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RDT Standards Transmittal

Hanford Engineering Development Laboratory

DISTRIBUTION	DATE August 10, 1973	NO. 127	
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RDT Standard

DRIVER FUEL ASSEMBLY

APRIL 1973

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UNITED STATES ATOMIC ENERGY COMMISSION
DIVISION OF REACTOR RESEARCH AND DEVELOPMENT

RDT E 13-16T
Date April 1973
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DRIVER FUEL ASSEMBLY

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DRIVER FUEL ASSEMBLY

1. SCOPE

This standard establishes the requirements for fabrication of driver fuel assemblies.

1.1 Application. This standard applies to driver fuel assemblies for use in fast flux, sodium cooled, nuclear reactors.

1.2 Definitions.

1.2.1 Driver Fuel Assembly. The basic nuclear power generating member of the reactor core. Its major components are: fuel pins, duct tube assembly, axial shield/orifice assembly, inlet nozzle, and handling socket.

1.2.2 Duct Tube Assembly. A hexagonal tubular structure which encloses the fuel pin bundle assembly and provides the channel for the primary coolant.

1.2.3 Fuel Pin. A stainless steel clad fuel column complete with insulator pellets, reflectors, tag gas capsule assemblies and plenum chamber.

1.2.4 Handling Socket. A component attached to the upper end of the duct tube to provide a means for inserting and removing the driver fuel assembly from the reactor core.

1.2.5 Inlet Nozzle. A component attached to the lower end of the shield/orifice assembly.

1.2.6 Lot. Assembly components of one type fabricated and processed consecutively in the same run and from the same heat of material.

1.2.7 Repair. As defined in RDT F 2-2.

1.2.8 Rework. As defined in RDT F 2-2.

1.2.9 Shield/Orifice Assembly. The component assembly located between the fuel pins and the inlet nozzle.

2. APPLICABLE DOCUMENTS

The following documents are part of this standard to the extent specified herein. The issue of a document in effect on the date of the invitation to bid, including any amendments also in effect on that date, shall apply unless otherwise specified. Where this standard appears to conflict with the requirements of a reference document, such conflict shall be brought to the attention of the purchaser for resolution.

2.1 RD T Standards.

RD T F 2-2T, Quality Assurance Program Requirements

RD T F 2-4T, Quality Verification Program Requirements

RD T F 3-2T, Calibration Program Requirements

RD T F 6-2T, Welding of Reactor Core Components and Test Capsules

RD T F 5-1T, Cleaning and Cleanliness Requirements for Nuclear Components

RD T F 7-2T, Preparations for Sealing, Packaging, Packing, and Marking of Components for Shipment and Storage

RD T F 7-3T, Requirements for Identification Marking of Reactor Plant Components and Piping

RD T F 8-6T, Hoisting and Rigging of Critical Components and Related Equipment

RD T M 2-15T, Nickel-Chromium Alloy Bars, Forgings, and Forging Stock (ASME SA-637 with Additional Requirements)

RD T M 2-2T, Stainless and Low Alloy Steel Forgings (ASME SA-182 with Additional Requirements)

RD T M 5-1T, Stainless Steel Plate, Sheet and Strip (ASME SA-240 with Additional Requirements)

RD T M 7-3T, Stainless Steel Bars and Shapes (ASME SA-479 with Additional Requirements)

2.2 American Society for Testing and Materials (ASTM) Standards.

ASTM E 29 Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values

2.3 American National Standards Institute (ANSI) Standards.

B 46.1, Surface Texture

2.4 Other Documents.

Other documents as specified in the Ordering Data.

2.5 Drawings.

As specified in the Ordering Data.

3. TECHNICAL REQUIREMENTS

3.1 Fuel Assembly Components.

3.1.1 Component Materials. Fuel assembly components shall be fabricated from materials meeting the requirements of the standards below. Use of alternate or additional materials shall be approved by purchaser.

1. RDT M 2-2.
2. RDT M 2-15.
3. RDT M 5-1.
4. RDT M 7-3.

3.1.2 Components. Fuel assemblies shall be fabricated and assembled from components meeting the requirements of standards, specifications, and drawings specified in this standard and in the Ordering Data.

3.2 Dimensions. Fuel assemblies shall meet the dimensional requirements of drawings specified in the Ordering Data.

3.3 Driver Fuel.

3.3.1 Fuel Pin Position. The location of each pin (by serial number) within each fuel assembly shall be recorded. Records of fuel pin identification and location shall be submitted to the purchaser for information.

