IAEA/ANL
Interregional Training Course

Technical and Administrative Preparations Required for Shipment of Research Reactor Spent Fuel to Its Country of Origin

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Lecture L.3.1a

Savannah River Site Appendix A Agreement Preparation Guidelines

Appendix A Preparation Guidance

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To: IAEA / USE Interregional Training Course Attendees

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PREPARATION OF APPENDIX A CONTRACT FORMS FOR THE SAVANNAH RIVER SITE

The Department of Energy (DOE) Appendix A contract form is the source document from which all Savannah River Site (SRS) storage, shipping, and disposition analyses are based. These analyses support, in most cases, the safe operation of the site's nuclear operations. The importance of an accurate and complete Appendix A, therefore, can not be overemphasized. As a result of problem areas that have been noted in recent Appendix A reviews, this document is being provided to enable the standardized completion of an Appendix A form. In addition, the Appendix A form itself has been revised to readily support description of the standard research reactor fuel type. The new form and the preparation guidelines will benefit the Reactor Operators by reducing the review and approval time at SRS.

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I. General Comments

- Schedule

Receipt of spent fuels by SRS is dependent upon the availability of the Appendix A and applicable prints well in advance (at least 270 days) before intended shipment date.

- Dimensions

All dimensions must be given in centimeters except in the case of small components such as connecting pins or handles where units may be identified in millimeters. Use of different units must be noted.

- Weights

All weights must be given in grams.

- Drawings

The description must agree with the material described in the Appendix A and should be a comprehensive illustration of the fuel. Typical drawings to be provided include over-all assembly, fuel plate, side plate, dummy plate, end fitting, spacer, handle, fabrication detail prints, etc. Six (6) copies of each drawing shall be provided.

- Cropping

Indication for cropped fuel assemblies is located in Section C.2.b..
Changes in weights and dimensions due to cropping shall be reflected in the appropriate description and cropping lines shall be marked for each affected drawing.

- Sodium

Fuel assemblies containing sodium are not permitted in SRS spent fuel facilities.

- Other

If available, provide two (2) copies of the manufacturer's fuel specification forms or equivalent.

II. Appendix A Form

A. Section C.1. Drawing Identification:

Include Drawing No., Revision No., and Title.

B. Section C.2. Material Description:

1. Fuel "Element" Description:

Notes:

- Weights are dry and unirradiated.

- If the assembly contains more than one element type (e.g. inner plate, outer plate), the Fuel "Element" Description table column may be divided or the entire page duplicated. Renumbering of pages is acceptable if table is duplicated.

Fuel element type

State as flat plate, curved plate, tube, or etc.

Required to:
a) cross-check drawings
b) support criticality analyses methodology

Nominal dimensions

State element dimensions as:
plate - length , width, and thickness
tube - length, outside diameter, and inside diameter

Dimensions for curved plate elements should be stated in their flat or pre-rolled form.

Required to:
a) cross-check drawings
b) support criticality analyses methodology

Nominal dimensions of fuel meat

State fuel meat dimensions as:
plate - length , width, and thickness
tube - length, outside diameter, and inside diameter

Dimensions for curved plate elements should be stated in their flat or pre-rolled form.

Required to:
a) cross-check drawings
b) support criticality analyses methodology
c) assembly cropping

Nominal total weight of fuel element

Total weight of element is the tabulation of fuel meat, cladding, and any additional weight contributors.

Required to:
a) cross-check of final calculated values

Chemical form of fuel meat

State fuel meat / form description. Research reactor fuel meat is typically found as a dispersant in matrix. Common form received is UAl_x in Aluminum matrix.

Required to:
a) support criticality analyses methodology
b) cross-check fuel meat values using stoichiometric composition
c) compare to Authorization Basis / Reference Fuel Assembly

Weight of fuel meat

Weight of fuel meat is typically the tabulation of the dispersant (UAl_x, U_3Si_x, U_3O_8, etc.) and matrix material (Al).

Required to:
a) cross-check calculated element weights

Weight of Total U

Nominal total weight of total U including uncertainty. The nominal weight plus the uncertainty shall bound the specific assembly values listed in Section E.

Required to:

a) calculate ^{238}U concentration, though ^{238}U mass is primarily dependent upon enrichment final value and should be in range

Weight of ^{235}U

Nominal weight of total ^{235}U including uncertainty. The nominal weight plus the uncertainty shall bound the specific assembly values listed in Section F.

Required to:

a) support criticality analyses methodology

Matrix material, weight

State material and specification (i.e. ASTM #) when available and nominal weight.

Required to:

a) accurately calculate the fuel concentration
b) determine final disposition requirements

Cladding material and method of sealing

State material and specification (i.e. ASTM #) and fabrication technique.

Required to:

a) prepare the cladding material mass input to the criticality model.
b) determine final disposition requirements

Clad thickness and weight

Clad thickness is defined as the cover thickness on one side of the fuel meat. Nominal weight is the total weight of both cover sheets and the frame sheet surrounding the fuel meat.

