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SNAP 8
EXPERIMENTAL REACTOR
FUEL ELEMENT
ACCEPTANCE TESTING
(Title Unclassified)

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SNAP REACTOR-
SNAP PROGRAM
M-3679 (33rd Ed.)

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SNAP 8
EXPERIMENTAL REACTOR
FUEL ELEMENT
ACCEPTANCE TESTING
(Title Unclassified)

By
H. J. HUBBELL
W. E. NAGEL

Exempt from CCRP Re-review Requirements
(per 7/22/82 Duff/Caudle memorandum)
HA
3/1/04

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ACKNOWLEDGMENT

Acknowledgment is made to the Fuel Element Production Development Group, from whose records this material was edited.

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ABSTRACT

This report outlines the Quality Test Program followed during the fabrication of the fuel elements for the SNAP 8 Experimental Reactor (S8ER) Core. The inspection and test methods applied are described. A summary of the inspection and test results obtained from the 215 fuel elements accepted for use in the S8ER Core is included. Manufacture of the fuel elements for this core was completed, and the elements were delivered, in September 1962.

I. INTRODUCTION

A. PURPOSE OF REPORT

This report describes the acceptance tests and inspections, summarizes the results of these tests, and explains some of the in-process controls for fuel and hydrogen barrier chemistry, during fabrication of the fuel elements for the S8ER Core.

B. QUALITY TEST PROGRAM PLANNING

The Quality Test Program was planned in coordination with the process engineering function of the Fuel Element Production Development Group. An important feature of the program was to establish inspection procedures, after the critical stages of manufacture. Because additional processing was not permitted until all quality requirements to these points were proven, or shown to be properly waived, they were termed upgrading points.

Seventeen upgrading points were selected, with the objective of assuring rapid detection of problem areas in the manufacturing process. The 17 points established for S8ER fuel element manufacture program were as follows:

Raw Material Receiving

- 1) Enriched uranium
- 2) Zirconium sponge
- 3) Hastelloy N (INOR-8) mill length tubing
- 4) Hastelloy N (INOR-8) bar stock

Fuel Alloy Manufacturing

- 5) Unhydrided fuel rods
- 6) Hydrided fuel rods
- 7) Finish machined hydrided fuel rods

Cladding Component Manufacturing

- 8) End cups
- 9) End caps

FABRICATION PROCESS SHEET
SNAP FUEL FABRICATION

Sheet No. _____ of _____

Description: Finished Fuel Element Test and Inspection		Project: SNAP 8	E.N. No.	Max Safe Lot Size:	PART NO. 7570-18011		
Material:		Enriched	G.O. No.	Rev. No.	Orig. By W. E. Nagel	INGOT NO.-LOT NO.	
		Normal		Date	Proc. Engr.	LOT QUAN.	
		Non-Fuel			Qual. Test		
Dept. No.	Seq. No.	Operation Description	Units Prod. Acc.	Rej.	By	Date	Remarks
733-33	1	Check element identification to requirements of Drawing No. 7570-18011.					
733-33	2	Check element Serial Numbers against assembly records and test records.					
754	3	Determine fuel to cup and cap end gap, using coated cup, coated tube, fuel rod dimension data. Record results on FEPDG Form 3-2-8.					
733-33	4	Determine helium and hydrogen leak rates of elements, as per AI Specification NA0212-007.					
754	5	Inspect for dimensions to requirements of Drawing No. 7570-18011, and record data on FEPDG Form 3-2-8.					
754	6	Zyglo inspect end plug up weld, using postemulsification process and ZL-22 penetrant. No indications permitted.					
733-33	7	Weigh to nearest 0.01 g, and record results on FEPDG Form 3-2-8.					
733-33	8	Verify, on Autoradiometric Analyzer, whether element contains enriched or normal fuel alloy.					
733-33	9	Release acceptable elements for packing and shipping.					

FORM 705-N

Figure 1. Fabrication Process "Test and Inspection" Sheet (Figure Unclassified)

10) End plugs

11) Tubes

Cladding Subassembly Manufacturing

12) Tube to end cap assemblies

13) Chromized tube to end cap assemblies

14) Coated tube to end cap assemblies

15) Chromized end cups

16) Coated end cups

Fuel Element Assembly

17) Finished fuel elements

Fabrication Process Test and Inspection sheets were prepared for each upgrading point. An example of the sheet, prepared for "Finished Fuel Elements," is shown in Figure 1. This sheet lists and describes each test and inspection operation. It also designates the forms used for recording data, and the forms used for disposition of the components.

The complete set of Fabrication Test and Inspection Process sheets obtained from the S8ER Core have been compiled in Technical Data Record NAA-SR-8283.

Included as routine quality test planning, but not covered in this report, were the gauge control, calibration schedules for process and test equipment and instrumentation, conformance of the inspection operations to criticality requirements, and source and special material management programs.

C. SUMMARY DESCRIPTION OF S8ER FUEL ELEMENTS

A total of 215 fuel elements were accepted for the S8ER Core; of these, 211 were assembled in the core. Each fuel element, as illustrated in Figure 2, contained a single fuel rod, in the form of a hydrided, solid uranium-zirconium alloy. The cladding envelope consisted of a tubing section, completed by an end plug and end cap, seal welded to the tubing. The interior of the cladding was coated with the 8763 D ceramic hydrogen barrier, developed by Atomics International. The barrier coating contained a burnable poison (Sm_2O_3), added to compensate for reactivity loss from fission product poison buildup and hydrogen loss.

a. Schematic

b. Components

7570-80210A

Figure 2. Fuel Element Assembly
(Figures Unclassified)

7568-5101A

The requirements from Specification No. 8ER1-180-001 "S8ER Fuel Element Assembly" have been compiled in Table I. Some dimension data, given in this specification, were superseded by subsequent drawing changes.

TABLE I

S8ER FUEL ELEMENT SPECIFICATION REQUIREMENTS

A. Uranium Requirements

U ²³⁵ Isotopic Enrichment	93.15 ± 0.15 wt %
Individual U Analysis	10.00 ± 0.60 wt %
U for Melt	10.00 ± 0.30 wt %
Total Weight U per Fuel Rod	30.40 ± 1.00 g
Distribution U per Linear Inch	2.17 ± 0.20 g

B. Hydrogen Content of Fuel Rod

Individual Fuel Rod	$6.0 \times 10^{22} \pm 0.20 \times 10^{22}$ atoms/cc
Average for 211 Element Core	$6.0 \times 10^{22} \pm 0.10 \times 10^{22}$ atoms/cc

C. Sm₂O₃ Poison Requirement

Distribution Sm ₂ O ₃ per Linear Inch	$3.42 \times 10^{-3} \pm 1.00 \times 10^{-3}$ g
Total Weight in Core	10.11 ± 1.01 g

D. Hydrogen Barrier Leak Rate Requirement

Leak Rate per Element	1.60 cc (STP)/hr maximum at 1400°F isothermal
-----------------------	---

E. Thermal Cycle Requirements

One cycle startup condition to 1450°F at 50°F/min maximum

F. Fuel Element Dimensions

Diameter	0.560 ± 0.001 in.
Length (Excluding Grid Pins)	14.470 ± 0.007 in.
Straightness (TIR)	0.008 in. (maximum)
Out of Roundness	0.001 in. (maximum)
Concentricity of Fuel Element and Indexing Rim	0.001 in. (maximum)
End Gap	0.025 ± 0.009 in.
Average Radial Gap	0.001 to 0.003 in.
Diameter of Grid Pins	0.140 ± 0.001 in.
Grid Pin Diameter Concentric with Cladding Tube	0.002 in. (maximum)
Envelope Diameter*	0.570 in. (maximum)

G. Helium Leak Test

Fuel Tube Assembly	No leak allowable at 1×10^{-7} cc/sec sensitivity
Blend Test	No leak allowable

*Diameter of smallest true cylinder within which entire fuel element would fit.

II. QUALITY TEST PROGRAM

A. FUEL ROD INSPECTION AND TESTS

1. Fuel Rod Fabrication Process Description

The fuel rods were extruded from triple arc melted 10% U - 90% Zr alloy billets. The fuel rods were hydrided to a nominal 1.60 wt % H before finish machining.

Raw materials for the fuel alloy consisted of minus 3/8-in. mesh zirconium sponge and 3/16-in. cubes of uranium metal. Zirconium carbide was added to later melts, after it was found that carbon reduced the cracking during hydriding. These materials were cold pressed into 1-in. square by 10-in. long compacts.

Three compacts were joined together by Heliarc welding, to form an electrode, 30 in. long. Two electrodes were consumably arc melted in an argon atmosphere, to produce a primary billet. Three primary billets were welded, end to end, and remelted in vacuum to homogenize the alloy.

The double arc melted billet was extruded, and then cut into four equal lengths. Each length was separately remelted in vacuum. These billets were extruded to nominal fuel rod diameter, and cut into fuel rod lengths. Each extrusion normally yielded four fuel rods.

As the extrusions were cut into fuel rods, samples for chemical analyses were obtained from each end of the extrusion and from between each of the fuel rods. Fuel rod and sample identification was coded to their positions in the extrusion, the extrusion identification, and the original melt number.

Fuel rods were hydrided in groups of eight. Rod surfaces were prepared for hydriding by grinding. The hydriding process was controlled by regulating the temperature and the hydrogen pressure within the furnace retort. When necessary, the hydrogen content of the rods was adjusted by rehydriding.

2. Fuel Rod Inspection

a. Fuel Alloy Raw Materials

Specifications were prepared and released for the procurement of the uranium⁷ and zirconium⁴. These specifications required that certified test

results be supplied with the material. Chemical analyses were routinely performed on the uranium and zirconium raw material, upon receipt at Atomics International. An in-process material identification and records program was instituted, to maintain positive control of all materials from the raw material state to the finished product.

b. Fuel Alloy Chemical Composition

(1) Uranium

X-ray fluorescence uranium analyses were performed on the solid wafer samples removed from the extrusions. With this technique, the uranium present was determined, in weight percent, from a calibrated curve prepared from NBS standard samples. The ratio of the intensity of uranium to the intensity of zirconium was plotted against the percent uranium. Based on repeated analyses, the standard deviation for this analytical technique was found to be 0.02 wt % U.

Individual uranium analytical results were required to meet the 10.00 ± 0.60 value; the averages of all five results from each extrusion were required to be within 10.00 ± 0.30 wt % U.

(2) Carbon

In those melts made, using carbon as an additive, volumetric carbon analyses were performed on drillings taken from the uranium sample wafers. The average carbon content of each fuel rod was determined from the samples taken from each end of a fuel rod.

(3) Impurities

Samples for impurity analyses were obtained from the sample wafers cut from the center of the extrusions. Oxygen analyses was performed by the vacuum fusion method, nitrogen analyses by the Kjeldahl method, and the other impurities were analyzed by an emission spectograph. The elements, and the ranges in which they were found to be present, are given in Table II.

(4) Hydrogen

Samples for hydrogen analyses were removed from each end of the hydrided fuel rods with a cutoff wheel. It was necessary to use a coolant, to avoid overheating the samples during their removal.

TABLE II
FUEL ALLOY IMPURITIES

Element	Range of Analytical Results (ppm)
Al	5-25
B	0.5-10
Ba	<5-30
Be	<0.5-2
Bi	<5
Ca	<10
Cd	<0.5-1
Co	1-6
Cr	25-75
Cu	30-800
Fe	75-2000
Li	<2-5
Mg	<1-10
Mn	<3-15
Mo	<10-45
Na	<50-175
Ni	<5-70
Pb	<2-80
Si	5-1500
Sn	<2-5
Ta	<5
V	<2
Zn	<25-325
O	1200-1800
N	150-350

Hydrogen analyses were performed, using a hot vacuum extraction analytical technique. With this technique, the sample was heated to approximately 1250°C, under vacuum. In this situation, hydrogen was quantitatively released, and the oxygen and nitrogen retained. The amount of hydrogen present was determined by direct volumetric measurements. The standard practice of conducting two analyses on a submitted sample is believed to have limited the total analytical error to ± 0.015 wt % H.

c. Final Acceptance

(1) Inspection

Finished machined fuel rods were dimensionally inspected, weighed, and their liquid-displacement densities were determined. They were visually inspected, using a 4 to 6X magnifying viewer. Surface discontinuities, such as cracks, pits, seams, or laps in the fuel rods were not permissible, within the limitations shown in Table III.

TABLE III
LIMITATIONS FOR FUEL ROD SURFACE DEFECTS

Individual Discontinuity Size		Discontinuity Distribution	Permissible Discontinuity Concentration
Length	Width		
1/4 in. or less	0.010 in. or less	Grouped	6 or less in any 1 in. ²
More than 1/4 in. but equal to or less than 1 in.	0.010 in.	Isolated	12 or less per rod
Any length	0.010 in. or less	In line arrangements, with a minimum of 1/4 in. spacing between discontinuities	Groups of discontinuities, 1 in. or less in total group length

Note:

Circumferential discontinuities, 1/4 in. or less in length, and discontinuities which do not enclose a finite surface area, were allowed.

(2) Determination of Fuel Rod Hydrogen, Density, and
Weight of Contained Uranium

(a) Total Weight of Uranium Contained in a Fuel Rod

The final net weight of the fuel rod was adjusted to compensate for the uranium x-ray fluorescence analysis having been performed prior to hydriding. The average weight percent uranium for the extrusion was used to make the calculation:

$$U_{\text{Rod}} = [\text{Rod Wt} - \text{Rod Wt (H\%)}] U\%_{\text{avg}}$$

(b) Maximum and Minimum Weight of Uranium per Linear
Inch of Fuel Rod

The maximum and minimum of the uranium x-ray fluorescence analytical results obtained from the final extrusion were used in making the calculations:

$$\text{(Maximum) U/in. of Rod} = \frac{[\text{Rod Wt} - \text{Rod Wt (H\%)}] U\%_{\text{max}}}{\text{Length of Rod in Inches}}$$

$$\text{(Minimum) U/in. of Rod} = \frac{[\text{Rod Wt} - \text{Rod Wt (H\%)}] U\%_{\text{min}}}{\text{Length of Rod in Inches}}$$

Note: The reduced diameter section and the radius of the fuel rod were not included in these calculations.

(c) Number of Hydrogen Atoms per Cubic Centimeter (N_H)

N_H is defined as the number of hydrogen atoms per cubic centimeter of fuel, multiplied by 10^{-22} . This gives a convenient hydrogen content value that can be rapidly converted to direct measurement of hydrogen content ($N_H = \text{Hydrogen Density} \times 10^{-22}$).

$$\text{Hydrogen Density} = \frac{\text{wt \% H}}{100} \times \text{Density of Rod (g/cc)}$$

$$\times \frac{6.024 \times 10^{23} \text{ (Avagadro's Number)}}{1.008 \text{ (mole H)}}$$

(3) Autoradiometric Measurements

Each finished machined fuel rod was tested by gamma autoradiometry, to determine the distribution of the U^{235} within a fuel rod, and to preclude gross variations. Acceptance was based on a comparison of the fuel rod count rate to the count rate obtained from a standard fuel rod. The standard was a production fuel rod containing a 9.90 ± 0.07 wt % of 92.46% enriched uranium (determined by three separate laboratory analyses). The standard was run before and after each group of fuel rods tested.

The autoradiometric analyzer was designed to measure the intensity of the 0.185 Mev gamma from the U^{235} radiation. The test system utilized a mechanical scanning device, for traversing a collimated scintillation counter along the length of the fuel rod as the fuel rod rotated. The collimator, for each revolution of the fuel rod, moved 1 in. in 50 sec. The collimator opening was 1 in. in length by 1/4 in. wide. A digital recorder was provided, to determine the uranium content in each linear inch of the fuel rod. An auxiliary scaler was included, for measuring the total uranium in the rod. The count rate was continuously recorded on a strip chart, which showed any variation in uranium content as a function of fuel rod circumference and length.

The fuel element test and inspection data were recorded on the form shown in Figure 3.

B. CLADDING COMPONENT INSPECTION AND TESTS

1. Cladding Raw Material

The supplier was required to furnish certified test results with the material. On receipt of the material at Atomics International, samples were taken for chemical and physical tests, to assure compliance with requirements and correct identification of the material. The test results obtained from the cladding material used in the S8ER fuel elements are listed in Table IV.

REPORT NO. _____

SNAP 8 FUEL ROD NO. _____ INSPECTION AND TEST DATA SHEET

TIR 1	
TIR 2	
TIR 3	
TIR 4	

D1 max.	
D1 min.	
D2	

L1	
L2	
R1	
R2	

Autoradiometric Measurements	
Total Counts	
Max. Counts/in.	
Min. Counts/in.	

Rod Melt No.	
Uranium Lot No.	
Isotopic Content	
Zirconium Lot No.	
Extrusion No.	
Location in Extrusion	
Impurity Analysis	
Avg. wt %	
Min. wt %	
Max. wt %	

H ₂ Furnace Run No.	
Avg. wt % H ₂	
Max. wt % H ₂	
Min. wt % H ₂	
N _H	
Total Wt. U in Rod	
Max. Wt. U/in.	
Min. Wt. U/in.	
Avg. wt % U	

Penetrant Inspection	
Visual Inspection	
Cleanliness	
Wt. of Rod	
Density of Rod	
Photographs	

Prepared By _____
 Date _____
 Approved By _____
 Date _____

Figure 3. SNAP 8 Fuel Rod Inspection and Test Data Sheet
 (Figure Unclassified)

TABLE IV
S8ER INOR-8 (HASTELLOY N) CLADDING CHEMICAL COM-
POSITION AND MECHANICAL PROPERTIES

Element	Chemical Composition (wt %)	
	Tubing (Heat No. Y8437)	5/8-in. Diameter Bar (Heat No. D2-0415)
Ni	74.17	Balance
Mo	15.85	16.77
Cr	6.53	7.09
Fe	2.53	4.27
C	0.07	0.08
Mn	0.30	0.49
Si	0.11	0.30
Al + Ti	0.40	0.02
Cu	0.01	0.01
S	0.007	0.008
B	0.005	0.005
O	0.0094	0.004
N	0.0028	0.001
H	0.0002	0.0002
P	—	0.003
Ta	0.024	—
W	—	0.04
Co	—	0.04

Mechanical Properties			
	Ultimate Tensile Strength (lb/in. ²)	Yield Strength* (lb/in. ²)	Elongation (% in 4D)
Heat No. Y8437	(a) 140,800	63,000	44.0
	(b) 138,300	66,800	49.0
	(c) 137,600	64,200	49.0
	(d) 137,900	63,900	48.0
	(a) 119,500	47,500	51.0
Heat No. D2-0415			

*At 0.2% offset

The cladding tubing, on receipt, was subjected to an extensive dimensional inspection test program. Ring and plug air gauges were used to measure the OD and ID, and resonance ultrasonic test equipment was used to measure wall thickness. Eddy current testing was used to examine the tubing for discontinuities. A section of production tubing was prepared as a standard. Three sets of 0.010-, 0.020-, and 0.030-in. diameter holes were drilled along the length of the tube. The eddy current equipment was calibrated to detect the holes

in the standard. Some of the production tubing was rejected by the eddy current test, because it contained a variation in the tubing wall thickness which produced eddy current indications in excess of the standards. This tubing was subsequently inspected, using a special immersion ultrasonic technique developed by a commercial laboratory for thin wall tubing. The ultrasonic test equipment was calibrated with a standard, prepared from a 4-ft length of production tubing with a 1/2-in. long by 0.0012-in. deep notch inscribed on the outside surface, parallel to the tube length.

2. End Cap and Plug

These components were machined from bar stock. Their test program consisted of dimension and fluorescent penetrant inspection, using ZL-22 penetrant and postemulsification technique. The diameters and wall thicknesses of the end caps were controlled, to match the tube diameters and wall thicknesses when they were welded into the fuel tube assembly.

3. Coated Fuel Tube Assembly

This assembly consists of a 16-in. length of tubing joined to an end cap, using tungsten inert gas (TIG) fusion welding. The weld quality was evaluated, using a special high-resolution radiographic technique that utilized a fine focal spot (0.4 mm) x-ray tube and double-loaded, single-emulsion, extra-fine-grain film.