3.3.2 Fissile Content. The fissile content of fuel in each fuel pin and fuel assembly shall be calculated and recorded, and shall be submitted to the purchaser. The fissile content of the fuel assembly shall be as specified in the Ordering Data.

3.4 Fuel Assembly Welds. Fuel assembly weld types and configurations shall meet the requirements of drawings specified in the Ordering Data. Non-destructive testing of welds not covered explicitly in the specified drawings or in this standard shall comply with RDT F 6-2.

3.5 Fuel Assembly Weight. The weight of each completed fuel assembly shall be submitted to the purchaser.

3.6 Surface Condition.

3.6.1 Cleanliness. Finished fuel assemblies shall be clean and free of chips, weld spatter, dirt, lubricants, and other foreign material. Cleaning shall comply with RDT F 5-1. Additional cleanliness requirements shall be identified in the Ordering Data.

3.6.2 Surface Texture. The fuel assembly surfaces shall not exhibit roughness greater than specified in drawings listed in the Ordering Data as determined in accordance with ANSI B46.1.

3.6.3 Surface Marring. Exterior surfaces of the finished fuel assemblies and surfaces of finished fuel assembly components shall be free of scratches, dents, or mars except of the dimensions and types listed below unless otherwise specified in component standards or in the Ordering Data. Surface imperfections such as handling marks, light mandrel, and die or roll marks will not be considered as injurious defects provided they are less than 0.010 inch in depth, and do not reduce the wall thickness to less than the minimum specified on drawings listed in the Ordering Data. Removal of defects by grinding, buffing, polishing, etc., is considered a repair subject to requirements of 3.10, but is permitted provided all other dimensions and surface finish requirements are maintained. The bottom of these defects shall be visible, rounded, and well faired in as confirmed by visual inspection.

3.7 Identification. Each fuel assembly shall be identified as specified in the Ordering Data. The method of identification shall conform to RDT F 7-3 and shall be approved by purchaser prior to use.

3.8 Workmanship. Completed fuel assemblies shall reflect high quality workmanship, shall be uniform in appearance, and shall bear no fingerprints or miscellaneous markings. Components shall be inspected at hold points designated in the assembly sequence to assure that handling damage has not occurred.

3.9 Processes.

3.9.1 Assembly Sequence. An assembly sequence which shows the steps and operations which are a part of the fuel assembly or component fabrication effort shall be prepared by the supplier and approved by the purchaser. The assembly sequence shall include a process flow diagram which shows audit and inspection hold points.

3.9.2 Welding Processes. All welding shall be in accordance with RDT F 6-2 unless otherwise specified in the Ordering Data.

3.9.3 Handling and Storage During Processing. Completed fuel assemblies and partially completed fuel assemblies shall be handled and stored in the vertical position in a manner to maintain conformance with this standard, individual component standards, and Ordering Data. Lifting of finished fuel assemblies shall be in accordance with RDT F 8-6.

3.10 Repair and Rework. Nonconforming fuel assemblies or components may be repaired or reworked provided the finished item conforms with this standard and the Ordering Data. Repair and rework shall be in accordance with procedures prepared by the supplier and approved by the purchaser.

4. QUALITY ASSURANCE REQUIREMENTS

4.1 Quality Assurance Program Requirements. The supplier shall plan,

establish, implement, and maintain a documented quality assurance program that fulfills all requirements of RDT F 2-2 Sections 1, 2, 4, 5, and 8. Individual components may be fabricated to RDT F 2-4 as specified on the drawings. Additional quality assurance requirements may be specified by the Ordering Data.

4.2 Quality Assurance Documentation. The supplier shall be responsible for the preparation of all quality assurance documentation required by the applicable sections of RDT F 2-2 or RDT F 2-4. The documents identified in Tables 1 or 2 shall be submitted to the purchaser for the applicable purpose at the indicated time. The granting of any process or procedural approvals by the purchaser shall not be construed to relieve the supplier in any way or to any extent from the full responsibility for delivering items conforming with all requirements of this standard and the Ordering Data.

4.3 Standards of Manufacture, Manufacturing Process, and Production. All standards or specifications shall be as established in Section 2. Other additional standards or specifications or modification of said standards and specifications proposed by the supplier shall be submitted to and approved by the purchaser prior to use.

