determined to be the result of human error following introduction of more modern machine tools at the manufacturer's facility. Once implemented, these enhancements will address identified causes of the event to prevent a recurrence. Previously fabricated elements have been (or will be) inspected to verify that the conditions that resulted in the fuel degradation incident are not present in those elements, although these conditions are minor in comparison to the conservatism present in the analysis. Therefore, previously fabricated elements possess the characteristics/properties credited in the SAR and may continue to be shipped under the revised CoC following the SAR changes outlined herein.