To aid in the measurements of tube wall thinning in the weld zone, a penetrameter was made from material which was radiographically similar to the cladding tubing. It was notched to 4, 10, 20, and 30% of the tube wall thickness. Holes, 0.005, 0.010, and 0.020 in. in diameter, were drilled to the same depths as the notches.

The penetrameter was radiographed with each group of welded fuel tubes. The density of the images produced by the penetrameter was used as a means of comparison for estimating the magnitude of defects in the weld zone. Weld defects of nonfusion or wall thinning (0.001 in. deep), and porosity (0.003 in. in diameter) were readily detected in the production radiography of the fuel tubes. A cross check of flaw measurements by four inspectors disclosed that an average accuracy of <0.001 in. could be achieved.

Each assembly was hydrostatically pressure tested at 1200 psig for 1 min. This pressure stressed the cladding to about 80% of the minimum guaranteed yield strength of the alloy. The helium leak test was performed by evacuating the interior of the tube and spraying helium over the exterior surface. The exterior surface of the weld was penetrant inspected, using ZL-22 penetrant and the postemulsification technique. Dimension inspection consisted of measuring the fuel tube OD, straightness, and wall thickness. The test results and measurement data from each tube assembly were recorded on the form shown in Figure 4.

A layer of chromium was deposited, by a thermal decomposition process, on the cladding prior to coating. This prevented the molybdenum in the alloy from oxidizing to the volatile MoO_3 at the ceramic firing temperature, which would result in a porosity in the ceramic. This chromizing process was proprietary, and was performed at a supplier's facility. A section of cladding tubing, for use as a process control specimen, was chromized with each lot of fuel tubes. The chromium layer thickness was measured metallographically from a sample of the control specimen. The chromizing quality was evaluated by heating the control specimen in air to 1900°F for 15 min and air cooling to room temperature. Excessive spalling of the chromium oxide layer, which formed during firing, was found by experience to be associated with poor coating quality.

Subsequent to the chromizing operation, the tubes were hydrogen outgassed, by heating to a temperature of 1800°F in a 10^{-4} torr vacuum for 12 hr. After these thermal treatments, it was necessary to straighten the tubes, prior to the hydrogen barrier coating operation. The straightening was accomplished by stretching and then rolling the tube over a mandrel. The ceramic hydrogen barrier coating was applied to the interior surface of the tubes by alternately applying a slip and then firing, until the required inside diameter was obtained.

The weight of coating was determined from the weight gain of the chromized fuel tube assembly. Coating thickness was measured with a Dermitron eddy current test instrument. The probes used with this instrument were designed to match the coated tube interior profile. The coating was examined for surface flaws with a Boroscope. Measurement of the coated assembly true circular ID was made, using a six-jet averaging air gauge plug, connected to a

REPORT NO. _____ SNAP 8 CAN NO. _____ INSPECTION AND TEST DATA SHEET

PLUG

CUP

TUBE TO CAP SUB-ASSEMBLY (CAN)

WELD

	Plug	Cup	Cap		Bare Can	Chromized Can	Coated Can
Material Type				Inside Diameter			
P. O. No.				Max. OD			
Heat No.				Min. OD			
Ultrasonic Insp.*				Avg. OD			
Dimensional Insp.				Ovality			
Penetrant Insp.				Max. TIR			

*Bar Stock Only

Tube No. _____	Sub-Assembly	Coated Cup
Material Type	Hydrostatic Test	Coating Type
P. O. No.	X-Ray Weld	Batch No.
Heat No.	Penetrant Inspection	Coating Thickness
Max. Wall Thickness	Chromizing Thickness	Visual Inspection
Min. Wall Thickness	Chromizing Firing Test	Dimensional Insp.
Max. TIR	Coating Type	Outside Diameter
Eddy Current Test	Coating Batch No.	Prepared By _____
	Coating Thickness	Date _____
	Total Wt. Poison	Approved By _____
	Wt. Poison/in. Tube	Date _____
	Boroscope Examination	
	Adherence Test	

Figure 4. SNAP 8 Can Inspection and Test Data Sheet
(Figure Unclassified)

recorder. The recorder trace presented a profile of the full length of the fuel tube interior. This data was required to determine the average fuel-to-cladding radial gap, and to insure the necessary blend cup interference fit.

Two ring samples were removed from the open end of each coated fuel tube. One sample was deflected 1/8 in., and the coating was examined for evidence of poor adherence to the cladding tube.

One sample, immediately adjacent to the final cut surface, was cut to 0.500 ± 0.010 in. length, and was used to determine the Sm_2O_3 poison content. This technique consisted of mechanically removing all the coating from the 0.500 in. sample, weighing the coating, and determining the wt % Sm_2O_3 by x-ray fluorescence. The wt % Sm_2O_3 was determined from a calibration curve constructed from prepared standards. On the basis of repeated analyses of prepared samples, the accuracy of this analytical technique was rated at 0.03 wt %. A mg/in. value for Sm_2O_3 content was calculated from the sample data. This value, multiplied by the nominal fuel rod length, gave the effective Sm_2O_3 per tube, from which the total amount in the core was determined. This Sm_2O_3 test procedure was based on the results obtained from the destructive test program, described in Section II-D-2, which indicated no significant difference in sample position.

4. Coated Cup

These components were machined from bar stock. They were dimension inspected, before and after being processed through chromizing, outgassing, and coating.

The test program for the coated cups was similar to that described for the coated cladding tubes. The cup coating, however, did not contain a poison. The outside diameter of the coated cup was used to select the coated cup for an interference fit with the inside diameter of the coated fuel tube.

C. FUEL ELEMENT ASSEMBLY INSPECTION AND TESTS

1. Assembly Process Description

The fuel rod was inserted in the coated fuel tube; and this assembly was placed in the blending fixture, which was evacuated and then back filled with 0.1 atm of helium. An induction coil was used to heat and expand the open end

REPORT NO. _____ SNAP 8 INSPECTION AND TEST DATA SHEET

FUEL ELEMENT NO. ____ FUEL ROD NO. ____ CAN NO. ____

L1	
L2 @ 0°	
L2 @ 120°	
L2 @ 240°	
L3	
L4	

	Minimum	Maximum	Ovality
D1			
D2			
D3			
D4†			
D5			

TIR 1	
TIR 2	
TIR 3*	
TIR 4	
TIR 5	

TIR readings are relative to centerline of pins
 *TIR 3 is the maximum TIR of the full length of the fuel element
 It is located ____ inches from the numbered end.
 †Diameter of weld

Helium Leak Test	
End Weld Penetrant Inspection	
Visual Inspection	
Fuel Element End Gap	
Final Wt. of Fuel Element	
Fuel Element Radial Gap	

Verification of Enrichment	
Permeation Rate	
Permeation Rate	

Prepared By _____ Date _____
 Approved By _____ Date _____

Figure 5. SNAP 8 Fuel Element Inspection and Test Data Sheet
 (Figure Unclassified)

of the assembly. A coated cup was inserted, flush with expanded end; and the tube and cup were brought to a temperature, where their coatings fused. This phase of the process was programmed by an infrared temperature control.

Immediately following blending, the blended end was helium leak tested. The end plug was then added to the blended cup end of the assembly, and TIG fusion welded to the tube assembly in a helium argon atmosphere, to complete the fuel element assembly.

2. Assembly Inspection

At the assembly site, the Inspection and Test Data Sheets for the fuel rod and the coated fuel tube were attached to the Fuel Element Assembly Inspection and Test Data Sheet shown in Figure 5. The Fuel Element Data Sheet was completed by recording the following inspection and test data:

a. Radial and Axial Gap Dimension

An average radial gap dimension was calculated, for each assembled element, as being one-half the difference between the fuel rod diameter and the coated fuel tube inside diameter.

The fuel element axial gap was calculated as being equal to the difference between the inside length of the coated fuel tube and the total combined length of the fuel rod and the coated cup. These measurements were verified by periodic in-process dimensional inspections. Attempts to use radiography to perform this measurement did not prove successful.

b. Permeation Test

The permeation test² was intended to measure the total leak rate of hydrogen from the fuel elements at an isothermal temperature of 1400°F, simulating the maximum reactor operating temperature.

The permeation test system consisted of two CEC Helium Mass Spectrometer Leak Detectors, modified to detect both helium and hydrogen. A bank of electrical resistance furnaces, containing mullite or Vycor furnace tubes, was connected by manifold to the mass spectrometer. The furnaces provided isothermal ($\pm 10^\circ\text{F}$) zones for the fuel element length. The heating rate was controlled, so as not to exceed $50^\circ\text{F}/\text{min}$, with the actual heating rate being 30 to $35^\circ\text{F}/\text{min}$.

During the initial 300°F rise, each fuel element was helium leak tested, to assure the integrity of the closure weld. The fuel element was then brought to the thermal cycle proof temperature of 1450°F, and held for 15 min, while again being leak tested for helium.

The mass spectrometer was switched from the helium to the hydrogen leak detection position. The temperature was reduced to 1400°F, to perform the hydrogen leak testing. The element was maintained at this temperature for a minimum of 2 hr. The hydrogen leak rate was taken as the final meter deflection observed during a half-hour interval in which the deflection did not change by more than 1-1/2 scale divisions. The fuel element was cooled to less than 750°F, at a rate not exceeding 50°F/min, before opening the furnace and cooling the fuel element to room temperature.

A three-point, least squares calibration, using standard hydrogen leaks, was performed at the start of each working week. The standard hydrogen leaks were of the constant pressure type. The leaks were operated in a constant temperature bath, with the inlet hydrogen gas pressure regulated to provide the constant pressure of 980 mm Hg, for which the leak was calibrated. Constant pressure standard leaks were in the range of 0.10 to 1.50 cc (STP)/hr.

A one-point calibration, using the largest of the three standard leaks, was performed at the start of each working shift. If a deviation larger than 10% of a scale reading was observed from one single-point calibration to the next, a three-point calibration was performed.

A linear calibration equation for the mass spectrometer was computed, by the method of least squares, as follows:

$$Y(\text{cc/hr}) = a(X_S - X_B) + b \quad ,$$

with:

$$a = \frac{3(X_S - X_B)(SL) - (X_S - X_B)(SL)}{3(X_S - X_B)^2 - (X_S - X_B)^2} \quad ,$$

$$b = \frac{(SL) - a(X_S - X_B)}{3}$$

where:

SL = The leak rate (cc/hr) of each particular
hydrogen standard leak used

X_S = Standard Leak Spectrometer deflection

X_B = Spectrometer background (was neglected, if less
than 10 divisions)

Y = Hydrogen flow rate [cc (STP)/hr]

a, b = Constants

for the three-point calibration. Figure 6 illustrates the linearity of the least squares curve vs an actual plot of the three calibration points.

Figure 6. Permeation Test Calibration Curve

Experience showed that the intercept value (b) does not change appreciably, within a 1-week operating period. Therefore, with the one-point calibrations, the value of (b), found from the three-point calibration, was used; and a new value of (a) was computed as follows:

$$a = \frac{(SL - b)}{(X_S - X_B)}$$

The furnace tube background rate (ϕ_F) was computed as follows:

$$\phi_F \text{ (cc/hr)} = a (X_F - X_B) + b \quad ,$$

where:

X_F = The final scale division at the end of a 10-min interval, in which the meter deflection change is equal to or less than 1.5 meter divisions (between 18 and 90 divisions).

The fuel element hydrogen permeation rate (ϕ_E) was computed as follows:

$$\phi_E = a (X_E - X_B) + b - \phi_F \quad ,$$

where:

X_E = Spectrometer deflection at the end of a final half-hour interval of permeation testing the fuel element.

An error analysis was initiated for the purpose of assigning 95% confidence limits to fuel element hydrogen permeation rate determinations. The analysis to date indicated that a hydrogen leak detector, calibrated daily with three hydrogen standard leaks, on the average, measures fuel element hydrogen permeation rate to ± 0.05 cc (STP)/hr for 95% confidence level. The analysis was extended to determine the added error where a detector was calibrated daily, using only one hydrogen standard leak. The results indicated the added errors seldom exceed ± 0.01 cc (STP)/hr.

Helium leak test calibration was accomplished daily. A glass leak was used to calibrate the spectrometer to 10^{-7} cc/sec helium sensitivity.

c. Postpermeation Test Inspection

Following the permeation test, the closure weld was penetrant inspected, final dimensional inspection was performed, and the final weight determined. All measurements were recorded on the data sheet shown in Figure 5.

The maximum envelope diameter measurements were obtained by placing the grid pins, located at the end of the fuel element, in V-blocks on a surface table, and determining the true centerline. The surface of the fuel

element was scanned by revolving the fuel element under a dial indicator. The distance from the point of maximum positive deflection to the centerline was measured. This radius value was doubled, to represent the maximum envelope diameter.

d. Enrichment Verification

The final test performed on each element was a verification of its type (i.e., enriched or natural uranium alloy). The Autoradiometric Uranium Analyzer was used to measure the intensity of the 0.18 Mev gamma radiation from U^{235} . It was established that the count rate from the enriched fuel elements was approximately 20 times greater than the rate from fuel elements containing natural uranium. The instrument was calibrated with a fuel element of known enrichment.

e. Packaging

The elements were packaged for storage and shipment. The inspection of the packaging of the fuel elements concluded the Quality Test Program.

D. DESTRUCTIVE TEST PROGRAM

1. Hydrogen Content and Distribution

To establish the correlation between the end sample gas analysis measurements and the total hydrogen content and distribution in the fuel rods, 17 fuel rods were destroyed and analyzed for their hydrogen content. Samples were obtained by taking four slices from each fuel rod, one from each end, one from one-third, and one from two-thirds, of the rod length. These samples were subsampled, to check the homogeneity of hydrogen content within the rod, both diametrically and horizontally. Duplicate hydrogen analyses were performed on each sample. The analytical results obtained are listed in Table V.

The analysis of variance technique was applied to determine hydrogen homogeneity within individual rods. This analysis indicated that there was no significant difference between samples taken from the center of the slices and those taken from the edge. There was no significant difference in results obtained from the four slices for each individual rod. The analysis indicated that the hydrogen content was homogenous, both diametrically and horizontally, throughout the individual fuel rods.

TABLE V
HYDROGEN CONTENT AND DISTRIBUTION IN FUEL RODS
REPRESENTATIVE OF S8ER FUEL

Fuel Rod Serial Number	Cross- Section Location	Hydrogen Analysis Results (wt %)						
		Sample Position Along Length				Location Average	Rod Average	Fuel Rod End Samples
		1	2	3	4			
550B-1	Surface Center	1.59	1.63	1.62	1.61	1.61	1.62	1.62
		1.63	1.61	1.62	1.60	1.62		
550B-4	Surface Center	1.62	1.64	1.64	1.62	1.63	1.63	1.63
		1.62	1.61	1.63	1.67	1.63		
555D-4	Surface Center	1.66	1.64	1.64	1.62	1.64	1.64	1.64
		1.62	1.62	1.61	1.66	1.63		
556B-2	Surface Center	1.62	1.62	1.61	1.62	1.62	1.62	1.64
		1.63	1.63	1.63	1.62	1.63		
556C-4	Surface Center	1.61	1.62	1.63	1.63	1.62	1.62	1.66
		1.58	1.61	1.63	1.61	1.61		
556D-4	Surface Center	1.65	1.63	1.65	1.64	1.64	1.64	1.65
		1.66	1.62	1.65	1.66	1.65		
557B-4	Surface Center	1.62	1.65	1.62	1.63	1.63	1.62	1.62
		1.63	1.61	1.62	1.58	1.61		
558B-3	Surface Center	1.60	1.62	1.64	1.61	1.62	1.62	1.63
		1.62	1.62	1.60	1.60	1.61		
560A-4	Surface Center	1.58	1.59	1.57	1.61	1.59	1.58	1.58
		1.58	1.59	1.60	1.56	1.58		
561A-3	Surface Center	1.55	1.60	1.59	1.61	1.59	1.59	1.59
		1.56	1.60	1.59	1.60	1.59		
562B-3	Surface Center	1.56	1.57	1.58	1.56	1.57	1.56	1.59
		1.57	1.58	1.55	1.56	1.56		
564D-1	Surface Center	1.62	1.64	1.62	1.61	1.62	1.62	1.62
		1.63	1.62	1.63	1.61	1.62		
565D-2	Surface Center	1.61	1.61	1.60	1.62	1.61	1.60	1.62
		1.59	1.60	1.60	1.61	1.60		
567D-1	Surface Center	1.56	1.55	1.57	1.54	1.55	1.55	1.57
		1.56	1.54	1.56	1.53	1.55		
568B-2	Surface Center	1.60	1.59	1.59	1.62	1.60	1.60	1.59
		1.59	1.59	1.59	1.60	1.59		
570C-1	Surface Center	1.60	1.61	1.61	1.60	1.61	1.61	1.60
		1.60	1.62	1.61	1.61	1.61		
556A-2	Surface Center	1.60	1.61	1.60	1.59	1.60	1.61	1.69
		1.62	1.61	1.58	1.64	1.61		

Test Sample Locations:

Notes:

- (1) "ES" designates the hydrogen end sample locations for unmachined fuel rods.
- (2) "S" and "C" designate the hydrogen surface and center sample locations for the fuel rods after being machined to size.
- (3) Positions 1, 2, 3, and 4 were approximately 1/3 of the machined fuel rod length apart.

Test data generated from the analyses of samples taken from the top and bottom of each of the eight rods was compared with the data for the whole rod. This analysis indicated no significant difference, and that it was feasible to analyze samples from the ends of fuel rods, to determine the hydrogen content of the fuel rods.

Cochran's test technique was used to determine if there was a significant difference between the estimated standard deviation between the rods. The test indicated there was no significant difference, indicating that the sampling technique and chemical analyses were good.

2. Sm_2O_3 Content and Distribution

Fourteen coated fuel tube assemblies were destructively tested, to assure that a sample taken from the end of the tube assembly could be used to determine the Sm_2O_3 content of the fuel tube. Five 1/2-in. samples were taken from equally spaced locations from each destructive tube, and analyzed for Sm_2O_3 , as described in Section II-B-3. The results obtained from these destructive tests are listed in Table VI.

The one-way analysis of variance technique was employed to determine whether a significant difference existed among the average Sm_2O_3 contents, as determined at five different positions. Results of this analysis indicated no significant difference in the averages at the 0.95 confidence level.

TABLE VI
COATED FUEL TUBE Sm_2O_3 CONTENT (mg/in.)

Fuel Tube Number	Sample Position				
	1	2	3	4	5
130	2.9	3.1	2.5	2.9	2.9
160	3.0	2.9	2.5	2.8	2.9
168	2.6	2.7	3.1	3.0	2.8
189	3.2	3.2	3.2	3.1	3.5
200	2.8	2.6	2.5	2.7	2.7
223	2.7	2.9	2.6	2.7	2.8
277	2.2	2.6	2.8	2.7	3.1
284	2.5	3.1	2.6	2.8	2.9
301	2.8	2.2	2.8	2.5	2.7
305	2.7	2.6	3.0	3.1	2.8
320	2.3	2.8	2.5	3.0	2.5
327	2.2	2.5	2.9	3.0	3.5
363	2.3	2.5	2.5	2.5	2.4
467	<u>2.9</u>	<u>3.1</u>	<u>3.4</u>	<u>3.3</u>	<u>3.6</u>
Average	2.65	2.77	2.78	2.86	2.94

III. RESULTS

A summary of all of the original inspection and test results from the 215 fuel elements accepted for the S8ER core is presented in the Appendix. The data are arranged in groupings, to agree with Fuel Rod, Fuel Tube, and Fuel Element Inspection and Test Data Sheets. All of the original data sheets have been compiled into NAA-SR-MEMO-7623. This memo also contains project approval of all measurements listed that deviate from specification requirements.