4.4 Records. Records shall be maintained on the complete fabrication history including material lists, manufacturing operations, lot numbers, and component numbers for the complete assembly sequence. Additional records shall be maintained and supplied as specified in the Ordering Data. The supplier shall supply such information with his reports on tests made on any delivered fuel assembly.

4.5 Responsibility. Unless otherwise specified, the supplier shall be responsible for the performance of all tests and inspections required in this standard and in the Ordering Data prior to submission to the purchaser of any item for acceptance. The performance of such tests and inspections does not limit the right of the purchaser to conduct such other tests and inspections as the purchaser deems necessary to assure that all items are in conformance with all requirements of this standard. Except as otherwise specified, the supplier may use either his own or any commercial facility acceptable to the purchaser. Complete records of all tests and examinations shall be kept and shall be available to the purchaser.

4.6 Inspection Requirements. Inspection requirements are listed in Table 3. Actual test methods used shall be equal to or better than the methods referenced and shall be approved by the purchaser.

4.7 Purchaser's Inspection.

4.7.1 Inspection Facilities. The supplier shall provide the purchaser's representatives all reasonable facilities to satisfy the purchaser that the material furnished is in accordance with the requirements of this standard.

4.7.2 Certification Records Review. Before fuel assemblies are released by the supplier, certification records shall be reviewed by the purchaser for compliance with Sections 3 and 4. Specific records will be as defined in the Ordering Data.

TABLE 1 - DOCUMENTATION SUBMITTAL REQUIREMENTS FOR CONFORMANCE WITH RDT F 2-2

<u>Item</u>	<u>Description</u>	<u>Ref. Paragraph of RDT F 2-2</u>	<u>Submit to Purchaser for Approval</u>	<u>Information</u>	<u>Time for Submittal to Purchaser</u>
1	Quality Assurance Program Plan (includes description of the procedures or plans required in 1.1 to 1.21 below)	2.2.2	X		With response to RFQ
1.1	Procurement Plan	4.2, 4.5	X		With response to RFQ
1.2	Inspection and Test Plan	5.3	X		With response to RFQ
1.3	Audit Plan and Procedure	8.	X		With response to RFQ
1.4	Procurement Document Review Procedure	4.4	X		With response to RFQ
1.5	Contract Change Control Procedure	4.6.1	X		With response to RFQ
1.6	Personnel Training and Certification Procedure	4.7	X		With response to RFQ
1.7	Equipment Calibration and Standards Procedure	4.8	X		With response to RFQ
1.8	Source Surveillance and Inspection Procedure	4.9	X		With response to RFQ
1.9	Receiving Inspection and Procedure	4.10	X		With response to RFQ
1.10	Control of Nonconforming Items Procedure	4.11	X		With response to RFQ

(Continued)

TABLE 1 - DOCUMENTATION SUBMITTAL REQUIREMENTS FOR CONFORMANCE WITH RDT F 2-2 (continued)

<u>Item</u>	<u>Description</u>	<u>Ref. Paragraph of RDT F 2-2</u>	<u>Submit to Purchaser for Approval</u>	<u>Information</u>	<u>Time for Submittal to Purchaser</u>
1.11	Control of Received Items Procedure	4.12	X		With response to RFQ
1.12	Material Identification and Control Procedure	5.4	X		With response to RFQ
1.13	Personnel Training and Certification Procedure	5.5.5	X		With response to RFQ
1.14	Inspection Status Indication Procedure	5.6.4	X		With response to RFQ
1.15	Document Control Procedure	5.7	X		With response to RFQ
1.16	Control of Inspection, Measurement and Test Equipment Procedures	5.8	X		With response to RFQ
1.17	Statistical Quality Control and Analysis Methods, Techniques	5.9	X		With response to RFQ
1.18	Control of Nonconforming Item Procedure	5.10	X		With response to RFQ
1.19	Corrective Action Procedure	5.11	X		With response to RFQ
1.20	Handling, Preservation, Packaging, Storage and Shipping Procedures	5.12	X		With response to RFQ
1.21	Quality Records Procedure	5.13	X		With response to RFQ

(Continued)

TABLE 1 - DOCUMENTATION SUBMITTAL REQUIREMENTS FOR CONFORMANCE WITH RDT F 2-2 (continued)