Required to:

a) prepare the cladding material mass input to the criticality model
b) cross-check calculated element weights

Bonding material

State material (i.e. Al-Si) and specification (i.e. ASTM #) and fabrication technique (i.e. dipping).

Required to:

a) support criticality analyses methodology
b) determine final requirements

Bonding thickness and weight

State bond thickness on one side of fuel meat and nominal weight of bonding in the whole element.

Required to:

a) support criticality analyses methodology
b) determine final disposition requirements

Other materials ...

State material, dimensions, weights of any other components that are integral to the fuel element.

Required to:

a) support criticality analyses methodology
b) determine final disposition requirements

2. Fuel "Assembly" Description:

Total number of elements

State total number of fuel elements and in parentheses differentiate between the element types (i.e. # of inner elements, # of outer elements).

Required to:

a) define the criticality model

Over-all dimensions

State dimensions in nominal length and cross-section / diameter. For box-type plate assembly, maximum cross-section is in the box portion of the assembly. For the box-type curved plate assembly, cross-section would include the apex of the plate curvature.

Required to:

a) define criticality model
b) determine facility compatability

Over-all weight

Over-all weight of assembly is the tabulation of fuel elements, side plates, end fittings, etc..

Required to:

a) evaluate storage rack loading analysis
b) cross check for consistency

Total weight of U

State total weight of U and uncertainty in the fuel assembly. Value shall equate to the tabulation of the fuel element U weights.

Required to:

a) cross check for consistency

Total weight of ^{235}U

State total weight of ^{235}U and uncertainty in the fuel assembly. Value shall equate to the tabulation of the fuel element ^{235}U weights.

Required to:

a) cross check for consistency

Enrichment %

State maximum ^{235}U in enrichment.

Required to:

a) determine total U concentration

Canning material & Canning dimensions and weight

State canning material and specification, dimensions in length and cross-section / diameter, and weight of can.

Canning is usually required in cases where the fuel assembly has been identified as failed or the fuel elements have been removed from the assemblies in order to ship in standard cask basket (i.e. University Test Reactor fuels). The fuel assembly descriptions of over-all weight and dimensions will reflect canning parameters.

For those fuels that are provided with casements (typically power fuels), the casing description may be used in place of canning.

Required to:

a) ensure shipping or storage system compatibility
b) support criticality analyses methodology

Side plate material & Side plate quantity, ...

State side plate material and specification, number of side plates in the assembly, dimensions in length, width, thickness, and weight of the individual side plate.

Required to:

a) support criticality analyses methodology

Side plate outer / inner slot depth & width

State slot depth and width

Required to:

a) support criticality analyses methodology
b) cross-check for consistency

Spacer material & Spacer quantity, dimensions, weight

State spacer material and specification, number of spacers in the assembly, dimensions in length, width, thickness, and weight of the individual spacer.

Required to:

a) cross-check for consistency

End box material & End box quantity, dimensions, weight

State end box material and specification, number of end boxes in the assembly, dimensions in length, cross-section or diameter, and weight of the individual end box.

Required to:

a) support criticality analyses methodology
b) determine storage compatibility
c) cropping of fuel assembly and scrap disposition
d) handling techniques

Braze / Weld material & Braze / weld dimensions and weight

State materials, dimensions, and weights. Drawings should indicate braze / weld locations

Required to:

a) final disposition requirements

Other structural material ...

State material, dimensions, weights of any other components that are integral to the fuel assembly. Items include dummy plates, thermocouples, handles, etc..

Required to:

a) support criticality analyses methodology
b) determine final disposition requirements

C. Section D. Fuel Identification

List assembly identification numbers, location on assembly, and method of marking. For cropped assemblies, ensure that no markings have been removed or distorted beyond recognition. Markings must be legible at approximately 8 meters underwater.

D. Section E. Fuel Irradiation Specifications

a. Fuel Irradiation History

Provide brief summary of core operation in terms of operating dates, time in reactor (days), power level (mwd/assembly), ^{235}U burnup (%), and cooling time (days). These values should be based on the average assembly. Include method of computation or program.

b. Post-Irradiation Specifications

Include applicable isotopics for the average assembly.

E. Section F. Fuel Irradiation History - Assembly Specific Data

The complete isotopic and irradition history is required for the specific assembly and shall be documented in the table provided in Section F. Facility operation considerations include:

Criticality

The maximum pre-irradiated U and ^{235}U contents for the specific assemblies shall be bounded by the average assembly values with uncertainty as listed in C.2.b..

Authorization Basis

- Verification of two (2) year minimum cooling from reactor shutdown
- maximum decay heat load not to exceed 135 watts
- maximum pre-irradiated ^{235}U g loading not to exceed 5,500 g

Repository

- Power level and burnup are provided to determine End of Life (EOL) values to support safety basis documentation as required by the final repository. Safety requirements still under construction

F. Section G. Specifications for Failed / Warped Fuel Units

Notification is required to DOE that assemblies are corroded, failed, or distorted at least 270 days before tentative shipping date. See Visual Inspection Data Sheet (attached).

G. Section H. Cask and Basket Identification

List shipping cask and basket combination to be utilized. Provide identification numbers if available.