The 215 fuel elements contained a total weight of 9.69 g of Sm_2O_3 . Because only 211 of these elements will be used in the core, the average values for some measurements were computed, and are listed in Table VII. In some instances,

TABLE VII
S8ER FUEL ELEMENT AVERAGE INSPECTION
AND TEST RESULTS

	Average	Standard Deviation
Fuel Element Length Minus Grid Pins (in.)	14.469	0.005
Fuel Element Diameter (in.)	0.562	0.002
Fuel Element Maximum TIR (in.)	0.0073	—
Fuel Element Radial Gap (in.)	0.0016	0.0003
Fuel Element Axial Gap (in.)	0.024	0.0002
Fuel Element Envelope Diameter (in.)	0.569	0.003
Hydrogen Leak Rate (cc/hr at 1400°F)	0.569	—
Sm_2O_3 Weight Per Inch of Fuel Rod Length (mg)	3.20	0.45
U Weight Per Inch of Fuel Rod Length (g)	2.18	—
N_H	5.96	0.090
Fuel Element Net Weight (g)	367.00	1.2
Fuel Rod Net Weight (g)	309.653	—
U Total Weight (g)	30.40	0.04
U^{235} (wt %)	93.15	0.015
Cladding Wall Thickness (in.)	0.0104	—
Coating Thickness (in.)	0.0022	—
Carbon* (wt %)	0.5	—

*For 188 fuel rods containing carbon

the standard deviation was calculated, to determine test result variations to evaluate the quality test program.

On the average, the characteristics of these fuel elements met, or were better than, the specified requirements for the S8ER. This was particularly true of the hydrogen retention. The average permeation rate for the 211 elements was 0.54 cc H₂(STP)/hr/fuel element at 1400°F isothermal, compared to the maximum specified value of 1.60 cc/hr under the same conditions.

Overall average yield of S8ER Fuel Elements through permeation testing was 81%. The main assignable reason for rejection due to permeation rates was a tight fit between fuel rod and ceramic during assembly. The force fit problem was eliminated, as an incidental result of a requirement for increased diametrical clearance to allow for fuel swelling.

Although most of the elements had one or more minor dimensional deviations, only seven elements were rejected for this reason. These deviations are noted in Table VIII. It should be noted that maximum ovality, diameter, bow, and concentricity are all combined in the envelope determinations.

TABLE VIII
PERCENT DEFECTIVE OF 215 S8ER ELEMENTS

Specification Requirement	Percent Defective
Assembly must fit through 0.570 in. envelope	40
Grid pins concentric with cladding tube, within 0.002 in. TIR	21
Diameter of grid pins, 0.140 ± 0.001 in.	14
Average radial gap, 0.001 to 0.003 in.	5
Length, 14.470 ± 0.007 in. (excluding grid pins)	9
End gap, 0.025 ± 0.009 in.	0.5

IV. CONCLUSIONS

The quality test program, developed for the S8ER fuel elements, satisfactorily demonstrated the quality of each element, made available all pertinent data for each element, and detected fabrication and processing problems at their point of origin, permitting early corrective action. Thorough testing, and a complete review of test data, established that each fuel element delivered met all quality requirements, or had been properly waived, where requirements were not met. Test and inspection data, pertaining to acceptance requirements, were submitted with each element. Also, much additional information, pertaining to fabrication and testing, has been retained, and will be available should it be required. Early detection of defective parts and material was made possible by the upgrading point quality analysis system. Thus, defect detection was averted at a later stage of manufacture, after considerable additional time and material would have been invested in the parts. Also, this aspect of the quality test program forced an early review of problem areas, and initiated the action and information necessary to the solution of the problem.

A review of the quality test program results for the S8ER fuel elements has resulted in the following recommendations for future fuel element manufacture of this general type:

- a) Analyze the fuel alloy for U^{235} enrichment before releasing fuel rods for assembly into elements.
- b) Expand the in-process quality control activity in all phases of fabrication (i. e., melting and forming, hydriding, component manufacture, hydrogen barrier coating, and assembly).
- c) Review the need for existing levels of testing at upgrading points, after expanded in-process control is instituted.
- d) Establish sample procedures and sample sizes, relative to a pre-selected quality level, for those characteristics which cannot be effectively and economically examined in their entirety by non-destructive means.

- c) Adjust dimension requirements to reflect process capability, for those dimensions which were out of tolerance to an excessive degree. This appears justified, since no difficulty was experienced in loading the S8ER critical assembly, although most of the elements contained some dimension discrepancies.
- f) The uranium homogeneity, although satisfactory for the S8ER fuel, should be improved, to permit reduced sampling. This would reduce costs and release time spent in waiting for sample analyses results.
- g) Reduce the impurity level of the fuel alloy melts, particularly for elements having high cross-section values.
- h) The chromizing operation was an important problem area, with respect to distortion of the tubes and adequacy of the chromized layer in the tube. This operation should be improved, a satisfactory substitute found for chromizing, or the need for chromizing eliminated.

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APPENDIX
FUEL ELEMENT INSPECTION AND TEST RESULTS

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Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End			Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin		
									Diameter (in.)	TIR (in.)	Diameters (in.)		TIR (in.)	Diameters (in.)		TIR Maximum (in.)		Diameters (in.)		TIR (in.)	Length (in.)	Diameter (in.)	TIR (in.)
											Minimum	Maximum		Minimum	Maximum			Minimum	Maximum				
E109	550B-2	367.201	1.39	0.0016	0.022	0.573	15.030	14.468	0.1402	0.0006	0.563	0.5645	0.0012	0.561	0.5628	0.012	7	0.561	0.561	0.002	0.245	0.141	0.006
E111	531C-1	365.476	0.28	0.0009	0.025	0.565	15.030	14.473	0.1375	0.002	0.562	0.5635	0.001	0.561	0.563	0.013	5	0.560	0.5605	0.0025	0.250	0.137	0.004
E137	569B-4	365.468	0.34	0.0012	0.024	0.575	15.030	14.473	0.1406	0.001	0.563	0.5645	0.0008	0.560	0.563	0.014	6-1/2	0.560	0.5605	0.001	0.252	0.1406	0.0025
E141	563D-2	367.929	0.28	0.0015	0.025	0.567	15.040	14.467	0.1400	0.0005	0.562	0.5644	0.002	0.5605	0.5635	0.005	7	0.561	0.562	0.0008	0.245	0.1407	0.0010
E146	570A-3	369.208	0.73	0.0012	0.024	0.575	15.015	14.470	0.1407	0.001	0.5625	0.5635	0.001	0.5615	0.563	0.010	8	0.5609	0.562	0.001	0.230	0.1405	0.0030
E149	570B-2	366.099	1.16	0.0013	0.027	0.568	15.040	14.471	0.1407	0.0013	0.562	0.5633	0.0022	0.561	0.563	0.005	7	0.559	0.563	0.002	0.252	0.1405	0.0040
E150	564B-3	365.532	0.83	0.0015	0.024	0.571	15.060	14.463	0.1400	0.0035	0.5625	0.563	0.0018	0.560	0.562	0.008	9	0.560	0.561	0.002	0.250	0.140	0.0010
E153	565B-1	366.279	1.58	0.0018	0.025	0.570	15.030	14.475	0.1394	0.004	0.5645	0.566	0.002	0.561	0.562	0.007	8	0.562	0.5615	0.003	0.250	0.140	0.0015
E154	567B-3	366.099	0.37	0.0013	0.027	0.570	15.030	14.474	0.141	0.0025	0.5617	0.5635	0.0005	0.560	0.562	0.0088	6	0.559	0.5628	0.0065	0.245	0.141	0.010
E155	569C-4	365.496	0.33	0.0020	0.022	0.572	15.035	14.470	0.1394	0.0015	0.562	0.563	0.004	0.560	0.563	0.007	7	0.562	0.563	0.0025	0.245	0.140	0.001
E164	569B-3	365.207	0.41	0.0017	0.046	0.572	15.040	14.476	0.136	0.002	0.5630	0.563	0.003	0.561	0.563	0.018	7	0.5613	0.562	0.001	0.245	0.136	0.0025
E171	549C-4	367.394	0.45	0.0011	0.024	0.567	15.030	14.475	0.141	0.007	0.5634	0.565	0.001	0.5615	0.5625	0.004	5	0.562	0.563	0.0007	0.260	0.141	0.0015
E174	572C-3	367.179	0.67	0.0023	0.024	0.571	15.030	14.463	0.1400	0.0015	0.5630	0.564	0.0015	0.561	0.562	0.008	6	0.5605	0.5615	0.001	0.242	0.1406	0.002
E175	570C-4	366.751	0.18	0.0014	0.023	0.572	15.030	14.463	0.1404	0.0007	0.5630	0.564	0.0002	0.560	0.5655	0.0075	7	0.5615	0.5625	0.002	0.245	0.1406	0.0013
E176	562A-2	365.532	0.68	0.0015	0.024	0.564	15.040	14.466	0.1390	0.0035	0.5625	0.563	0.0018	0.560	0.562	0.008	7	0.560	0.561	0.002	0.250	0.1405	0.005
E177	558A-4	362.454	1.71	0.0013	0.024	0.573	15.025	14.461	0.1406	0.0015	0.5620	0.5633	0.002	0.560	0.562	0.010	7	0.560	0.561	0.002	0.250	0.141	0.0015
E179	555B-3	362.831	0.64	0.0006	0.025	0.568	15.030	14.470	0.1406	0.0007	0.5610	0.562	0.001	0.560	0.562	0.004	6	0.559	0.561	0.0013	0.250	0.1405	0.0005
E181	558E-4	365.734	0.42	0.0023	0.025	0.567	15.040	14.472	0.1400	0.0007	0.5625	0.5635	0.0014	0.562	0.563	0.0065	7	0.562	0.5635	0.0014	0.260	0.1403	0.0005
E182	571C-2	368.490	0.24	0.0010	0.025	0.571	15.040	14.462	0.1405	0.0005	0.563	0.564	0.0004	0.5615	0.564	0.008	9-1/2	0.562	0.563	0.0013	0.245	0.140	0.002
E187	563C-3	367.533	0.23	0.0013	0.026	0.575	15.050	14.474	0.1402	0.0015	0.563	0.564	0.0013	0.561	0.563	0.010	7	0.561	0.562	0.0015	0.245	0.140	0.0017
E188	532D-3	364.916	0.12	0.0023	0.021	0.574	15.040	14.474	0.1370	0.0005	0.5625	0.5635	0.0008	0.5605	0.563	0.014	7	0.560	0.5605	0.002	0.247	0.137	0.002
E191	558D-2	367.610	0.34	0.0011	0.022	0.571	15.030	14.462	0.1404	0.0015	0.5652	0.563	0.0013	0.5615	0.564	0.007	6-1/2	0.562	0.5635	0.0065	0.255	0.1405	0.002
E192	557C-3	367.619	0.45	0.0011	0.025	0.567	15.045	14.463	0.1404	0.0003	0.5630	0.564	0.0007	0.562	0.563	0.002	7-1/4	0.5625	0.564	0.001	0.250	0.1408	0.001
E193	570A-1	367.178	1.42	0.0010	0.021	0.574	15.030	14.455	0.1400	0.004	0.563	0.564	0.0001	0.5625	0.5635	0.011	7	0.5615	0.562	0.001	0.250	0.141	0.0015
E197	550B-3	367.567	0.48	0.0012	0.027	0.564	15.035	14.470	0.1406	0.0005	0.561	0.563	0.0015	0.560	0.5625	0.004	5	0.558	0.563	0.0026	0.255	0.1406	0.0025
E201	569D-2	366.656	0.47	0.0014	0.0235	0.575	15.030	14.476	0.1402	0.001	0.563	0.5635	0.0025	0.562	0.563	0.010	7	0.5605	0.562	0.001	0.253	0.1408	0.002
E206	572C-4	367.772	0.45	0.0010	0.022	0.567	15.030	14.477	0.1404	0.001	0.563	0.565	0.0007	0.561	0.562	0.004	6-1/2	0.560	0.561	0.0025	0.242	0.1407	0.006
E212	535A-1	366.105	0.44	0.0012	0.025	0.569	15.030	14.474	0.1405	0.0015	0.5625	0.5635	0.001	0.562	0.563	0.004	7	0.5605	0.5615	0.001	0.250	0.1407	0.002
E231	571C-3	368.655	0.33	0.0015	0.023	0.569	15.020	14.462	0.1403	0.002	0.5632	0.564	0.0005	0.562	0.563	0.007	4	0.563	0.563	0.001	0.240	0.1408	0.0014
E232	565C-5	366.992	0.44	0.0018	0.023	0.571	15.030	14.477	0.1399	0.0005	0.564	0.5645	0.001	0.562	0.563	0.007	7	0.562	0.562	0.001	0.310	0.1395	0.002
E236	569C-3	365.457	0.28	0.0014	0.023	0.566	15.030	14.460	0.1403	0.0015	0.5625	0.563	0.0015	0.561	0.562	0.005	7	0.559	0.562	0.0015	0.245	0.1405	0.002
E237	570B-1	366.822	0.62	0.0012	0.025	0.568	15.045	14.472	0.1403	0.002	0.5636	0.565	0.002	0.561	0.563	0.006	8	0.561	0.563	0.008	0.260	0.140	0.001
E241	563D-1	366.864	0.79	0.0005	0.025	0.568	15.040	14.481	0.1407	0.004	0.5612	0.562	0.0033	0.561	0.562	0.002	7	0.559	0.560	0.004	0.245	0.1406	0.007
E244	572B-4	367.435	0.62	0.0008	0.026	0.566	15.030	14.471	0.1401	0.002	0.562	0.563	0.0025	0.561	0.562	0.004	7	0.558	0.560	0.0015	0.245	0.142	0.006
E245	558D-4	367.691	1.38	0.0008	0.023	0.571	15.030	14.463	0.1409	0.0015	0.563	0.5635	0.0007	0.561	0.562	0.009	8-1/2	0.5625	0.563	0.0015	0.250	0.1402	0.0006
E247	571A-4	367.252	0.29	0.0015	0.024	0.570	15.090	14.475	0.1402	0.0005	0.563	0.564	0.001	0.561	0.563	0.007	6	0.560	0.562	0.002	0.310	0.1405	0.002

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Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements																Fuel Tube Assembly Measurements							
		Net Weight (g)	Density (g/cc)	Uranium					Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section									
				(wt %)	Enrichment	Weight (g)	Weight/in. (g)			(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)								
							Minimum	Maximum																	
E109	550B-2	309.651	6.087	9.81	93.16	30.09	2.08	2.19	0.36	1.625	5.91	14.002	0.5323	0.5324	0.0002	0.5246	0.380	0.5355	0.0008	0.0019	0.0113	0.0097	1.64	2.8	39
E111	531C-1	307.871	6.055	10.00	93.18	30.26	2.12	2.23	—	1.715	6.20	13.999	0.5322	0.5324	0.0035	0.5223	0.380	0.5342	0.0032	0.0034	0.0110	0.0096	1.60	2.8	39
E137	569B-4	309.000	6.076	9.88	93.15	30.03	2.13	2.16	0.585	1.63	5.92	14.000	0.5320	0.5322	0.001	0.5240	0.380	0.5345	0.0012	0.0019	0.0105	0.0096	1.50	2.8	39
E141	563D-2	310.716	6.110	10.24	93.15	31.29	2.21	2.26	0.535	1.66	6.06	13.999	0.5324	0.5324	0.0002	0.5236	0.370	0.5355	0.0014	0.0017	0.0106	0.0100	1.68	3.4	48
E146	570A-3	310.134	6.098	10.09	93.15	30.77	2.19	2.21	0.50	1.665	6.07	14.000	0.5324	0.5324	0.002	0.5247	0.380	0.5348	0.0030	0.0032	0.0107	0.0101	1.52	3.1	43
E149	570B-2	310.090	6.094	9.87	93.15	30.11	2.13	2.17	0.53	1.605	5.84	13.9965	0.5327	0.5327	0.0003	0.5239	0.380	0.5353	0.0012	0.0015	0.0113	0.0097	1.68	3.4	48
E150	564B-3	309.606	6.091	9.94	93.15	30.28	2.14	2.21	0.505	1.605	6.03	13.999	0.5320	0.5320	0.0001	0.5236	0.380	0.5351	0.0023	0.0026	0.0113	0.0097	1.87	3.3	46
E153	565B-1	309.833	6.094	10.09	93.15	30.77	2.18	2.21	0.515	1.65	5.84	13.998	0.5321	0.5321	0.001	0.5235	0.380	0.5357	0.0016	0.0020	0.0113	0.0097	1.57	2.6	36
E154	567B-3	309.842	6.094	9.97	93.15	30.39	2.13	2.27	0.525	1.61	5.88	14.002	0.5322	0.5322	0.0006	0.5240	0.380	0.5351	0.0012	0.0019	0.0113	0.0097	1.59	3.2	45
E155	569C-4	309.560	6.091	10.00	93.15	30.46	2.15	2.22	0.56	1.605	5.84	14.001	0.5322	0.5322	0.001	0.5238	0.380	0.5363	0.0013	0.0018	0.0113	0.0097	1.73	2.8	39
E164	569B-3	308.108	6.090	9.98	93.15	29.93	2.12	2.16	0.60	1.68	6.11	13.997	0.5315	0.5315	0.0023	0.5244	0.365	0.5349	0.0031	0.0032	0.0110	0.0105	1.68	3.3	46
E171	549C-4	310.394	6.093	10.09	93.16	30.92	2.17	2.25	0.29	1.605	5.84	14.000	0.5326	0.5326	0.0002	0.5235	0.380	0.5349	0.0009	0.0013	0.0110	0.0106	1.46	3.1	43
E174	572C-3	309.755	6.093	9.96	93.15	30.34	2.10	2.26	0.47	1.65	6.01	14.000	0.5323	0.5323	0.0003	0.5240	0.380	0.5345	0.0015	0.0017	0.0113	0.0097	1.60	3.7	52
E175	570C-4	310.220	6.103	10.02	93.15	30.58	2.17	2.20	0.525	1.62	5.91	14.001	0.5321	0.5322	0.0001	0.5240	0.380	0.5351	0.0012	0.0025	0.0112	0.0100	1.52	2.9	41
E176	562A-2	309.689	6.093	10.03	93.15	30.63	2.12	2.24	0.49	1.64	5.81	13.999	0.5321	0.5323	0.002	0.5234	0.380	0.5350	0.0014	0.0016	0.0110	0.0097	1.74	3.1	43
E177	558A-4	310.107	6.092	10.07	93.15	30.72	2.18	2.21	0.485	1.64	5.97	14.000	0.5323	0.5324	0.0002	0.5238	0.380	0.5348	0.0026	0.0031	0.0099	0.0080	1.45	2.7	38
E179	555B-3	310.218	6.078	9.77	93.13	29.83	2.10	2.20	0.43	1.57	5.70	13.999	0.5325	0.5328	0.0005	0.5236	0.380	0.5359	0.0012	0.0015	0.0096	0.0095	1.80	3.6	50
E181	558E-4	309.335	6.083	9.86	93.15	30.00	2.09	2.18	0.425	1.645	5.97	13.999	0.5321	0.5321	0.001	0.5240	0.380	0.5378	0.0006	0.0013	0.0103	0.0098	1.66	2.9	41
E182	571C-2	310.865	6.108	10.10	93.15	30.89	2.19	2.22	0.50	1.62	5.91	13.999	0.5326	0.5326	0.001	0.5236	0.380	0.5345	0.0010	0.0013	0.0112	0.0101	1.56	3.2	45
E187	563C-3	310.227	6.100	10.14	93.15	30.94	2.15	2.24	0.38	1.64	6.00	13.998	0.5323	0.5323	0.0005	0.5242	0.380	0.5348	0.0014	0.0016	0.0113	0.0097	1.64	3.5	49
E188	532D-3	307.918	6.057	9.98	93.17	29.96	2.09	2.19	—	1.715	6.21	14.003	0.5323	0.5323	0.0002	0.5227	0.380	0.5350	0.0034	0.0036	0.0106	0.0100	1.54	3.4	48
E191	558D-2	310.196	6.087	9.88	93.15	30.15	2.12	2.18	0.535	1.63	5.93	14.002	0.5325	0.5325	0.0008	0.5245	0.385	0.5347	0.0010	0.0011	0.0106	0.0101	1.56	3.2	45
E192	557C-3	310.049	6.083	10.00	93.13	30.50	2.13	2.22	0.465	1.64	5.96	14.000	0.5326	0.5326	0.001	0.5240	0.380	0.5348	0.0025	0.0030	0.0105	0.0101	1.49	2.8	39
E193	570A-1	309.261	6.095	10.04	93.15	30.69	2.18	2.20	0.495	1.66	6.05	14.003	0.5320	0.5320	0.0055	0.5246	0.380	0.5352	0.0036	0.0037	0.0106	0.0100	1.67	3.1	43
E197	550B-3	309.582	6.098	9.91	93.16	30.09	2.08	2.19	0.37	1.62	5.90	13.997	0.5324	0.5324	0.0002	0.5245	0.380	0.5348	0.0008	0.0011	0.0106	0.0101	1.61	3.4	48
E201	569D-2	309.888	6.093	9.86	93.15	30.07	2.13	2.19	0.555	1.59	5.79	14.000	0.5324	0.5324	0.0003	0.5247	0.380	0.5352	0.0032	0.0034	0.0114	0.0100	1.58	3.2	45
E206	572C-4	309.707	6.093	9.96	93.15	30.34	2.10	2.26	0.48	1.63	5.97	14.002	0.5320	0.5322	0.0008	0.5240	0.380	0.5341	0.0013	0.0017	0.0106	0.0100	1.54	3.4	48
E212	535A-1	307.695	6.056	10.09	93.17	30.51	2.15	2.20	—	1.71	6.19	13.999	0.5322	0.5322	0.0002	0.5225	0.380	0.5347	0.0031	0.0032	0.0115	0.0110	1.56	3.4	48
E231	571C-3	310.587	6.110	10.10	93.15	30.87	2.19	2.22	0.405	1.60	5.84	14.001	0.5322	0.5322	0.0005	0.5235	0.380	0.5351	0.0011	0.0012	0.0121	0.0107	1.70	3.0	42
E232	565C-5	309.564	6.092	10.05	93.15	30.61	2.15	2.26	0.535	1.595	5.81	14.001	0.5320	0.5322	0.0004	0.5234	0.380	0.5358	0.0021	0.0025	0.0103	0.0100	1.84	2.8	39
E236	569C-3	309.828	6.095	10.00	93.15	30.49	2.16	2.23	0.555	1.60	5.83	14.001	0.5322	0.5323	0.0010	0.5240	0.380	0.5351	0.0013	0.0020	0.0103	0.0100	1.69	3.4	48
E237	570B-1	308.940	6.071	9.87	93.15	30.00	2.12	2.16	0.54	1.61	5.84	13.999	0.5325	0.5325	0.0008	0.5239	0.380	0.5350	0.0013	0.0016	0.0110	0.0105	1.59	3.2	45
E241	563D-1	309.836	6.090	10.24	93.15	31.20	2.20	2.25	0.545	1.65	6.00	13.999	0.5326	0.5328	0.0015	0.5232	0.380	0.5337	0.0022	0.0034	0.0110	0.0105	1.58	3.6	50
E244	572B-4	310.243	6.093	9.95	93.15	30.37	2.14	2.19	0.50	1.625	5.93	13.9985	0.5326	0.5326	0.0006	0.5267	0.380	0.5342	0.0023	0.0030	0.0110	0.0106	1.76	3.7	52
E245	558D-4	310.319	6.091	9.88	93.15	30.16	2.12	2.18	0.545	1.64	5.97	14.001	0.5330	0.5330	0.0007	0.5243	0.380	0.5346	0.0011	0.0013	0.0108	0.0103	1.77	3.8	53
E247	571A-4	309.650	6.084	9.95	93.15	30.29	2.15	2.17	0.535	1.62	5.89	14.000	0.5323	0.5323	0.006	0.5232	0.395	0.5354	0.0019	0.0023	0.0113	0.0097	1.54	2.5	35