<u>Item</u>	<u>Description</u>	<u>Ref. Paragraph of RDT F 2-2</u>	<u>Submit to Purchaser for Approval</u>	<u>Information</u>	<u>Time for Submittal to Purchaser</u>
2	Inspection Instructions and Test Procedure	4.10.1	X		30 days prior to use
3	Fabrication and Assembly Procedures and Instructions	5.5.1	X		30 days prior to use
4	Process Qualification Procedures	5.5.2	X		30 days prior to use
5	NDT Procedures and Qualification Procedures	5.5.3	X		30 days prior to use
6	Cleaning Procedures	5.5.4	X		30 days prior to use
7	Inspection and Test Procedures	5.6.2	X		30 days prior to use
8	Certifications	5.6.5		X	With items submitted for acceptance
9	Sampling Plans	5.9 & 4.10.1	X		With response to RFQ
9.1	Changes to Sampling Plans	5.9 & 4.10.1	X		30 days prior to use
10	Quality Records	5.13		X	As appropriate
11	Quality Status Report	2.4.3		X	Monthly
12	Documentation of Nonconforming Items	5.10 & 4.11	X		As generated and prior to use

TABLE 2 - DOCUMENTATION SUBMITTAL REQUIREMENTS FOR CONFORMANCE WITH RDT F 2-4

Item	Description	Reference Paragraph of RDT F 2-4	Submit to Purchaser for		Time of Submittal to Purchaser
			Approval	Information	
1	Quality Verification Plan to include sampling plans	2.1.1	X		With response to RFQ
2	Inspection and Test Procedures	3.1	X		30 days Prior to use
3	Test Equipment Calibra- tion and Control Plan	6.0	X		With response to RFQ
4	Control of Nonconforming Items Procedure	7.0	X		With response to RFQ
5	Document Control Procedures	3.2	X		With response to RFQ
6	Identification and Marking Procedures	4.0	X		With response to RFQ
7	Audit Procedures	10.0	X		With response to RFQ
8	Audit Reports	10.0		X	As Generated
9	Corrective Action Procedures	8.0	X		With response to RFQ
10	Corrective Action Reports	8.0	X		As Generated
11	Inspection and Test Results to include Certifications	5.5		X	With Delivery of the Product
12	Documentation of Nonconforming Items	7.0	X		As generated and prior to use

TABLE 3 - QUALITY CONFORMANCE INSPECTION

Characteristic	Requirement	Inspection Plan	Reference Test Method
1 Fuel Assembly Component			
a) Component Materials	3.1.1	Certification	Supplier's records.
b) Components	3.1.2	Certification	Supplier's records.
2 Dimensions			
a) Lengths	3.2	Each fuel assembly and all components	Standard gaging.
b) Weld Surfaces	3.2	Each fuel assembly and all components	Standard gaging.
c) Straightness	3.2	Each fuel assembly	Standard gaging.
d) Alignment	3.2	Each fuel assembly	Finished fuel assemblies shall be inspected in the vertical position using standard gaging.
e) Twist	3.2	Each fuel assembly	Standard gaging.
3 Driver Fuel			
a) Fuel Pin Position	3.3.1	Certification	Supplier's records.
b) Fissile Content	3.3.2	Each fuel pin and assembly	Summation of individual fuel column fissile contents from fuel supplier's records.
4 Welds	3.4	Each weld	Supplier's records and test results in accordance with RDT F 6-2.
5 Fuel Assembly Weight	3.5	Each fuel assembly	Weigh and record (Accuracy $\pm$ 0.5 lb)

(Continued)

TABLE 3 - QUALITY CONFORMANCE INSPECTION (continued)

Characteristic	Requirement	Inspection Plan	Reference Test Method
6 Cleanliness	3.6.1	Each fuel assembly	Visual inspection, supplier's records, and wipe test.
7 Surface Texture	3.6.2	Each fuel assembly	Visual inspection and compare with roughness standards and reference profilometer readings. A mutually agreed upon roughness measurement method shall be used in case of disagreement.
8 Surface Marring	3.6.3	Each fuel assembly	Visual inspection.
9 Identification	3.7	Each fuel assembly	Standard gaging and visual inspection for readability & compliance with Ordering Data.
10 Workmanship	3.8	Each fuel assembly	Visual inspection.
11 Assembly Sequence	3.9.1	Certification	Supplier's records
12 Welding Processes	3.9.2	Certification	Supplier's records and inspection of weld qualification results.
13 Handling and Storage During Processing	3.9.3	Certification	Supplier's records.
14 Repair and Rework	3.10	Certification	Supplier's records.