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Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End		Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin				
									Diameter (in.)	TIR (in.)	Diameters (in.)		TIR (in.)	Diameters (in.)			TIR Maximum (in.)	Diameters (in.)		TIR (in.)	Length (in.)		Diameter (in.)	TIR (in.)
											Minimum	Maximum		Minimum	Maximum			Minimum	Maximum					
E249	568C-2	365.843	1.14	0.0015	0.024	0.564	15.045	14.467	0.1406	0.0002	0.5625	0.5635	0.0008	0.561	0.562	0.0025	7	0.561	0.563	0.002	0.250	0.1405	0.004	
E262	572C-2	366.395	1.35	0.0009	0.023	0.572	15.040	14.482	0.1405	0.002	0.5610	0.5624	0.0015	0.5605	0.561	0.012	6	0.5578	0.560	0.005	0.250	0.1400	0.008	
E268	572C-1	366.542	0.57	0.0009	0.024	0.564	—	14.477	0.1402	0.0005	0.5635	0.5640	0.002	0.5615	0.564	0.0045	7	0.5603	0.561	0.003	0.250	0.1400	0.003	
E271	559C-4	365.627	0.33	0.0023	0.025	0.571	15.090	14.472	0.1394	0.003	0.5625	0.5625	0.004	0.561	0.562	0.011	12	0.5615	0.562	0.005	0.315	0.1400	0.001	
E272	561C-4	367.767	0.76	0.0015	0.022	0.565	15.100	14.473	0.1403	0.004	0.564	0.565	0.0045	0.5605	0.562	0.005	7	0.5625	0.563	0.001	0.320	0.1391	0.001	
E274	557A-3	366.307	0.37	0.0016	0.024	0.565	15.110	14.477	0.1395	0.004	0.5625	0.5645	0.0025	0.561	0.563	0.004	7	0.5625	0.5625	0.0015	0.315	0.1405	0.0015	
E278	565A-2	366.587	0.42	0.002	0.024	0.566	15.100	14.465	0.1400	0.002	0.562	0.563	0.0005	0.561	0.562	0.006	8	0.5625	0.563	0.002	0.325	0.1410	0.001	
E280	556A-4	367.004	0.34	0.0016	0.023	0.571	15.090	14.470	0.1410	0.002	0.563	0.5635	0.0002	0.560	0.565	0.010	7	0.563	0.564	0.0015	0.310	0.138	0.002	
E281	530D-1	365.102	0.33	0.001	0.023	0.568	15.090	14.465	0.1396	0.002	0.5625	0.5630	0.0012	0.561	0.562	0.005	7	0.5625	0.563	0.002	0.310	0.139	0.002	
E283	557A-4	367.108	0.31	0.0016	0.0235	0.577	15.100	14.467	0.1400	0.002	0.5635	0.5645	0.002	0.561	0.562	0.004	8	0.562	0.562	0.001	0.310	0.1397	0.002	
E286	532D-2	364.255	0.34	0.0013	0.029	0.571	15.080	14.457	0.1395	0.0005	0.5615	0.562	0.002	0.561	0.562	0.008	8	0.5615	0.5625	0.001	0.315	0.1402	0.001	
E287	531C-3	364.466	0.38	0.0019	0.028	0.572	15.100	14.467	0.137	0.002	0.5635	0.564	0.0025	0.561	0.562	0.015	7	0.562	0.563	0.0025	0.305	0.137	0.002	
E288	571C-4	367.751	0.50	0.001	0.023	0.567	15.070	14.456	0.1405	0.0025	0.562	0.563	0.0015	0.5605	0.562	0.0045	7	0.562	0.562	0.0015	0.310	0.1405	0.002	
E289	570A-4	366.977	0.46	0.0018	0.022	0.568	15.096	14.463	0.1400	0.001	0.5635	0.564	0.0025	0.560	0.562	0.005	7	0.562	0.563	0.001	0.315	0.140	0.002	
E291	555C-2	367.381	0.73	0.0009	0.025	0.566	15.100	14.477	0.1360	0.001	0.564	0.565	0.001	0.5615	0.563	0.014	7	0.563	0.564	0.003	0.312	0.1365	0.004	
E292	568D-2	367.793	0.50	0.0011	0.025	0.573	15.090	14.467	0.1400	0.001	0.563	0.5635	0.0013	0.562	0.563	0.010	7	0.5625	0.564	0.0015	0.315	0.141	0.0028	
E293	531C-4	366.154	0.20	0.0013	0.025	0.568	15.080	14.460	0.1395	0.001	0.563	0.564	0.004	0.562	0.563	0.0045	7	0.562	0.563	0.003	0.310	0.139	0.003	
E302	572B-3	367.775	0.34	0.0013	0.025	0.568	15.040	14.478	0.1400	0.0015	0.5634	0.564	0.001	0.5613	0.564	0.0045	7	0.561	0.5615	0.0005	0.249	0.140	0.0025	
E303	565A-4	367.643	0.48	0.002	0.027	0.568	15.090	14.469	0.1400	0.001	0.562	0.563	0.0018	0.562	0.560	0.004	11	0.5635	0.5645	0.0015	0.305	0.140	0.004	
E304	571D-4	365.792	1.05	0.002	0.022	0.569	15.100	14.468	0.1390	0.004	0.5665	0.568	0.0035	0.560	0.563	0.004	8	0.561	0.5615	0.007	0.310	0.1395	0.0015	
E307	559C-1	367.563	0.83	0.0018	0.023	0.571	15.060	14.471	0.1385	0.004	0.563	0.5655	0.0015	0.562	0.562	0.0045	10	0.5625	0.563	0.0015	0.310	0.1395	0.003	
E308	557D-4	366.011	0.38	0.0022	0.022	0.569	15.090	14.466	0.1384	0.002	0.5593	0.5615	0.005	0.561	0.562	0.007	9	0.561	0.562	0.003	0.310	0.1403	0.004	
E309	559C-3	366.785	0.33	0.0018	0.025	0.568	15.100	14.473	0.139	0.004	0.5625	0.564	0.006	0.561	0.563	0.008	11	0.5615	0.562	0.0015	0.310	0.141	0.001	
E310	565C-3	366.864	0.19	0.0016	0.024	0.565	15.100	14.474	0.140	0.0065	0.562	0.563	0.0025	0.5605	0.562	0.0095	9	0.562	0.562	0.0015	0.310	0.1368	0.003	
E311	564B-2	367.748	0.64	0.0013	0.025	0.562	15.075	14.464	0.1403	0.0007	0.561	0.563	0.0013	0.562	0.563	0.0018	7	0.562	0.564	0.0012	0.305	0.1403	0.0005	
E313	550D-1	368.111	0.96	0.0008	0.024	0.565	15.092	14.474	0.1405	0.0009	0.564	0.565	0.001	0.562	0.563	0.005	7	0.562	0.5625	0.0015	0.300	0.1405	0.0025	
E315	560C-1	367.451	0.30	0.0019	0.024	0.567	15.090	14.468	0.1404	0.001	0.5625	0.564	0.0015	0.561	0.563	0.007	7	0.5618	0.562	0.001	0.305	0.1383	0.001	
E316	571C-1	368.229	0.32	0.0013	0.024	0.569	—	14.463	0.1406	0.001	0.5615	0.5632	0.0017	0.5615	0.562	0.0065	8	0.561	0.5625	0.0014	0.300	0.1408	0.006	
E318	567D-4	367.361	0.30	0.0012	0.027	0.565	15.084	14.459	0.1385	0.0015	0.563	0.5635	0.0035	0.561	0.564	0.007	8	0.562	0.5625	0.0008	0.312	0.1395	0.0025	
E319	555C-3	367.012	0.65	0.0012	0.024	0.569	15.030	14.477	0.1406	0.0008	0.5625	0.5640	0.0015	0.561	0.563	0.004	7	0.562	0.5625	0.001	0.245	0.1406	0.002	
E322	555D-2	367.591	0.31	0.0015	0.023	0.569	15.096	14.469	0.1395	0.001	0.563	0.5645	0.0008	0.5615	0.563	0.006	11	0.561	0.562	0.002	0.305	0.140	0.003	
E323	565B-2	366.383	0.39	0.0016	0.023	0.569	15.090	14.463	0.1395	0.001	0.563	0.564	0.0055	0.5605	0.562	0.008	7	0.560	0.561	0.0033	0.310	0.1395	0.002	
E329	557A-2	366.903	0.33	0.002	0.022	0.568	15.090	14.469	0.1400	0.0005	0.5635	0.565	0.002	0.561	0.562	0.004	7	0.561	0.562	0.0025	0.310	0.1395	0.005	
E330	555B-4	367.591	0.33	0.0018	0.026	0.574	15.125	14.461	0.1390	0.0025	0.5635	0.565	0.0015	0.561	0.563	0.010	7	0.561	0.562	0.003	0.310	0.140	0.0015	
E332	565C-2	368.164	0.64	0.0016	0.023	0.571	15.090	14.461	0.1408	0.001	0.564	0.565	0.0005	0.5615	0.562	0.006	4	0.5625	0.563	0.0015	0.310	0.140	0.003	

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Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements															Fuel Tube Assembly Measurements								
		Net Weight (g)	Density (g/cc)	Uranium				Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section		Inside Diameter (in.)	Coating Thickness (in.)		Tube Wall Thickness (in.)		Sm ₂ O ₃ Poison			
				(wt %)	Enrich- ment	Weight (g)	Weight/in. (g)		(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)		Minimum	Maximum	Maximum	Minimum	(wt %)	Weight/in. (mg)	Total Weight (mg)	
							Minimum																		Maximum
E249	568C-2	309.590	6.085	9.78	93.15	29.78	2.10	2.12	0.53	1.63	5.96	14.000	0.5323	0.5323	0.001	0.524	0.380	0.5353	0.0025	0.0030	0.0113	0.0097	1.72	3.6	50
E262	572C-2	309.705	6.094	9.96	93.15	30.34	2.10	2.26	0.46	1.635	5.97	14.001	0.5320	0.5320	0.0015	0.524	0.380	0.5338	0.0025	0.0034	0.0107	0.0103	1.60	3.2	45
E268	572C-1	309.703	6.089	9.96	93.15	30.34	2.10	2.26	0.475	1.625	5.91	14.000	0.5321	0.5322	0.0006	0.5235	0.380	0.5340	0.0025	0.0034	0.0107	0.0100	1.79	3.9	55
E271	559C-4	309.662	6.097	10.05	93.15	30.62	2.18	2.21	0.505	1.595	5.82	13.999	0.5320	0.5320	0.0007	0.523	0.380	0.5367	0.0011	0.0014	0.0107	0.0104	1.97	3.0	42
E272	561C-4	311.304	6.108	10.25	93.15	30.39	2.19	2.28	0.565	1.625	5.95	14.002	0.5327	0.5330	0.0004	0.5245	0.380	0.5365	0.0015	0.0017	0.0107	0.0105	1.71	3.6	50
E274	557A-3	309.786	6.093	10.18	93.15	31.03	2.19	2.23	0.445	1.61	5.86	14.000	0.5322	0.5323	0.0005	0.5224	0.380	0.5355	0.0020	0.0021	0.0108	0.0105	1.54	2.4	34
E278	565A-2	309.812	6.094	9.79	93.15	29.88	2.11	2.16	0.53	1.61	5.86	14.000	0.5322	0.5323	0.0008	0.5241	0.388	0.5358	0.0016	0.0020	0.0108	0.0105	1.73	2.6	36
E280	556A-4	309.228	6.083	9.92	93.13	30.16	2.12	2.21	0.39	1.685	6.12	14.001	0.5323	0.5323	0.0007	0.5245	0.385	0.5360	0.0011	0.0023	0.0109	0.0105	1.95	3.2	45
E281	530D-1	307.963	6.055	10.04	93.19	30.39	2.16	2.19		1.71	6.19	14.001	0.5320	0.5323	0.0007	0.5226	0.380	0.5342	0.0015	0.0020	0.0107	0.0104	1.56	3.2	45
E283	557A-4	309.775	6.093	10.18	93.13	31.02	2.19	2.23	0.425	1.64	5.97	14.0005	0.5322	0.5323	0.0005	0.5226	0.380	0.5355	0.0016	0.0019	0.0107	0.0104	1.59	2.4	34
E286	532D-2	309.036	6.058	9.90	93.17	30.08	2.14	2.20		1.69	6.09	13.995	0.5318	0.5320	0.0002	0.525	0.390	0.5345	0.0008	0.0010	0.0107	0.0105	1.73	2.8	39
E287	531C-3	307.678	6.055	10.00	93.18	30.25	2.12	2.23		1.69	6.15	13.998	0.5322	0.5322	0.0012	0.5225	0.380	0.5360	0.0018	0.0020	0.0107	0.0105	1.84	2.8	39
E288	571C-4	310.750	6.106	10.10	93.15	30.88	2.19	2.22	0.485	1.605	5.86	14.001	0.5325	0.5325	0.0017	0.5245	0.380	0.5345	0.0010	0.0013	0.0108	0.0104	1.72	3.6	50
E289	570A-4	310.225	6.098	10.09	93.15	30.79	2.19	2.21	0.50	1.625	5.92	14.001	0.5324	0.5324	0.0002	0.5246	0.380	0.5361	0.0009	0.0014	0.0107	0.0104	1.81	2.9	41
E291	555C-2	310.165	6.085	9.77	93.18	29.80	2.10	2.17	0.36	1.675	6.09	13.999	0.5324	0.5328	0.0003	0.5236	0.380	0.5345	0.0009	0.0017	0.0113	0.0097	1.65	3.2	45
E292	568D-2	309.699	6.090	10.03	93.15	30.56	2.15	2.22	0.545	1.62	5.84	13.999	0.5324	0.5324	0.001	0.5238	0.380	0.5346	0.0026	0.0029	0.0107	0.0102	1.72	3.6	50
E293	531C-4	307.714	6.051	10.00	93.19	30.25	2.16	2.19		1.705	6.05	13.999	0.5320	0.5320	0.0035	0.5225	0.380	0.5345	0.0017	0.0024	0.0106	0.0103	1.60	3.1	43
E302	572B-3	310.106	6.093	9.95	93.15	30.36	2.14	2.19	0.50	1.615	5.88	13.999	0.5325	0.5325	0.0001	0.5236	0.380	0.5351	0.0013	0.0015	0.0113	0.0097	1.55	3.1	43
E303	565A-4	310.040	6.094	9.79	93.15	29.86	2.11	2.16	0.52	1.62	5.90	13.997	0.5324	0.5324	0.0015	0.5236	0.380	0.5364	0.0017	0.0020	0.0109	0.0098	1.90	2.9	41
E304	571D-4	309.613	6.086	10.00	93.15	30.44	2.14	2.20	0.565	1.69	6.15	14.001	0.5321	0.5321	0.0008	0.5237	0.375	0.5362	0.0009	0.0013	0.0106	0.0096	1.86	3.3	46
E307	559C-1	310.068	6.097	10.05	93.15	30.67	2.18	2.21	0.515	1.675	6.09	14.000	0.5320	0.5320	0.0002	0.5236	0.375	0.5357	0.0014	0.0015	0.0113	0.0097	1.82	3.3	46
E308	557D-4	310.014	6.098	10.16	93.15	30.97	2.19	2.24	0.42	1.675	6.09	14.001	0.5321	0.5321	0.002	0.5240	0.380	0.5365	0.0009	0.0010	0.0103	0.0097	1.82	3.0	42
E309	559C-3	309.797	6.094	10.05	93.15	30.64	2.18	2.21	0.48	1.595	5.82	13.999	0.5320	0.5320	0.0002	0.5237	0.380	0.5359	0.0016	0.0018	0.0108	0.0097	1.78	2.9	41
E310	565C-3	310.276	6.095	10.05	93.15	30.66	2.15	2.24	0.55	1.59	5.85	14.000	0.5325	0.5325	0.0015	0.5238	0.380	0.5357	0.0022	0.0025	0.0108	0.0098	1.80	3.2	45
E311	564B-2	309.597	6.093	9.94	93.15	30.26	2.14	2.16	0.535	1.67	6.08	13.999	0.5321	0.5321	0.002	0.5234	0.380	0.5347	0.0027	0.0033	0.0110	0.0104	1.56	3.0	42
E313	550D-1	310.718	6.097	10.32	93.16	31.55	2.23	2.26	0.36	1.595	5.81	14.000	0.5327	0.5329	0.0002	0.5235	0.380	0.5344	0.0011	0.0016	0.0109	0.0099	1.53	2.8	39
E315	560C-1	310.158	6.104	10.17	93.15	31.03	2.19	2.25	0.445	1.625	5.93	13.999	0.5320	0.5320	0.0013	0.5227	0.380	0.5364	0.0009	0.0011	0.0106	0.0101	2.06	3.6	50
E316	571C-1	311.156	6.107	10.10	93.15	30.92	2.20	2.22	0.495	1.625	5.93	14.000	0.5326	0.5326	0.0008	0.5245	0.380	0.5352	0.0010	0.0012	0.0108	0.0100	—	3.4	48
E318	567D-4	310.270	6.099	9.93	93.15	30.32	2.14	2.21	0.45	1.60	5.83	13.997	0.5324	0.5324	0.0005	0.5246	0.380	0.5348	0.0012	0.0015	0.0104	0.0097	1.62	3.1	43
E319	555C-3	309.958	6.082	9.77	93.13	29.78	2.10	2.17	0.39	1.65	6.00	14.000	0.5325	0.5328	0.0004	0.5235	0.380	0.5350	0.0012	0.0016	0.0110	0.0102	1.59	3.2	45
E322	555D-2	309.818	6.074	9.93	93.13	30.26	2.08	2.11	0.405	1.63	5.92	14.001	0.5330	0.5330	0.0004	0.5246	0.380	0.5360	0.0013	0.0015	0.0108	0.0108	1.73	2.5	35
E323	565B-2	310.195	6.095	10.09	93.15	30.80	2.18	2.21	0.525	1.605	5.85	14.000	0.5325	0.5325	0.0017	0.5238	0.380	0.5358	0.0022	0.0023	0.0105	0.0098	1.92	3.2	45
E329	557A-2	309.344	6.094	10.18	93.13	30.98	2.19	2.22	0.445	1.625	5.94	14.002	0.5317	0.5318	0.0007	0.5224	0.380	0.5357	0.0015	0.0015	0.0111	0.0099	1.67	2.3	32
E330	555B-4	309.712	6.092	9.77	93.13	29.76	2.09	2.19	0.39	1.64	5.97	13.998	0.5324	0.5324	0.0004	0.5236	0.380	0.5360	0.0019	0.0022	0.0111	0.0104	1.89	3.3	46
E332	565C-2	310.346	6.093	10.05	93.15	30.66	2.15	2.24	0.545	1.615	5.85	14.000	0.5325	0.5325	0.0008	0.5236	0.380	0.5358	0.0019	0.0022	0.0112	0.0098	1.77	2.9	41
E335	559A-1	309.699	6.092	9.98	93.15	30.40	2.14	2.19	0.42	1.64	5.97	13.999	0.5322	0.5322	0.0002	0.5240	0.380	0.5362	0.0011	0.0013	0.0106	0.0100	1.67	2.8	39

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Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End		Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin			
									Diameter (in.)	TIR (in.)	Diameters (in.)		TIR (in.)	Diameters (in.)			TIR Maximum (in.)	Diameters (in.)		TIR (in.)	Length (in.)	Diameter (in.)	TIR (in.)
											Minimum	Maximum		Minimum	Maximum			Minimum	Maximum				
E335	559A-1	367.418	0.34	0.002	0.025	0.569	15.090	14.470	0.1404	0.003	0.563	0.5635	0.0015	0.561	0.564	0.0085	10	0.5613	0.563	0.0015	0.312	0.1404	0.003
E336	559A-2	366.455	0.34	0.0018	0.025	0.566	15.090	14.473	0.1400	0.001	0.5625	0.5635	0.004	0.561	0.562	0.004	7	0.562	0.563	0.001	0.300	0.1400	0.003
E337	569B-2	366.578	0.41	0.002	0.022	0.574	15.100	14.468	0.1386	0.003	0.5620	0.5640	0.0055	0.560	0.564	0.008	8	0.562	0.5625	0.005	0.305	0.1390	0.002
E339	562A-3	367.179	0.56	0.0017	0.024	0.571	15.100	14.467	0.1400	0.0006	0.5650	0.5655	0.0018	0.561	0.562	0.009	11	0.561	0.562	0.002	0.310	0.1410	0.003
E340	565D-3	366.919	0.44	0.0011	0.024	0.565	15.080	14.470	0.1400	0.0003	0.561	0.5625	0.0035	0.561	0.562	0.0035	8	0.5615	0.562	0.002	0.310	0.1390	0.004
E341	565C-4	366.576	0.65	0.0014	0.023	0.567	15.000	14.460	0.1406	0.0037	0.562	0.5635	0.0015	0.562	0.5635	0.005	6	0.562	0.563	0.001	0.242	0.1408	0.002
E342	549B-2	365.426	0.03	0.0025	0.023	0.569	15.100	14.469	0.1397	0.003	0.5635	0.565	0.002	0.561	0.563	0.005	9	0.5605	0.561	0.001	0.315	0.1400	0.0035
E343	555D-3	366.042	1.71	0.0021	0.025	0.570	15.090	14.472	0.1400	0.001	0.562	0.564	0.0008	0.561	0.562	0.007	10	0.561	0.562	0.0013	0.315	0.1390	0.003
E346	565A-3	366.614	0.46	0.0019	0.025	0.574	15.100	14.472	0.1405	0.002	0.563	0.564	0.0017	0.5605	0.5625	0.009	3	0.562	0.562	0.0018	0.325	0.1405	0.002
E347	567C-4	365.914	0.38	0.0021	0.022	0.575	15.090	14.467	0.1392	0.0015	0.563	0.564	0.0025	0.559	0.563	0.005	5	0.561	0.562	0.0005	0.315	0.1395	0.002
E348	562C-1	366.063	1.57	0.0022	0.024	0.571	15.075	14.469	0.1400	0.0005	0.562	0.562	0.004	0.561	0.563	0.010	10	0.562	0.5635	0.0018	0.310	0.1400	0.0007
E349	570A-2	368.189	1.36	0.0021	0.024	0.569	15.091	14.471	0.1395	0.0005	0.563	0.564	0.004	0.562	0.563	0.010	11	0.562	0.5635	0.0018	0.310	0.1405	0.002
E350	561C-3	367.908	0.41	0.0016	0.022	0.567	15.090	14.465	0.1400	0.0007	0.563	0.563	0.002	0.561	0.562	0.0033	7	0.562	0.563	0.001	0.310	0.1405	0.0015
E351	582A-1	364.646	0.42	0.0018	0.031	0.569	15.100	14.474	0.1403	0.0015	0.563	0.5635	0.002	0.5615	0.5625	0.0075	11	0.562	0.562	0.0015	0.310	0.1405	0.003
E352	569D-4	366.791	0.32	0.002	0.021	0.572	15.070	14.473	0.1400	0.0008	0.5635	0.565	0.0025	0.561	0.563	0.008	10	0.562	0.563	0.0008	0.280	0.138	0.0008
E353	569D-3	367.207	0.32	0.0017	0.018	0.568	15.100	14.472	0.1396	0.002	0.564	0.5645	0.0025	0.561	0.563	0.005	12	0.5625	0.563	0.0002	0.325	0.1402	0.0005
E356	557A-1	366.945	1.54	0.0022	0.028	0.568	15.100	14.467	0.1380	0.002	0.562	0.564	0.0035	0.561	0.562	0.004	10	0.563	0.5635	0.001	0.310	0.1406	0.001
E357	555A-1	367.196	0.99	0.0017	0.026	0.573	15.100	14.470	0.1385	0.002	0.561	0.563	0.002	0.5604	0.563	0.008	8	0.562	0.563	0.002	0.310	0.1402	0.002
E358	565C-1	367.585	0.56	0.0021	0.024	0.569	15.090	14.462	0.1390	0.004	0.564	0.5654	0.0025	0.561	0.563	0.006	9	0.5625	0.563	0.0013	—	0.1402	0.002
E359	555C-4	366.563	0.97	0.0015	0.023	0.566	15.090	14.471	0.1390	0.002	0.562	0.563	0.0015	0.560	0.563	0.005	7	0.5615	0.562	0.0005	0.302	0.1400	0.0005
E360	582B-2	365.885	0.43	0.0015	0.024	0.575	15.080	14.470	0.1405	0.001	0.5632	0.5632	0.001	0.5615	0.5625	0.010	4	0.560	0.562	0.0035	0.310	0.1405	0.0015
E361	571B-2	367.757	0.76	0.0019	0.024	0.569	15.080	14.472	0.1358	0.003	0.5635	0.5635	0.003	0.5615	0.5625	0.013	9	0.560	0.561	0.0025	0.310	0.1365	0.003
E367	560B-4	367.145	0.40	0.0016	0.022	0.573	15.060	14.470	0.1410	0.0005	0.5633	0.564	0.0013	0.561	0.564	0.008	11	0.5595	0.561	0.002	0.305	0.1410	0.0008
E369	561A-4	367.421	0.43	0.0017	0.023	0.572	15.070	14.461	0.1398	0.001	0.563	0.564	0.001	0.561	0.5625	0.007	7	0.560	0.561	0.0025	0.305	0.1408	0.002
E370	557D-1	367.107	0.34	0.0018	0.024	0.574	15.080	14.463	0.1408	0.001	0.5625	0.5635	0.002	0.5615	0.5625	0.010	5	0.560	0.562	0.0025	0.310	0.1392	0.0025
E372	563A-2	367.385	1.07	0.0015	0.025	0.572	15.090	14.462	0.1410	0.0005	0.563	0.564	0.0017	0.5615	0.562	0.010	7	0.564	0.565	0.0025	0.310	0.1403	0.002
E378	549B-1	367.134	0.44	0.0012	0.023	0.572	15.090	14.467	0.1400	0.001	0.5615	0.562	0.0035	0.561	0.563	0.010	5	0.560	0.5605	0.003	0.310	0.140	0.003
E379	569A-2	367.339	0.91	0.0015	0.022	0.571	15.070	14.467	0.1380	0.001	0.561	0.562	0.004	0.561	0.5625	0.008	7	0.560	0.5615	0.0015	0.310	0.1395	0.002
E383	571A-3	367.318	0.50	0.0033	0.023	0.570	15.090	14.472	0.1400	0.001	0.563	0.564	0.0005	0.562	0.5635	0.007	5	0.5595	0.561	0.002	0.310	0.1398	0.003
E384	565B-4	366.429	0.57	0.0017	0.025	0.575	15.080	14.470	0.1400	0.001	0.563	0.5635	0.002	0.561	0.5625	0.0025	7	0.5600	0.5615	0.003	0.310	0.1396	0.003
E388	565D-4	367.060	0.54	0.0018	0.024	0.575	15.090	14.470	0.1405	0.002	0.563	0.564	0.0015	0.5615	0.563	0.009	4	0.5600	0.562	0.001	0.310	0.1408	0.0015
E389	564A-2	367.444	0.75	0.0017	0.024	0.573	15.070	14.466	0.1360	0.0003	0.563	0.5635	0.003	0.5615	0.563	0.014	5	0.560	0.561	0.005	0.310	0.1360	0.001
E392	559A-3	367.570	0.41	0.0018	0.023	0.565	15.090	14.468	0.1360	0.0005	0.563	0.564	0.002	0.561	0.562	0.013	4	0.561	0.562	0.004	0.310	0.1360	0.0015
E394	565B-3	367.369	0.26	0.0017	0.024	0.571	15.080	14.470	0.1400	0.001	0.564	0.565	0.001	0.561	0.562	0.008	10	0.5595	0.561	0.001	0.310	0.1360	0.0005
E396	571B-1	367.512	0.59	0.0016	0.024	0.567	15.090	14.474	0.1400	0.0007	0.5625	0.564	0.0017	0.561	0.562	0.0065	5	0.5595	0.561	0.0025	0.310	0.141	0.0007
E397	549D-2	368.393	0.36	0.0015	0.026	0.571	15.090	14.473	0.1400	0.0005	0.5635	0.565	0.002	0.5615	0.562	0.0075	7	0.560	0.561	0.002	0.310	0.140	0.001
E398	559B-1	355.770	0.54	0.0027	0.021	0.568	15.075	14.466	0.140	0.002	0.5635	0.564	0.002	0.561	0.562	0.001	8	0.560	0.561	0.002	0.305	0.1405	0.002

BLANK

Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements																Fuel Tube Assembly Measurements								
		Net Weight (g)	Density (g/cc)	Uranium				Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section		Inside Diameter (in.)	Coating Thickness (in.)		Tube Wall Thickness (in.)		Sm ₂ O ₃ Poison				
				(wt %)	Enrich- ment	Weight (g)	Weight/in. (g)		(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)		Minimum	Maximum	Maximum	Minimum	(wt %)	Weight/in. (mg)	Total Weight (mg)		
							Minimum																		Maximum	
E336	559A-2	309.919	6.096	9.98	93.15	30.41	2.14	2.19	0.425	1.68	6.09	13.998	0.5323	0.5323	0.0003	0.5243	0.380	0.5362	0.0014	0.0016	0.0108	0.0102	1.88	3.2	45	
E337	569B-2	309.692	6.090	9.88	93.15	30.11	2.13	2.17	0.615	1.645	5.97	14.001	0.5322	0.5322	0.004	0.5244	0.380	0.5362	0.0016	0.0018	0.0104	0.0097	1.76	2.7	38	
E339	562A-3	310.197	6.097	10.03	93.15	30.61	2.12	2.24	0.505	1.61	5.86	13.999	0.5324	0.5324	0.001	0.5235	0.380	0.5359	0.0019	0.0020	0.0104	0.0098	1.83	2.6	36	
E340	565D-3	310.133	6.094	9.98	93.15	30.18	2.13	2.18	0.545	1.605	5.84	14.000	0.5324	0.5324	0.0001	0.5245	0.380	0.5346	0.0014	0.0024	0.0106	0.0094	1.76	3.6	50	
E341	565C-4	309.696	6.085	10.05	93.15	30.62	2.15	2.26	0.545	1.62	5.87	14.001	0.5324	0.5325	0.0002	0.5245	0.380	0.5353	0.0008	0.0011	0.0110	0.0106	1.77	3.0	42	
E342	549B-2	309.676	6.093	9.97	93.16	30.37	2.16	2.19	0.37	1.625	5.92	14.000	0.5320	0.5320	0.0005	0.5230	0.380	0.5370	0.0014	0.0017	0.0107	0.0100	1.64	2.8	39	
E343	555D-3	309.713	6.075	9.93	93.13	30.26	2.08	2.11	0.42	1.60	5.81	13.999	0.5327	0.5327	0.0008	0.5242	0.380	0.5368	0.0014	0.0018	0.0107	0.0098	1.77	2.9	41	
E346	565A-3	309.735	6.092	9.80	93.15	29.88	2.11	2.16	0.515	1.66	6.03	13.998	0.5321	0.5322	0.0002	0.5237	0.380	0.5360	0.0015	0.0018	0.0105	0.0103	1.69	2.7	38	
E347	567C-4	309.658	6.089	9.93	93.15	30.46	2.15	2.20	0.51	1.62	5.82	14.001	0.5321	0.5321	0.0001	0.5236	0.380	0.5364	0.0016	0.0017	0.0106	0.0098	1.69	2.5	35	
E348	562C-1	309.678	6.096	9.95	93.15	30.31	2.14	2.18	0.49	1.615	5.88	14.001	0.5320	0.5320	0.0003	0.5247	0.380	0.5364	0.0015	0.0019	0.0104	0.0100	1.64	2.7	38	
E349	570A-2	310.246	6.10	10.09	93.15	30.80	2.19	2.21	0.465	1.605	5.85	14.001	0.5324	0.5324	0.0003	0.5247	0.380	0.5365	0.0015	0.0017	0.0108	0.0104	1.83	2.8	39	
E350	561C-3	310.888	6.107	10.25	93.13	30.36	2.19	2.27	0.575	1.60	5.84	14.001	0.5323	0.5323	0.0002	0.5235	0.380	0.5356	0.0019	0.0022	0.0105	0.0101	1.69	2.5	35	
E351	582A-1	308.084	6.083	10.14	93.28	30.72	2.17	2.22	0.175	1.665	6.05	13.988	0.5323	0.5323	0.0015	0.5247	0.380	0.5358	0.0030	0.0037	0.0109	0.0106	1.97	3.9	55	
E352	569D-4	309.714	6.094	9.86	93.15	30.05	2.12	2.19	0.55	1.605	5.84	14.002	0.5320	0.5321	0.001	0.5238	0.380	0.5361	0.0015	0.0017	0.0106	0.0103	1.76	2.9	41	
E353	569D-3	309.722	6.091	9.86	93.15	30.05	2.12	2.19	0.495	1.595	5.82	14.002	0.5322	0.5322	0.0011	0.5210	0.380	0.5357	0.0015	0.0020	0.0106	0.0103	1.66	2.5	35	
E356	557A-1	309.775	6.093	10.18	93.13	31.02	2.19	2.23	0.45	1.64	5.97	13.998	0.5322	0.5322	0.0004	0.5225	0.380	0.5366	0.0017	0.0024	0.0106	0.0102	1.56	2.9	41	
E357	555A-1	310.240	6.091	9.98	93.13	30.45	2.16	2.21	0.36	1.655	6.06	13.999	0.5325	0.5327	0.0002	0.5235	0.380	0.5360	0.0011	0.0014	0.0109	0.0103	1.82	2.5	35	
E358	565C-1	310.045	6.094	10.25	93.15	30.66	2.15	2.24	0.57	1.605	5.85	13.999	0.5323	0.5323	0.001	0.5235	0.380	0.5366	0.0019	0.0023	0.0113	0.0097	1.87	2.8	39	
E359	555C-4	309.783	6.082	9.77	93.13	29.76	2.10	2.17	0.41	1.66	6.03	14.000	0.5326	0.5327	0.0007	0.5245	0.380	0.5358	0.0008	0.0013	0.0105	0.0103	1.85	2.7	38	
E360	582B-2	308.593	6.065	10.07	93.28	30.56	2.13	2.13	0.21	1.665	6.03	14.000	0.5322	0.5332	0.0007	0.5237	0.380	0.5352	0.0026	0.0031	0.0110	0.0104	1.16	3.4	48	
E361	571B-2	309.845	6.104	9.95	93.15	30.32	2.08	2.14	0.485	1.64	6.00	13.999	0.5322	0.5322	0.0006	0.5240	0.380	0.5357	0.0030	0.0037	0.0110	0.0105	1.50	2.4	34	
E367	560B-4	309.541	6.087	10.00	93.15	30.46	2.15	2.20	0.455	1.60	5.82	14.001	0.5324	0.5325	0.0005	0.5238	0.380	0.5357	0.0019	0.0029	0.0110	0.0105	1.36	2.5	35	
E369	561A-4	310.470	6.098	10.20	93.15	31.14	2.19	2.26	0.50	1.585	5.87	13.995	0.5325	0.5325	0.0005	0.5241	0.380	0.5358	0.0029	0.0039	0.0108	0.0102	1.46	2.7	38	
E370	557D-1	309.910	6.100	10.16	93.13	30.19	2.19	2.24	0.40	1.655	6.09	14.000	0.5320	0.5320	0.0006	0.5240	0.400	0.5356	0.0020	0.0030	0.0110	0.0104	1.56	3.2	45	
E372	563A-2	309.689	6.093	9.93	93.15	30.25	2.14	2.17	0.57	1.64	5.97	13.999	0.5324	0.5324	0.0013	0.5241	0.375	0.5356	0.0025	0.0035	0.0106	0.0106	1.39	2.5	35	
E378	549B-1	309.776	6.089	9.97	93.16	30.39	2.16	2.19	0.345	1.595	5.80	14.000	0.5324	0.5324	0.0006	0.5241	0.380	0.5348	0.0024	0.0035	0.0105	0.0100	1.53	3.4	48	
E379	569A-2	310.241	6.100	10.13	93.15	30.92	2.14	2.27	0.52	1.52	5.80	14.001	0.5323	0.5323	0.001	0.5237	0.375	0.5352	0.0029	0.0036	0.0110	0.0103	1.30	2.9	41	
E383	571A-3	309.650	6.084	9.77	93.15	30.28	2.16	2.17	0.43	1.62	6.15	13.999	0.5325	0.5328	0.0005	0.5236	0.375	0.5365	0.0023	0.0031	0.0108	0.0105	1.65	2.7	38	
E384	565B-4	309.539	6.090	10.09	93.15	30.76	2.18	2.21	0.525	1.63	5.93	14.000	0.5321	0.5321	0.0008	0.5237	0.375	0.5357	0.0021	0.0033	0.0110	0.0100	1.33	2.4	34	
E388	565D-4	309.685	6.091	9.89	93.15	30.18	2.13	2.18	0.535	1.595	5.80	13.999	0.5324	0.5324	0.0013	0.5238	0.375	0.5359	0.0019	0.0027	0.0115	0.0100	1.43	3.6	36	
E389	564A-2	310.044	6.098	10.04	93.15	30.62	2.16	2.21	0.52	1.63	5.94	14.000	0.5320	0.5320	0.001	0.5234	0.380	0.5355	0.0026	0.0030	0.0108	0.0105	1.47	3.0	42	
E392	559A-3	309.980	5.994	9.98	93.15	30.42	2.15	2.19	0.58	1.665	5.96	14.000	0.5320	0.5322	0.0004	0.5236	0.380	0.5355	0.0025	0.0035	0.0110	0.0104	1.57	3.2	45	
E394	565B-3	309.869	6.092	10.09	93.15	30.77	2.19	2.20	0.53	1.58	5.75	13.997	0.5322	0.5322	0.0005	0.5237	0.380	0.5358	0.0028	0.0032	0.0110	0.0106	1.51	2.9	41	
E396	571B-1	310.363	6.101	9.95	93.15	30.34	2.09	2.24	0.515	1.59	5.80	14.001	0.5322	0.5322	0.0014	0.5237	0.375	0.5355	0.0023	0.0037	0.0110	0.0106	1.35	2.8	39	
E397	549D-2	310.480	6.097	10.52	93.16	31.52	2.20	2.27	0.32	1.61	5.88	14.002	0.5323	0.5323	0.0012	0.5240	0.380	0.5352	0.0032	0.0039	0.0110	0.0108	1.25	2.6	36	
E398	559B-1	309.769	6.089	10.02	93.15	30.18	2.13	2.23	0.40	1.595	5.80	14.002	0.5321	0.5321	0.0002	0.5238	0.375	0.5375	0.0013	0.0024	0.0108	0.0104	2.09	4.1	57	