4.7.3 Fuel assemblies released for shipment by the purchaser's inspector at the place of manufacture, but subsequently shown through specified tests or analysis prior to irradiation not to conform with this standard and Ordering Data, are subject to rejection.

4.8 Environmental Control of Measuring and Test Equipment. Measuring and test equipment and measuring standards shall be calibrated in accordance with RDT F 3-2.

4.9 Periodic, Progress and Critical Items Reports. Reports of progress in fabrication, inspection, and testing (quality status), and shipping shall be made at specified intervals. These reports shall relate the progress made since the last report with only enough repetition of previously reported events to frame the contents of the present report. These periodic reports shall also include difficulties encountered (such as failures and malfunctions) and the efforts made or planned for overcoming them. Problems foreseen as possible disruptions of the schedule shall be identified as critical items and brought to the attention of the purchaser as early as possible.

4.10 Determination of Compliance and Data Recording for Inspection and Test.

4.10.1 Tolerance Limit Interpretation. The following applies to all specified limits in this standard and Ordering Data.

a. Chemical Composition. For purposes of determining conformance with chemical composition requirements, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of ASTM E 29.

b. Tensile Requirements. For purposes of determining conformance with tensile requirements, an observed value or a calculated value shall be rounded off to the nearest 100 psi for tensile strength and to the nearest 0.1 percent for elongation, in accordance with the rounding-off method of ASTM E 29.

c. Dimensional Requirements. The method for determining conformance with dimensional requirements shall be as specified in the Ordering Data (rounding off or absolute method as defined in ASTM E 29).

4.10.2 Equipment/Technique Accuracy. Unless otherwise required or approved by the purchaser, determinations shall be made with equipment or techniques reading accurately as noted below.

a. Decimal Numbers. Use a device measuring in units no greater than 10 percent of the specified tolerance range. For limits specified as "minimum" or "maximum," use a device measuring in units to one decimal place beyond the characteristic specified.

b. Fractional Numbers. Use a device measuring in units no greater than one-eighth of the specified tolerance range.

c. Angles. Use a device measuring in increments no greater than 10 percent of the specified tolerance range.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Fuel assemblies shall be packaged in accordance with the Ordering Data to maintain conformance to this standard and RDT Standard F 7-2.

5.2 Shipping Container. A complete description of packing procedures and shipping containers, including drawings, shall be submitted to and approved by the purchaser before use.

5.3 Labeling. Each shipping container shall be clearly marked with the following information:

1. Purchase order number
2. Type of contained material identified by drawing number, revision number, and part number
3. Identification number to permit determining serial number of fuel assembly in container
4. Total fissile content
5. Radiation level
6. Date packaged
7. Center of gravity of shipping container
8. Weight
9. Name of supplier
10. Address of receiver

5.4 Handling. Handling of finished fuel assemblies shall be in accordance with RDT F 8-6.

6. NOTES AND ORDERING DATA CHECKLIST

6.1 Ordering Data Checklist. The detail requirements and conditions necessary to fabricate, examine, test, and deliver fuel assemblies in accordance with this standard are to be included in the Ordering Data. These requirements are also indicated in the Ordering Data Checklist. The Ordering Data Checklist includes topics to which this standard makes specific reference, as well as other supplemental information needing definition by the purchaser. The applicable paragraph number in this standard is used herein to identify information and its location. Any omission of an item in the Ordering Data indicates that the particular paragraph of the standard is believed to adequately specify the requirements.

<u>Item</u>	<u>Refer to Paragraph</u>
1. Other Documents	2.4
2. Drawings	2.5
3. Components	3.1.2
4. Dimensions	3.2
5. Fissile Content	3.3.2
6. Fuel Assembly Welds	3.4
7. Cleanliness	3.6.1
8. Surface Texture	3.6.2
9. Surface Marring	3.6.3
10. Identification	3.7
11. Welding Processes	3.9.2
12. Handling and Storage During Processing	3.9.3
13. Quality Assurance Program Requirements	4.1
14. Records	4.3
15. Certification Records Review	4.6.2
16. Tolerance Limit Interpretation - Dimensional Requirements	4.8.1
17. Packaging	5.1