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Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End			Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin		
									Diameter (in.)	TIR (in.)	Diameters (in.)		TIR (in.)	Diameters (in.)		TIR Maximum (in.)		Diameters (in.)		TIR (in.)	Length (in.)	Diameter (in.)	TIR (in.)
											Minimum	Maximum		Minimum	Maximum			Minimum	Maximum				
E400	559A-5	366.978	1.65	0.0015	0.024	0.570	15.090	14.468	0.140	0.001	0.563	0.563	0.0025	0.5615	0.562	0.0055	4	0.560	0.561	0.002	0.310	0.1402	0.0006
E402	563A-3	367.323	0.52	0.0018	0.023	0.577	15.080	14.468	0.140	0.0008	0.562	0.5625	0.001	0.562	0.562	0.015	5	0.561	0.5615	0.005	0.310	0.138	0.0025
E403	558A-1	367.545	0.41	0.0016	0.026	0.573	15.080	14.473	0.140	0.0006	0.5635	0.564	0.0008	0.561	0.5625	0.0095	4	0.561	0.562	0.0015	0.310	0.1395	0.0025
E408	557C-4	367.725	0.45	0.0018	0.022	0.567	15.090	14.466	0.141	0.0002	0.562	0.5625	0.0015	0.561	0.563	0.003	5	0.559	0.561	0.0015	0.310	0.1408	0.0015
E410	561D-2	368.387	0.59	0.0017	0.026	0.569	15.095	14.473	0.1403	0.001	0.564	0.5643	0.0035	0.562	0.563	0.008	8	0.560	0.561	0.0005	0.310	0.1408	0.0015
E411	557B-1	366.361	0.30	0.0015	0.030	0.570	15.090	14.468	0.1405	0.001	0.563	0.5635	0.0025	0.561	0.562	0.005	2	0.5595	0.561	0.0015	0.310	0.1404	0.003
E412	558D-3	367.866	0.43	0.0015	0.023	0.569	15.070	14.469	0.1395	0.0005	0.5615	0.5635	0.003	0.561	0.562	0.006	4	0.561	0.562	0.001	0.300	0.1392	0.0005
E413	568B-1	367.960	0.68	0.0016	0.023	0.574	15.090	14.466	0.141	0.0005	0.563	0.564	0.002	0.562	0.562	0.003	7	0.5605	0.5615	0.001	0.315	0.1403	0.0005
E415	562C-4	367.873	0.60	0.0018	0.022	0.572	15.090	14.472	0.141	0.001	0.563	0.564	0.0015	0.5615	0.562	0.005	7	0.560	0.5615	0.0018	0.320	0.1407	0.0005
E416	555D-1	367.200	0.59	0.0018	0.024	0.569	15.090	14.469	0.1402	0.0005	0.564	0.565	0.002	0.5615	0.563	0.0055	6	0.5605	0.562	0.002	0.310	0.1398	0.0005
E417	562A-1	367.061	0.48	0.0014	0.024	0.570	15.090	14.471	0.1403	0.0015	0.562	0.563	0.004	0.560	0.562	0.008	10	0.561	0.562	0.002	0.315	0.140	0.002
E419	549C-1	367.142	0.43	0.0016	0.024	0.567	15.070	14.466	0.1395	0.0005	0.5635	0.564	0.0007	0.562	0.562	0.004	11	0.5605	0.562	0.0015	0.315	0.140	0.0002
E420	558C-3	367.034	1.06	0.0017	0.022	0.574	15.090	14.474	0.1396	0.0012	0.563	0.564	0.0055	0.5615	0.562	0.011	7	0.559	0.5615	0.0015	0.310	0.140	0.001
E421	536C-4	365.321	0.32	0.0016	0.025	0.573	15.070	14.460	0.1397	0.004	0.563	0.564	0.003	0.561	0.563	0.010	5	0.561	0.562	0.002	0.305	0.1386	0.002
E422	556B-4	366.348	0.33	0.0017	0.024	0.567	15.068	14.468	0.1406	0.0007	0.563	0.5635	0.001	0.561	0.562	0.002	7	0.559	0.562	0.0015	0.310	0.139	0.002
E423	572D-1	367.534	0.34	0.0015	0.025	0.575	15.070	14.457	0.1396	0.0002	0.562	0.563	0.0018	0.5615	0.562	0.0085	3	0.561	0.5625	0.001	0.305	0.141	0.0015
E424	567A-2	367.019	0.46	0.0015	0.021	0.572	15.090	14.474	0.1405	0.001	0.5635	0.564	0.003	0.5615	0.562	0.012	8	0.5605	0.562	0.002	0.310	0.1393	0.004
E425	571D-3	367.068	0.53	0.0018	0.022	0.566	15.085	14.468	0.139	0.0008	0.5635	0.564	0.002	0.561	0.562	0.003	4	0.560	0.561	0.001	0.315	0.140	0.0018
E426	567C-2	366.669	0.44	0.0019	0.021	0.570	15.090	14.470	0.1395	0.0013	0.563	0.564	0.0025	0.561	0.562	0.003	10	0.562	0.5625	0.001	0.310	0.1402	0.0005
E427	568A-3	367.895	0.48	0.0018	0.021	0.573	15.070	14.456	0.140	0.0005	0.564	0.563	0.003	0.5615	0.562	0.012	10	0.5615	0.5625	0.003	0.310	0.1374	0.0005
E428	567C-1	366.828	0.36	0.0015	0.022	0.572	15.085	14.470	0.1387	0.0002	0.5625	0.564	0.001	0.5605	0.562	0.008	4	0.561	0.562	0.0015	0.310	0.1402	0.001
E429	568A-1	367.716	1.34	0.0018	0.024	0.573	15.070	14.472	0.1406	0.0005	0.563	0.564	0.0015	0.561	0.563	0.008	11	0.562	0.5625	0.0015	0.310	0.139	0.0015
E430	562D-2	366.050	0.56	0.0016	0.024	0.568	15.090	14.466	0.1405	0.0005	0.5625	0.5625	0.001	0.561	0.563	0.004	11	0.560	0.561	0.0015	0.310	0.140	0.001
E431	558C-4	366.767	0.35	0.0017	0.021	0.568	15.080	14.470	0.139	0.001	0.562	0.5625	0.001	0.561	0.562	0.0025	10	0.561	0.562	0.0065	0.310	0.139	0.0015
E432	567B-2	366.731	0.38	0.0015	0.022	0.564	15.090	14.470	0.139	0.0005	0.563	0.564	0.0005	0.560	0.562	0.0015	7	0.560	0.562	0.0015	0.310	0.141	0.0015
E433	562D-4	367.569	0.42	0.0015	0.023	0.570	15.080	14.468	0.1408	0.0003	0.563	0.564	0.0025	0.561	0.563	0.0045	4	0.560	0.561	0.002	0.315	0.139	0.0013
E434	550D-3	367.392	0.40	0.0017	0.022	0.566	15.090	14.470	0.1402	0.0006	0.563	0.564	0.0005	0.5615	0.562	0.004	3	0.560	0.562	0.002	0.310	0.1392	0.0015
E435	567A-4	367.631	0.36	0.0013	0.021	0.573	15.080	14.474	0.1398	0.0003	0.563	0.5635	0.0001	0.561	0.562	0.008	9	0.560	0.561	0.0015	0.310	0.140	0.0005
E437	560B-3	367.155	0.40	0.0017	0.026	0.573	15.070	14.466	0.1387	0.0003	0.562	0.5635	0.0035	0.561	0.562	0.010	9	0.561	0.562	0.001	0.315	0.1403	0.001
E439	567D-2	367.684	1.58	0.0015	0.025	0.574	15.080	14.466	0.1397	0.0005	0.562	0.5625	0.003	0.5615	0.562	0.010	10	0.5615	0.562	0.002	0.300	0.140	0.0007
E440	549D-4	367.452	0.33	0.0016	0.024	0.570	15.070	14.467	0.1396	0.0005	0.5615	0.562	0.002	0.5603	0.5615	0.010	5	0.560	0.561	0.0015	0.305	0.1396	0.001
E441	550C-2	366.451	0.36	0.0015	0.027	0.569	15.090	14.472	0.1394	0.001	0.5615	0.562	0.002	0.5615	0.5615	0.005	12	0.560	0.561	0.0025	0.310	0.1396	0.002
E442	563B-2	367.736	0.26	0.0015	0.019	0.571	15.070	14.466	0.1396	0.0005	0.563	0.564	0.0035	0.561	0.562	0.006	4	0.5605	0.562	0.002	0.305	0.140	0.0015
E443	530A-1	364.445	0.44	0.0017	0.029	0.568	15.090	14.470	0.1394	0.0005	0.5635	0.564	0.002	0.563	0.564	0.006	10	0.560	0.561	0.0025	0.315	0.1395	0.0005
E445	549C-2	366.903	0.15	0.0016	0.024	0.566	15.090	14.475	0.1292	0.0005	0.5625	0.564	0.0015	0.5615	0.5625	0.011	5.5	0.560	0.5625	0.0025	0.310	0.136	0.0015
E446	561D-1	366.950	0.85	0.0017	0.021	0.566	15.090	14.464	0.1402	0.0012	0.563	0.564	0.001	0.561	0.562	0.003	5.5	0.5605	0.5615	0.002	0.310	0.1397	0.001

BLANK

Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements															Fuel Tube Assembly Measurements								
		Net Weight (g)	Density (g/cc)	Uranium				Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section		Inside Diameter (in.)	Coating Thickness (in.)		Tube Wall Thickness (in.)		Sm ₂ O ₃ Poison			
				(wt %)	Enrichment	Weight (g)	Weight/in. (g)		(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)		Minimum	Maximum	Maximum	Minimum	(wt %)	Weight/in. (mg)	Total Weight (mg)	
							Minimum																		Maximum
E400	559A-5	309.875	6.093	9.98	93.15	30.43	2.15	2.19	0.51	1.615	5.88	14.000	0.5324	0.5324	0.0006	0.5244	0.375	0.5355	0.0028	0.0036	0.0108	0.0102	1.32	2.4	34
E402	563A-3	309.457	6.087	9.93	93.17	30.77	2.14	2.20	0.575	1.66	6.09	14.001	0.5320	0.5320	0.002	0.5238	0.380	0.5355	0.0020	0.0027	0.0110	0.0107	1.58	3.7	52
E403	558A-1	309.949	6.092	10.07	93.15	30.70	2.18	2.21	0.485	1.645	5.97	13.998	0.5321	0.5321	0.0005	0.5240	0.375	0.5353	0.0018	0.0026	0.0100	0.0100	1.38	2.9	41
E408	557C-4	310.374	6.078	10.00	93.13	30.52	2.14	2.22	0.475	1.66	6.03	14.001	0.5320	0.5320	0.0002	0.5230	0.395	0.5356	0.0020	0.0027	0.0110	0.0107	1.80	4.5	63
E410	561D-2	310.220	6.102	10.08	93.15	30.77	2.17	2.23	0.54	1.595	5.82	13.999	0.5320	0.5320	0.002	0.5239	0.375	0.5356	0.0025	0.0032	0.0111	0.0107	1.46	2.7	38
E411	557B-1	309.104	6.070	9.94	93.13	30.22	2.12	2.21	0.49	1.65	5.98	13.993	0.5326	0.5326	0.0002	0.5240	0.380	0.5356	0.0025	0.0031	0.0105	0.0100	1.90	3.4	48
E412	558D-3	310.570	6.093	9.98	93.15	30.18	2.12	2.18	0.525	1.635	5.95	14.001	0.5330	0.5330	0.0002	0.5296	0.380	0.5359	0.0023	0.0027	0.0105	0.010	1.72	3.5	49
E413	568B-1	309.850	6.090	9.95	93.15	30.41	2.17	2.25	0.51	1.635	5.95	14.001	0.5323	0.5323	0.0012	0.5240	0.380	0.5359	0.0023	0.0027	0.0105	0.010	1.92	4.2	59
E415	562C-4	309.971	6.094	9.95	93.15	30.35	2.14	2.19	0.505	1.61	5.86	14.002	0.5323	0.5323	0.0004	0.5234	0.380	0.5355	0.0026	0.0031	0.0105	0.010	1.67	3.5	49
E416	555D-1	310.718	6.097	9.93	93.15	30.28	2.13	2.23	0.49	1.595	6.01	14.000	0.5325	0.5325	0.0005	0.5240	0.380	0.5360	0.0023	0.0026	0.0105	0.010	1.78	3.7	52
E417	562A-1	310.333	6.098	10.03	93.15	30.42	2.12	2.24	0.465	1.60	5.83	14.000	0.5326	0.5324	0.0035	0.5236	0.380	0.5352	0.0024	0.0028	0.0105	0.010	1.17	3.7	52
E419	549C-1	309.643	6.095	10.09	93.16	30.96	2.15	2.24	0.29	1.665	6.06	14.000	0.5320	0.5322	0.0012	0.5235	0.375	0.5355	0.0022	0.0027	0.0105	0.010	1.60	3.5	49
E420	558C-3	309.707	6.094	9.95	93.15	30.31	2.09	2.20	0.525	1.66	6.03	14.002	0.5321	0.5321	0.0013	0.5233	0.375	0.5352	0.0025	0.0035	0.0105	0.010	1.33	3.0	42
E421	536C-4	308.398	6.053	10.11	93.17	30.64	2.17	2.20	0.405	1.71	6.15	13.999	0.5325	0.5325	0.006	0.5240	0.375	0.5357	0.0022	0.0030	0.0105	0.010	1.99	2.7	38
E422	556B-4	309.432	6.085	10.04	93.13	30.56	2.14	2.27	0.42	1.635	5.96	14.000	0.5320	0.5323	0.0001	0.5240	0.375	0.5357	0.0024	0.0033	0.0105	0.010	1.61	3.9	55
E423	572D-1	309.724	6.093	9.77	93.15	29.77	2.09	2.15	0.505	1.63	5.93	13.999	0.5328	0.5328	0.0003	0.5234	0.380	0.5359	0.0021	0.0024	0.0105	0.010	1.70	3.2	45
E424	567A-2	309.933	6.081	9.98	93.15	30.42	2.13	2.23	0.515	1.645	5.98	14.002	0.5323	0.5323	0.0002	0.5231	0.380	0.5353	0.0024	0.0033	0.0105	0.010	2.12	4.3	60
E425	571D-3	309.964	6.092	10.00	93.15	30.48	2.14	2.20	0.57	1.655	6.02	14.002	0.5321	0.5321	0.0005	0.5239	0.380	0.5357	0.0022	0.0025	0.0100	0.010	1.55	4.0	56
E426	567C-2	309.501	6.094	9.93	93.15	30.22	2.12	2.22	0.53	1.645	5.99	14.005	0.5320	0.5320	0.0006	0.5235	0.380	0.5357	0.0019	0.0023	0.0105	0.010	1.67	3.9	55
E427	568A-3	310.162	6.101	10.12	93.15	30.97	2.17	2.24	0.525	1.635	5.96	14.002	0.5320	0.5320	0.0006	0.5240	0.390	0.5355	0.0021	0.0027	0.0105	0.010	1.69	3.5	49
E428	567C-1	310.063	6.096	9.93	93.15	30.29	2.02	2.26	0.58	1.60	5.83	14.002	0.5323	0.5323	0.0002	0.5237	0.380	0.5353	0.0023	0.0026	0.011	0.0103	1.65	3.5	49
E429	568A-1	310.016	6.099	10.15	93.15	30.97	2.17	2.24	0.475	1.59	5.83	14.000	0.5320	0.5320	0.0005	0.5240	0.390	0.5356	0.0020	0.0023	0.011	0.0105	1.65	3.3	46
E430	562D-2	310.388	6.104	10.10	93.15	30.85	2.19	2.23	0.525	1.595	5.81	14.000	0.5323	0.5323	0.0006	0.5240	0.380	0.5356	0.0018	0.0021	0.011	0.011	1.69	4.4	62
E431	558C-4	309.480	6.092	9.95	93.15	30.29	2.09	2.20	0.49	1.64	5.97	14.003	0.5316	0.5316	0.001	0.5240	0.375	0.5350	0.0028	0.0032	0.011	0.0103	1.50	3.5	49
E432	567B-2	310.087	6.094	9.97	93.15	30.41	2.13	2.27	0.54	1.62	5.92	14.002	0.5323	0.5324	0.0006	0.5234	0.380	0.5354	0.0025	0.0030	0.0105	0.010	1.57	3.1	43
E433	562D-4	310.270	6.099	10.10	93.15	30.84	2.19	2.23	0.51	1.595	5.87	13.999	0.5322	0.5322	0.0005	0.5236	0.380	0.5352	0.0015	0.0021	0.0107	0.010	1.63	3.3	46
E434	550D-3	309.812	6.090	10.28	93.16	31.32	2.22	2.25	0.37	1.665	6.06	14.002	0.5323	0.5323	0.002	0.5240	0.385	0.5357	0.0024	0.0036	0.0110	0.0104	1.36	2.7	38
E436	567A-4	310.220	6.067	9.98	93.15	30.39	2.13	2.23	0.52	1.615	5.85	14.003	0.5324	0.5324	0.0003	0.5237	0.380	0.5350	0.0025	0.0030	0.0110	0.0106	1.66	3.8	53
E437	560B-3	310.135	6.091	10.00	93.15	30.50	2.15	2.20	0.485	1.585	6.04	13.999	0.5326	0.5326	0.001	0.5235	0.380	0.5360	0.0020	0.0023	0.0110	0.0104	1.62	3.3	46
E439	567D-2	309.823	6.089	9.93	93.15	30.25	2.13	2.20	0.49	1.665	6.06	13.999	0.5323	0.5323	0.0013	0.5240	0.380	0.5351	0.0026	0.0028	0.0105	0.011	1.72	3.6	50
E440	549D-4	310.503	6.096	10.32	93.16	31.65	2.20	2.27	0.29	1.62	5.90	14.000	0.5324	0.5324	0.001	0.5240	0.380	0.5356	0.0024	0.0028	0.0105	0.010	1.55	3.3	46
E441	550C-2	309.132	6.082	9.92	93.16	30.39	2.11	2.22	0.315	1.625	6.05	13.997	0.5324	0.5326	0.003	0.5237	0.375	0.5355	0.0027	0.0032	0.0110	0.0106	1.57	3.1	43
E442	563B-2	310.204	6.095	9.83	93.15	29.99	2.12	2.15	0.495	1.595	5.94	14.002	0.5325	0.5325	0.0008	0.5240	0.380	0.5355	0.0020	0.0024	0.011	0.0105	1.63	4.0	56
E443	530A-1	307.100	6.054	9.87	93.19	29.79	2.11	2.14	-	1.72	6.20	13.994	0.5320	0.5320	0.0003	0.5234	0.375	0.5353	0.0014	0.0017	0.011	0.0106	1.60	3.4	48
E445	549C-2	309.126	6.094	10.09	93.16	30.93	2.15	2.24	0.285	1.67	6.08	14.002	0.5320	0.5320	0.0005	0.5240	0.380	0.5353	0.0024	0.0027	0.0110	0.0104	1.51	2.9	41

BLANK

Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End		Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin			
																	Diameters (in.)		TIR (in.)				Length (in.)
									Diameter (in.)	TIR (in.)	Diameters (in.)		Diameters (in.)		TIR Maximum (in.)								
											Minimum	Maximum	Minimum	Maximum									
E447	582A-4	365.779	0.32	0.0015	0.025	0.572	15.100	14.475	0.1406	0.0015	0.563	0.564	0.001	0.561	0.562	0.007	11.5	0.560	0.562	0.003	0.310	0.1386	0.001
E448	549D-3	367.885	0.47	0.0015	0.024	0.566	15.090	14.463	0.140	0.0007	0.5635	0.564	0.0035	0.5605	0.562	0.003	12	0.560	0.561	0.0015	0.310	0.140	0.0005
E449	582A-3	365.723	0.40	0.0015	0.025	0.570	15.090	14.471	0.1403	0.0015	0.5625	0.5635	0.004	0.561	0.562	0.006	11.5	0.560	0.562	0.002	0.310	0.1392	0.0005
E450	563C-1	367.527	0.44	0.0018	0.022	0.574	15.100	14.474	0.141	0.0005	0.561	0.562	0.0025	0.561	0.562	0.012	7	0.5595	0.5615	0.003	0.310	0.1385	0.002
E451	568B-3	366.962	0.31	0.0016	0.024	0.568	15.100	14.477	0.1412	0.0005	0.5625	0.564	0.002	0.561	0.563	0.008	5	0.560	0.561	0.002	0.310	0.140	0.002
E452	571A-2	366.540	1.45	0.0016	0.021	0.5695	15.075	14.468	0.1395	0.001	0.5625	0.564	0.002	0.561	0.562	0.0005	11	0.560	0.5615	0.001	0.315	0.140	0.001
E453	582B-1	365.110	0.59	0.0015	0.021	0.568	15.080	14.465	0.1392	0.0015	0.563	0.5645	0.0005	0.561	0.562	0.0025	7	0.5595	0.561	0.002	0.310	0.140	0.0015
E454	567A-3	366.905	0.43	0.0015	0.026	0.570	15.085	14.469	0.1408	0.001	0.562	0.563	0.002	0.5615	0.5625	0.006	6	0.559	0.561	0.0015	0.310	0.140	0.002
E456	565A-1	368.000	1.19	0.0015	0.025	0.570	15.090	14.472	0.1400	0.001	0.564	0.5645	0.002	0.5615	0.5625	0.006	12	0.5615	0.5625	0.0015	0.310	0.1396	0.0025
E457	568A-4	367.110	0.75	0.0016	0.023	0.566	15.080	14.469	0.1386	0.0005	0.5624	0.563	0.002	0.561	0.562	0.006	7	0.561	0.562	0.0015	0.315	0.1406	0.002
E458	562D-1	365.910	0.39	0.0017	0.023	0.569	15.075	14.470	0.134	0.0005	0.5615	0.562	0.004	0.561	0.562	0.008	7	0.560	0.562	0.004	0.310	0.141	0.002
E461	560B-2	367.287	0.42	0.0018	0.023	0.573	15.080	14.468	0.141	0.002	0.562	0.564	0.002	0.562	0.562	0.010	7	0.5605	0.5615	0.003	0.310	0.139	0.0015
E462	559D-1	367.723	1.65	0.0013	0.028	0.5685	15.090	14.472	0.1398	0.001	0.560	0.564	0.002	0.561	0.562	0.004	7	0.560	0.561	0.002	0.310	0.1407	0.0007
E463	563B-3	367.450	0.68	0.0016	0.023	0.572	15.090	14.468	0.1395	0.001	0.563	0.564	0.004	0.561	0.562	0.004	10.5	0.5605	0.5615	0.002	0.310	0.1397	0.001
E464	569C-1	367.610	1.48	0.0016	0.022	0.571	15.070	14.470	0.1380	0.0005	0.5625	0.564	0.0005	0.561	0.562	0.010	7	0.561	0.5615	0.0025	0.315	0.1395	0.003
E466	567C-3	367.721	0.29	0.0017	0.020	0.570	15.070	14.467	0.1398	0.0005	0.563	0.564	0.0005	0.561	0.562	0.0055	5.5	0.5615	0.5625	0.002	0.305	0.140	0.001
E470	537A-2	363.555	0.26	0.0016	0.029	0.574	15.090	14.471	0.1393	0.0005	0.563	0.563	0.001	0.561	0.563	0.010	4.5	0.561	0.5625	0.0025	0.310	0.1405	0.001
E471	556D-3	367.589	0.43	0.0012	0.023	0.568	15.070	14.468	0.1404	0.0005	0.5625	0.563	0.0015	0.561	0.562	0.0065	3.5	0.560	0.561	0.0015	0.310	0.1395	0.001
E472	561C-2	368.334	0.30	0.0019	0.026	0.568	15.080	14.470	0.1398	0.001	0.562	0.564	0.003	0.562	0.563	0.006	11	0.561	0.562	0.002	0.310	0.140	0.0015
E474	572A-3	366.859	0.31	0.0021	0.024	0.568	15.090	14.467	0.140	0.001	0.561	0.563	0.002	0.5605	0.5645	0.005	7.5	0.561	0.562	0.0015	0.310	0.1404	0.003
E475	568B-4	367.487	0.40	0.0017	0.023	0.571	15.090	14.470	0.140	0.003	0.5635	0.564	0.005	0.5615	0.563	0.008	4	0.561	0.5612	0.001	0.310	0.1405	0.003
E476	572B-2	366.807	0.61	0.0015	0.026	0.574	15.090	14.471	0.138	0.0005	0.563	0.5635	0.0015	0.561	0.562	0.012	4	0.560	0.562	0.003	0.310	0.1405	0.0006
E477	558A-2	367.262	0.27	0.0016	0.023	0.570	15.090	14.473	0.139	0.001	0.563	0.5635	0.0035	0.5615	0.562	0.005	3	0.560	0.561	0.0005	0.305	0.1407	0.002
E478	582B-3	366.494	0.43	0.0014	0.023	0.574	15.080	14.474	0.140	0.001	0.564	0.5645	0.001	0.562	0.562	0.010	7	0.562	0.5625	0.003	0.310	0.140	0.0005
E479	559C-2	368.118	0.85	0.0016	0.024	0.573	15.090	14.464	0.1389	0.0015	0.5635	0.5645	0.0015	0.5615	0.5625	0.009	5	0.5595	0.5615	0.0015	0.315	0.1389	0.0017
E481	582C-3	366.099	0.37	0.0017	0.022	0.566	15.090	14.472	0.1403	0.0005	0.563	0.565	0.003	0.561	0.563	0.0045	11.5	0.561	0.563	0.003	0.310	0.1400	0.002
E482	560C-2	367.455	0.92	0.002	0.021	0.572	15.090	14.468	0.1397	0.0005	0.5625	0.563	0.004	0.5605	0.5625	0.011	5.5	0.560	0.561	0.0025	0.310	0.1407	0.001
E483	571D-2	367.055	0.34	0.0017	0.025	0.561	15.090	14.468	0.139	0.001	0.562	0.5635	0.002	0.561	0.5625	0.0045	5	0.5605	0.5615	0.002	0.310	0.1405	0.002
E484	570D-1	367.061	0.23	0.0017	0.022	0.571	15.100	14.475	0.1405	0.001	0.563	0.563	0.002	0.561	0.563	0.010	5.5	0.5605	0.561	0.0015	0.310	0.1390	0.0035
E485	571B-4	367.619	0.34	0.0016	0.024	0.566	15.070	14.471	0.1396	0.0005	0.562	0.563	0.002	0.5605	0.5625	0.0045	6	0.560	0.562	0.001	0.310	0.140	0.003
E486	582C-2	365.408	0.25	0.002	0.023	0.564	15.090	14.474	0.1355	0.002	0.562	0.5625	0.003	0.561	0.562	0.013	5	0.5605	0.5615	0.0025	0.310	0.140	0.0025
E487	582A-2	366.381	0.90	0.0018	0.023	0.575	15.090	14.470	0.140	0.003	0.5645	0.566	0.003	0.5615	0.563	0.009	11	0.561	0.562	0.002	0.310	0.1404	0.002
E488	534D-4	364.700	0.32	0.0015	0.022	0.570	15.090	14.467	0.1395	0.001	0.561	0.563	0.0035	0.561	0.5615	0.0085	11	0.560	0.562	0.0035	0.310	0.1406	0.0035
E489	568C-1	366.983	0.59	0.0014	0.024	0.568	15.065	14.465	0.1395	0.001	0.5625	0.564	0.0015	0.561	0.562	0.007	6	0.560	0.562	0.002	0.310	0.1402	0.0015
E490	572B-1	366.619	1.51	0.0015	0.023	0.573	15.090	14.472	0.1405	0.002	0.563	0.564	0.001	0.5605	0.562	0.006	4	0.561	0.562	0.0025	0.310	0.140	0.0015

BLANK

Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements																Fuel Tube Assembly Measurements								
		Net Weight (g)	Density (g/cc)	Uranium					Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section		Inside Diameter (in.)	Coating Thickness (in.)		Tube Wall Thickness (in.)		Sm ₂ O ₃ Poison			
				(wt %)	Enrichment	Weight (g)	Weight/in. (g)			(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)		Minimum	Maximum	Maximum	Minimum	(wt %)	Weight/in. (mg)	Total Weight (mg)	
							Minimum	Maximum																		
E446	561D-1	309.852	6.095	10.08	93.15	30.73	2.17	2.22	0.545	1.605	5.84	13.994	0.5323	0.5323	0.0039	0.5234	0.375	0.5356	0.0026	0.0034	0.0107	0.0104	1.38	4.1	57	
E447	582A-4	308.526	6.067	10.19	93.28	30.76	2.17	2.22	0.18	1.685	6.19	13.999	0.5223	0.5223	0.0025	0.5250	0.380	0.5354	0.0025	0.0026	0.011	0.0105	1.25	2.5	35	
E448	549D-3	310.682	6.094	10.32	93.16	31.67	2.20	2.27	0.335	1.585	5.77	13.999	0.5325	0.5327	0.0004	0.5240	0.380	0.5357	0.0025	0.0032	0.0105	0.0102	1.62	3.2	45	
E449	582A-3	308.699	6.055	10.14	93.28	30.77	2.17	2.22	0.175	1.71	6.19	13.999	0.5325	0.5325	0.0006	0.5242	0.380	0.5354	0.0025	0.0028	0.0106	0.0104	1.44	3.1	43	
E450	563C-1	310.623	6.109	10.14	93.15	30.99	2.16	2.24	0.54	1.605	5.86	14.002	0.5321	0.5321	0.0003	0.5238	0.390	0.5356	0.0020	0.0022	0.0108	0.0102	1.60	3.5	49	
E451	568B-3	309.463	6.086	9.98	93.15	30.43	2.13	2.23	0.51	1.67	6.07	13.999	0.5323	0.5323	0.0002	0.5231	0.380	0.5355	0.0024	0.0029	0.0110	0.0104	1.39	2.8	39	
E452	571A-2	309.545	6.087	9.95	93.15	30.52	2.16	2.22	0.53	1.60	5.82	14.000	0.5322	0.5322	0.0008	0.5235	0.375	0.5355	0.0018	0.0020	0.0110	0.0104	1.57	3.3	46	
E453	582B-1	308.289	6.067	10.07	93.28	30.52	2.12	2.22	0.23	1.70	6.15	13.999	0.5324	0.5324	0.001	0.5237	0.380	0.5355	0.0018	0.0023	0.0104	0.010	1.27	2.9	41	
E454	567A-3	309.803	6.092	9.98	93.15	30.41	2.13	2.23	0.53	1.65	6.01	13.998	0.5323	0.5323	0.0002	0.5240	0.380	0.5353	0.0025	0.0026	0.0105	0.010	1.33	2.7	38	
E456	565A-1	310.121	6.095	9.79	93.15	29.86	2.12	2.16	0.53	1.63	5.94	13.997	0.5323	0.5325	0.0013	0.5235	0.380	0.5355	0.0026	0.0033	0.0105	0.010	1.65	3.0	42	
E457	568A-4	309.920	6.097	10.15	93.15	30.93	2.17	2.24	0.525	1.64	6.03	13.999	0.5320	0.5320	0.0002	0.5240	0.390	0.5354	0.0014	0.0020	0.0105	0.010	1.40	3.0	42	
E458	562D-1	309.033	6.065	10.10	93.15	30.71	2.18	2.22	0.515	1.615	5.85	14.000	0.5323	0.5323	0.0012	0.5245	0.380	0.5356	0.0016	0.0018	0.0105	0.010	1.65	3.8	53	
E461	560B-2	308.855	6.096	10.00	93.15	30.49	2.15	2.20	0.46	1.61	5.86	14.002	0.5322	0.5322	0.0002	0.5240	0.380	0.5357	0.0010	0.0020	0.0109	0.0105	1.61	3.5	49	
E462	559D-1	306.676	6.096	9.90	93.15	30.17	2.14	2.17	0.46	1.635	6.04	13.996	0.5325	0.5326	0.0004	0.5237	0.380	0.5351	0.0021	0.0026	0.0108	0.0105	1.68	3.6	50	
E463	563B-3	309.566	6.092	9.83	93.15	29.93	2.12	2.18	0.495	1.63	5.93	14.001	0.5323	0.5323	0.001	0.5236	0.375	0.5355	0.0024	0.0031	0.0110	0.0105	1.88	3.5	49	
E464	569C-1	310.003	6.093	10.00	93.15	30.51	2.16	2.23	0.585	1.675	6.09	14.002	0.5324	0.5324	0.001	0.5250	0.380	0.5356	0.0025	0.0031	0.0110	0.0104	1.76	3.7	52	
E466	567C-3	310.010	6.094	9.93	93.17	30.28	2.13	2.28	0.50	1.615	5.92	14.003	0.5323	0.5323	0.0001	0.5236	0.380	0.5357	0.0023	0.0031	0.0110	0.0104	1.65	3.4	48	
E470	537A-2	306.158	6.029	9.89	93.17	29.77	2.08	2.15	-	1.665	5.97	13.995	0.5320	0.5320	0.0005	0.5238	0.375	0.5353	0.0023	0.0027	0.0106	0.0102	1.58	3.4	48	
E471	556D-3	310.130	6.083	9.98	93.13	30.44	2.13	2.22	0.40	1.635	5.94	14.000	0.5328	0.5328	0.0004	0.5243	0.380	0.5352	0.0021	0.0033	0.0107	0.0103	1.44	3.1	43	
E472	561C-2	310.545	6.095	10.25	93.15	31.32	2.18	2.27	0.57	1.615	5.88	13.998	0.5323	0.5324	0.001	0.5224	0.375	0.5360	0.0025	0.0027	0.0107	0.0103	1.56	3.3	46	
E474	572A-3	309.767	6.106	9.95	93.15	30.26	2.12	2.21	0.49	1.68	6.09	13.999	0.5323	0.5322	0.0015	0.5223	0.375	0.5365	0.0021	0.0026	0.0108	0.0100	1.51	3.1	43	
E475	568B-4	309.699	6.085	10.00	93.15	30.47	2.14	2.23	0.515	1.605	5.87	14.000	0.5323	0.5323	0.001	0.5237	0.375	0.5356	0.0024	0.0029	0.0107	0.0104	1.30	2.8	39	
E476	572B-2	309.565	6.091	9.95	93.15	30.29	2.13	2.18	0.50	1.665	6.03	13.997	0.5322	0.5323	0.0018	0.5240	0.380	0.5351	0.0024	0.0029	0.0106	0.0103	1.15	2.6	36	
E477	558A-2	309.865	6.098	10.07	93.15	30.69	2.18	2.20	0.505	1.65	6.03	14.001	0.5322	0.5322	0.0007	0.5240	0.375	0.5353	0.0023	0.0031	0.0105	0.0103	1.55	3.4	48	
E478	582B-3	308.632	6.068	10.07	93.28	30.56	2.13	2.22	0.23	1.685	6.11	14.000	0.5324	0.5324	0.0005	0.5240	0.380	0.5352	0.0023	0.0026	0.0107	0.0103	1.28	2.7	38	
E479	559C-2	310.038	6.098	10.05	93.15	30.66	2.18	2.21	0.525	1.605	5.85	14.000	0.5322	0.5322	0.004	0.5233	0.375	0.5354	0.0026	0.0031	0.0107	0.0103	1.56	3.4	48	
E481	582C-3	308.747	6.066	10.21	93.28	30.98	2.16	2.23	0.205	1.705	6.15	14.001	0.5320	0.5320	0.002	0.5230	0.375	0.5353	0.0022	0.0024	0.0107	0.0103	1.69	3.4	48	
E482	560C-2	310.114	6.109	10.17	93.15	31.02	2.19	2.25	0.445	1.615	5.89	13.998	0.5316	0.5320	0.0007	0.5235	0.390	0.5357	0.0025	0.0029	0.0106	0.0103	-	3.9	55	
E483	571D-2	310.300	6.106	10.00	93.15	30.52	2.15	2.21	0.565	1.64	5.97	13.998	0.5323	0.5324	0.003	0.5255	0.375	0.5358	0.0025	0.0034	0.0105	0.0101	1.35	2.9	39	
E484	570D-1	309.759	6.089	9.92	93.15	30.23	2.13	2.19	0.475	1.615	5.87	14.001	0.5322	0.5322	0.0001	0.5232	0.375	0.5356	0.0024	0.0030	0.0106	0.0100	1.24	2.6	36	
E485	571B-4	310.290	6.107	9.95	93.15	30.34	2.08	2.24	0.465	1.65	6.03	13.999	0.5323	0.5325	0.0005	0.5225	0.400	0.5357	0.0022	0.0025	0.0106	0.0098	1.71	3.6	50	
E486	582C-2	308.659	6.070	10.21	93.28	30.98	2.16	2.23	0.19	1.705	6.15	14.001	0.5317	0.5317	0.0015	0.5236	0.375	0.5358	0.0025	0.0029	0.0106	0.0098	1.62	3.5	49	
E487	582A-2	308.562	6.066	10.14	93.28	30.76	2.17	2.22	0.18	1.69	6.13	14.000	0.5320	0.5325	0.0013	0.5246	0.380	0.5358	0.0023	0.0028	0.0107	0.0104	1.47	3.2	45	
E488	534D-4	307.668	6.058	10.10	93.17	30.54	2.14	2.25	-	1.71	6.20	14.001	0.5319	0.5319	0.0004	0.5242	0.390	0.5350	0.0026	0.0032	0.0107	0.0101	1.34	3.3	46	
E489	568C-1	309.833	6.097	9.78	93.15	29.80	2.10	2.19	0.53	1.60	5.82	13.999	0.5324	0.5325	0.002	0.5232	0.375	0.5357	0.0028	0.0031	0.0107	0.0107	1.30	2.7	38	
E490	572B-1	309.655	6.088	9.95	93.15	30.30	2.13	2.19	0.475	1.645	5.97	14.000	0.5322	0.5322	0.0003	0.5240	0.380	0.5353	0.0024	0.0028	0.0104	0.0098	1.26	2.7	38	

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Fuel Element Serial Number	Fuel Rod Serial Number	Net Weight (g)	Hydrogen Leak Rate (cc/hr) 1400°F	Radial Gap (in.)	Axial Gap (in.)	Envelope Diameter (in.)	Length (in.)	Length Minus Grid Pins (in.)	Plug End Grid Pins		1/4 in. From Plug End			Center of Element			Location of Maximum TIR from No. End (in.)	Cap End Weld Area			Cap End Grid Pin		
																		Diameters (in.)		TIR (in.)			
											Diameter (in.)	TIR (in.)	Diameters (in.)	TIR Maximum (in.)	Diameters (in.)	TIR Maximum (in.)		Diameters (in.)	TIR (in.)		Length (in.)	Diameter (in.)	TIR (in.)
									Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
E491	567A-1	367.029	0.39	0.0016	0.023	0.573	15.090	14.477	0.1400	0.0005	0.563	0.5645	0.0035	0.561	0.563	0.0115	11	0.560	0.561	0.001	0.310	0.140	0.0015
E492	558D-1	365.369	0.65	0.002	0.023	0.568	15.090	14.465	0.1405	0.0015	0.5615	0.563	0.001	0.560	0.563	0.008	4.5	0.5595	0.5615	0.0015	0.310	0.140	0.003
E493	564A-3	367.934	0.18	0.0019	0.021	0.567	15.090	14.475	0.136	0.0015	0.562	0.563	0.005	0.561	0.562	0.0135	7.5	0.561	0.562	0.004	0.310	0.1303	0.002
E496	532C-2	364.047	0.48	0.0018	0.022	0.567	15.090	14.468	0.139	0.001	0.563	0.5635	0.0035	0.561	0.562	0.006	4	0.560	0.5625	0.003	0.310	0.1397	0.002
E499	556C-3	366.570	0.81	0.0018	0.024	0.570	15.100	14.472	0.140	0.0015	0.562	0.563	0.0015	0.561	0.5625	0.008	7	0.561	0.562	0.0025	0.310	0.1398	0.005
E500	557B-5	363.879	0.28	0.0018	0.026	0.565	15.090	14.473	0.1388	0.001	0.563	0.5635	0.001	0.5605	0.562	0.004	11.5	0.5605	0.562	0.003	0.310	0.141	0.0045
E501	538C-4	364.894	0.22	0.0017	0.025	0.571	15.075	14.476	0.1408	0.001	0.563	0.563	0.0025	0.5615	0.562	0.010	9	0.5605	0.5625	0.0015	0.305	0.1402	0.001
E503	556D-1	367.093	0.21	0.0013	0.020	0.565	15.085	14.471	0.1395	0.001	0.562	0.5635	0.002	0.562	0.562	0.005	11.5	0.561	0.562	0.002	0.320	0.140	0.0005
E504	561C-1	368.816	0.21	0.0016	0.023	0.568	15.080	14.470	0.140	0.001	0.562	0.564	0.002	0.561	0.5625	0.007	7	0.560	0.561	0.0025	0.305	0.1399	0.001
E505	555A-4	367.337	0.37	0.0017	0.023	0.571	15.080	14.469	0.1393	0.001	0.563	0.565	0.0015	0.561	0.562	0.008	4	0.5605	0.5625	0.0025	0.310	0.1407	0.0025
E506	555B-2	367.482	0.14	0.0014	0.024	0.569	15.090	14.474	0.1404	0.0005	0.563	0.564	0.001	0.561	0.5625	0.007	11	0.5615	0.562	0.002	0.305	0.1399	0.0025
E508	563C-2	368.368	0.11	0.0015	0.024	0.572	15.080	14.471	0.137	0.0025	0.562	0.5625	0.002	0.5615	0.562	0.013	7.5	0.5615	0.562	0.001	0.310	0.137	0.007
E509	564A-1	366.424	0.15	0.0019	0.025	0.568	15.090	14.472	0.1405	0.0005	0.563	0.564	0.002	0.560	0.563	0.0065	6	0.560	0.563	0.002	0.315	0.140	0.0015
E510	556B-3	365.817	0.43	0.002	0.023	0.566	15.090	14.475	0.1397	0.002	0.5625	0.564	0.0035	0.5605	0.562	0.005	4	0.560	0.562	0.0025	0.310	0.140	0.003
E511	571D-1	366.522	0.90	0.002	0.021	0.574	15.080	14.468	0.1395	0.0005	0.562	0.563	0.0005	0.561	0.5625	0.012	10.5	0.561	0.563	0.003	0.310	0.1405	0.0025
E513	582C-4	366.421	1.05	0.0017	0.022	0.562	15.090	14.474	0.1405	0.0005	0.5635	0.564	0.001	0.561	0.563	0.0025	7.5	0.5605	0.563	0.002	0.310	0.1405	0.0015
E514	569D-1	366.483	0.47	0.0022	0.023	0.570	15.090	14.470	0.1365	0.0025	0.563	0.565	0.002	0.561	0.5625	0.014	4	0.560	0.562	0.002	0.310	0.137	0.001
E515	560A-2	369.233	0.34	0.0016	0.025	0.570	15.080	14.466	0.140	0.0005	0.5635	0.564	0.0012	0.5615	0.5625	0.008	9	0.560	0.561	0.0015	0.310	0.140	0.002
E516	562A-4	367.111	1.02	0.0017	0.024	0.573	15.090	14.468	0.1408	0.0005	0.562	0.564	0.001	0.561	0.562	0.010	10	0.5605	0.563	0.002	0.315	0.1405	0.002
E517	559B-4	367.507	0.34	0.0016	0.023	0.570	15.090	14.472	0.1392	0.0005	0.5625	0.563	0.003	0.5615	0.562	0.008	12	0.5595	0.5615	0.002	0.310	0.1398	0.002
E518	572A-2	367.281	0.42	0.0018	0.023	0.567	15.080	14.472	0.1405	0.0015	0.5625	0.564	0.002	0.561	0.563	0.004	3.5	0.561	0.562	0.002	0.310	0.141	0.008
E519	564B-4	366.395	0.47	0.0022	0.021	0.562	15.090	14.474	0.139	0.003	0.563	0.564	0.004	0.561	0.562	0.002	7.5	0.559	0.563	0.0025	0.310	0.1402	0.002
E520	560A-3	367.867	0.08	0.0018	0.026	0.572	15.090	14.475	0.140	0.0005	0.562	0.564	0.0025	0.562	0.562	0.0105	11	0.5605	0.562	0.0015	0.305	0.140	0.0015
E521	567D-3	367.518	0.34	0.002	0.023	0.568	15.070	14.476	0.137	0.0005	0.563	0.564	0.0025	0.561	0.563	0.005	7	0.559	0.561	0.0005	0.310	0.140	0.002
E522	568A-2	367.314	0.62	0.0021	0.021	0.573	15.090	14.470	0.1407	0.0005	0.563	0.564	0.002	0.561	0.563	0.013	9	0.561	0.562	0.0025	0.320	0.1402	0.002
E523	555A-2	367.187	0.50	0.0017	0.024	0.569	15.090	14.474	0.1402	0.0005	0.563	0.564	0.002	0.561	0.562	0.0075	9	0.560	0.562	0.002	0.310	0.140	0.002
E524	555B-1	366.521	0.13	0.0019	0.023	0.572	15.090	14.472	0.1407	0.0025	0.5635	0.564	0.002	0.561	0.5625	0.011	11.5	0.560	0.561	0.0015	0.310	0.140	0.0015
E525	550A-1	366.682	0.21	0.0016	0.030	0.570	15.090	14.474	0.139	0.002	0.562	0.563	0.0025	0.560	0.563	0.010	5	0.562	0.5625	0.0005	0.320	0.1402	0.0005
E526	556A-3	365.918	0.40	0.0016	0.024	0.569	15.090	14.467	0.1404	0.0005	0.5625	0.5635	0.001	0.5605	0.562	0.008	9	0.560	0.561	0.0015	0.310	0.1404	0.002
E527	564B-1	366.089	0.48	0.0018	0.024	0.569	15.075	14.466	0.1405	0.0005	0.562	0.5635	0.0016	0.5605	0.562	0.008	7.5	0.560	0.561	0.002	0.310	0.1405	0.0025
E528	531A-1	363.544	0.15	0.002	0.026	0.568	15.090	14.473	0.138	0.0005	0.562	0.564	0.0015	0.561	0.562	0.0016	8.5	0.561	0.5615	0.0015	0.310	0.1380	0.002
E529	570D-2	367.010	0.83	0.002	0.024	0.572	15.090	14.469	0.1375	0.0005	0.564	0.5645	0.002	0.561	0.562	0.0013	8	0.560	0.5625	0.002	0.310	0.140	0.002
E530	557D-2	369.729	0.09	0.0016	0.024	0.572	15.090	14.475	0.1404	0.001	0.564	0.5645	0.0005	0.562	0.562	0.0095	10	0.560	0.563	0.002	0.310	0.1405	0.0015
E531	540D-4	365.635	0.05	0.0017	0.024	0.568	15.100	14.477	0.137	0.001	0.5635	0.564	0.003	0.561	0.562	0.014	8	0.561	0.562	0.002	0.310	0.1365	0.004
E532	582B-4	365.008	0.51	0.0016	0.023	0.570	15.090	14.472	0.140	0.001	0.5625	0.564	0.0025	0.561	0.562	0.008	7	0.560	0.561	0.003	0.310	0.141	0.0015
E533	531D-4	367.090	0.55	0.0009	0.020	0.566	15.080	14.475	0.140	0.001	0.5625	0.564	0.0015	0.561	0.562	0.003	10	0.5605	0.561	0.002	0.310	0.140	0.001

BLANK

SECRET

Fuel Element Serial Number	Fuel Rod Serial Number	Fuel Rod Measurements																Fuel Tube Assembly Measurements								
		Net Weight (g)	Density (g/cc)	Uranium					Carbon (wt %)	Hydrogen		Length (in.)	Diameters (in.)		TIR (in.)	Reduced Section		Inside Diameter (in.)	Coating Thickness (in.)		Tube Wall Thickness (in.)		Sm ₂ O ₃ Poison			
				(wt %)	Enrich- ment	Weight (g)	Weight/in. (g)			(wt %)	N _H		Minimum	Maximum		Diameter (in.)	Length (in.)		Minimum	Maximum	Maximum	Minimum	(wt %)	Weight/in. (mg)	Total Weight (mg)	
							Minimum	Maximum																		
E491	567A-1	310.028	6.106	9.98	93.15	30.18	2.12	2.21	0.53	1.595	5.82	14.000	0.5322	0.5322	0.0006	0.5245	0.375	0.5355	0.0022	0.0025	0.0106	0.0102	1.35	3.0	42	
E492	558D-1	308.926	6.089	9.88	93.15	30.02	2.12	2.17	0.52	1.64	5.96	14.001	0.5315	0.5318	0.0001	0.5240	0.395	0.5358	0.0026	0.0032	0.0106	0.0100	1.62	3.4	48	
E493	564A-3	310.575	6.103	10.04	93.15	30.68	2.16	2.21	0.525	1.605	5.85	14.002	0.5322	0.5323	0.0002	0.5236	0.380	0.5350	0.0037	0.0030	0.0105	0.0099	1.48	3.2	45	
E496	532C-2	308.321	6.050	9.87	93.17	29.91	2.11	2.16	-	1.605	6.15	14.001	0.5326	0.5330	0.0085	0.5240	0.375	0.5363	0.0023	0.0025	0.0105	0.0101	1.29	2.7	38	
E499	556C-3	309.317	6.082	9.60	93.13	29.21	2.09	2.13	0.39	1.645	5.97	14.000	0.5322	0.5322	0.0007	0.5240	0.380	0.5357	0.0023	0.0026	0.0106	0.0104	1.52	3.4	48	
E500	557B-5	307.467	6.084	9.94	93.13	30.05	2.10	2.19	0.435	1.61	5.85	13.998	0.5310	0.5320	0.0045	0.5230	0.375	0.5360	0.0024	0.0027	0.0106	0.0100	1.67	3.8	53	
E501	538C-4	307.786	6.017	9.75	93.17	29.50	2.07	2.15	-	1.695	6.09	13.999	0.5323	0.5323	0.0003	0.5240	0.380	0.5358	0.0024	0.0028	0.0106	0.0104	1.65	3.5	49	
E503	556D-1	310.056	6.082	9.98	93.13	30.44	2.13	2.22	0.425	1.645	5.98	14.003	0.5329	0.5329	0.0008	0.5242	0.380	0.5357	0.0027	0.0036	0.0106	0.0103	1.98	3.2	45	
E504	561C-1	308.499	6.086	10.25	93.15	31.51	2.20	2.29	0.545	1.695	5.86	14.002	0.5335	0.5337	0.0003	0.5238	0.375	0.5356	0.0022	0.0028	0.0107	0.0103	1.73	3.9	55	
E505	555A-4	310.038	6.087	9.98	93.13	30.93	2.16	2.21	0.40	1.645	6.09	14.000	0.5327	0.5327	0.0008	0.5220	0.380	0.5361	0.0023	0.0032	0.0107	0.0103	1.66	3.6	50	
E506	555B-2	309.612	6.039	10.00	93.13	30.64	2.12	2.23	0.405	1.605	5.79	14.000	0.5324	0.5324	0.0007	0.5240	0.380	0.5352	0.0023	0.0026	0.0107	0.0103	2.01	4.3	60	
E508	563C-2	312.083	6.097	10.14	93.15	31.14	2.17	2.26	0.605	1.605	5.81	14.000	0.5335	0.5335	0.0005	0.5240	0.375	0.5366	0.0022	0.0026	0.0105	0.0103	1.83	4.1	57	
E509	564A-1	309.977	6.098	10.04	93.15	30.61	2.16	2.21	0.505	1.65	6.03	13.999	0.5320	0.5320	0.0004	0.5237	0.380	0.5358	0.0023	0.0024	0.0106	0.0099	1.77	3.9	55	
E510	556B-3	309.447	6.086	10.04	93.13	30.55	2.14	2.27	0.42	1.67	6.09	14.000	0.5323	0.5323	0.0025	0.5225	0.375	0.5362	0.0027	0.0032	0.0107	0.0098	1.35	2.9	41	
E511	571D-1	309.449	6.092	10.04	93.15	30.44	2.14	2.20	0.545	1.635	5.95	14.002	0.5325	0.5325	0.0015	0.5230	0.375	0.5362	0.0025	0.0027	0.0108	0.0101	1.58	3.3	46	
E513	582C-4	308.500	6.084	10.00	93.28	30.97	2.16	2.23	0.195	1.715	6.20	14.001	0.5320	0.5320	0.0013	0.5235	0.375	0.5353	0.0026	0.0033	0.0108	0.0103	1.39	3.3	46	
E514	569D-1	309.339	6.082	10.21	93.15	30.01	2.12	2.21	0.545	1.605	5.83	14.001	0.5321	0.5321	0.0013	0.5236	0.375	0.5364	0.0020	0.0025	0.0107	0.0104	1.76	3.6	50	
E515	560A-2	309.339	6.082	9.87	93.15	30.58	2.15	2.21	0.40	1.60	5.81	13.999	0.5336	0.5336	0.0018	0.5235	0.375	0.5367	0.0021	0.0027	0.0108	0.0103	1.91	4.0	56	
E516	562A-1	309.604	6.101	9.95	93.15	30.63	2.12	2.24	0.52	1.595	5.74	14.000	0.5324	0.5324	0.0007	0.5237	0.375	0.5357	0.0024	0.0029	0.0107	0.0104	1.86	3.9	55	
E517	559B-4	309.769	6.089	10.03	93.15	30.60	2.13	2.23	0.46	1.595	6.03	14.001	0.5323	0.5323	0.010	0.5245	0.375	0.5355	0.0023	0.0031	0.0107	0.0102	1.67	3.4	48	
E518	572A-2	309.633	6.096	10.02	93.15	30.26	2.13	2.19	0.505	1.65	6.01	13.998	0.5323	0.5325	0.0018	0.5241	0.375	0.5349	0.0030	0.0033	0.0108	0.0099	1.46	3.1	43	
E519	564B-4	309.621	6.094	10.15	93.15	30.28	2.14	2.21	0.505	1.595	5.81	14.000	0.5321	0.5321	0.0012	0.5235	0.380	0.5364	0.0022	0.0025	0.0107	0.0100	1.37	3.1	43	
E520	560A-3	310.614	6.102	9.95	93.15	30.41	2.14	2.20	0.435	1.61	5.87	13.998	0.5325	0.5325	0.0095	0.5240	0.375	0.5360	0.0024	0.0027	0.0107	0.0102	1.63	3.6	50	
E521	567D-3	310.133	6.094	9.93	93.15	30.33	2.14	2.21	0.455	1.605	5.83	14.001	0.5325	0.5325	0.001	0.5246	0.380	0.5364	0.0025	0.0027	0.0107	0.0102	1.80	4.3	60	
E522	568A-2	310.072	6.100	10.15	93.15	30.97	2.17	2.24	0.50	1.605	5.85	14.002	0.5320	0.5320	0.0002	0.5243	0.385	0.5362	0.0025	0.0030	0.0107	0.0101	1.42	3.0	42	
E523	555A-2	310.213	6.085	9.98	93.13	30.46	2.16	2.21	0.37	1.605	5.84	14.000	0.5325	0.5326	0.0005	0.5246	0.380	0.5359	0.0025	0.0027	0.0105	0.0103	1.49	3.0	42	
E524	555B-1	308.983	6.082	10.00	93.13	30.40	2.11	2.23	0.39	1.62	5.89	14.001	0.5320	0.5320	0.0028	0.5240	0.375	0.5357	0.0022	0.0027	0.0107	0.0101	1.73	3.7	52	
E525	550A-1	309.705	6.086	10.11	93.16	30.01	2.16	2.24	0.305	1.61	5.85	13.994	0.5323	0.5323	0.0025	0.5240	0.380	0.5353	0.0024	0.0028	0.0107	0.0101	1.97	4.1	57	
E526	556A-3	309.079	6.080	9.92	93.13	30.15	2.12	2.21	0.41	1.665	6.05	13.999	0.5323	0.5323	0.0007	0.5241	0.380	0.5355	0.0025	0.0035	0.0105	0.0100	1.54	3.3	46	
E527	564B-1	309.488	6.090	9.94	93.15	30.25	2.14	2.21	0.525	1.66	6.04	13.999	0.5323	0.5323	0.0013	0.5235	0.380	0.5358	0.0025	0.0035	0.0104	0.0100	1.48	3.5	49	
E528	531A-1	307.312	6.055	9.94	93.18	30.03	2.12	2.16	-	1.695	6.15	13.998	0.5322	0.5322	0.0007	0.5239	0.380	0.5362	0.0021	0.0024	0.0106	0.0095	1.83	3.4	48	
E529	570D-2	309.792	6.087	9.92	93.15	30.22	2.13	2.18	0.505	1.65	6.00	13.999	0.5324	0.5324	0.002	0.5240	0.385	0.5363	0.0023	0.0027	0.0106	0.0101	1.82	4.1	57	
E530	557D-2	309.910	6.100	10.16	93.13	30.97	2.19	2.24	0.40	1.655	6.03	14.000	0.5320	0.5321	0.001	0.5228	0.390	0.5354	0.0025	0.0030	0.0108	0.0107	1.77	4.1	57	
E531	540D-4	307.804	6.056	9.79	93.17	29.62	2.11	2.12	-	1.715	6.20	14.000	0.5323	0.5323	0.0004	0.5245	0.375	0.5357	0.0025	0.0028	0.0107	0.0104	1.60	3.5	49	
E532	582B-4	307.544	6.045	10.07	93.28	30.44	2.12	2.18	0.21	1.71	6.18	14.001	0.5324	0.5324	0.0017	0.5244	0.380	0.5357	0.0022	0.0026	0.0106	0.0102	1.79	3.7	52	
E533	531D-4	310.307	6.054	9.91	93.17	30.23	2.12	2.20	-	1.70	6.15	14.003	0.5340	0.5340	0.0007	0.5240	0.380	0.5357	0.0022	0.0027	0.0107	0.009	1.37	2.9	41	

SECRET