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DATE January 14, 1966

FUEL REFERENCE DESIGN AND
PERTINENT OPERATING DATA FOR
COPRODUCT DEMONSTRATION LOAD

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FUEL REFERENCE DESIGN AND
PERTINENT OPERATING DATA FOR
COPRODUCT DEMONSTRATION LOAD

January 14, 1966

E. G. Pierick

Research and Engineering
N-Reactor Department

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By Authority of *B. J. C. Mealy*

Sup List 1 dated 5-1-72

By *B. Jones 6-13-72*
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-2-

RL-NRD-737

TO: Distribution

FUEL REFERENCE DESIGN AND
PERTINENT OPERATING DATA FOR
COPRODUCT DEMONSTRATION LOAD

Transmitted herewith is the current coproduct fuel reference design and pertinent data for the demonstration load. This reference design and operating data are to be used for planning of the demonstration load. If changes are required in design or operating data, they must be cleared through this office prior to use.

Updating of this information will be on a monthly basis. All recommended changes should be in my hands by the first week of each month; updated information will be published the second week of each month.

EG Pierick
Manager, Advanced Programs
Advanced Technology

EG Pierick:bmp

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-3-

RL-NRD-737

FUEL REFERENCE DESIGN AND
PERTINENT OPERATING DATA FOR
COPRODUCT DEMONSTRATION LOAD

The current coproduct fuel reference design and pertinent operating data for the demonstration load, as of January 12, 1966, are given below.

FUEL REFERENCE DESIGN

	<u>Nominal</u>	<u>Tolerance</u>
<u>Driver</u>		
Outside Diameter - inches	2.399	+ 0.010
Inside Diameter - inches	1.718	<u>+ 0.010</u>
Zircaloy-2 Clad Thickness - mils		
Outer	35	- 9
Inner	25	- 9
Length	26.5	<u>+ 0.06*</u>
Rework Length	24.80	<u>+ 0.06</u>
	21.88	<u>+ 0.06</u>
End Closure	Fully brazed, 90° Chevron	
End Cap	H-3-26019	
Enrichment - Percent U-235	2.1 <u>+ 0.006</u>	
Fuel Weight		
# U/ft of Process Tube	14.6	
# U/ft of Fuel Element	14.7	
Composition	U + 350 ppm Fe + 800 ppm Al + 100 ppm Si + 550 ppm C	
Fuel Supports	8 - 4 at each end - Standard suitcase handle supports - Iron shoes	

*Length similar to Mark 1a fuel. Safe handling criteria for both fuels must be established.

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-4-

RL-NRD-737

Target

Outside Diameter of Zr - inches	1.335 ± 0.010
Inside Diameter of Zr - inches	1.275 ± 0.007
Al Clad Thickness - mils	94 ± 6
Al Composition	1100 Alloy
Zircaloy-2 Clad Thickness - mils	30 ± 8
Diameter of Core	1.075 ± 0.005
Diametral Clearance	
Core and Al Gap	0
Zr to Al Gap	0.006 ± 0.003
Length of Core in Assembly	24.92 ± 0.06
Rework Length of Core	23.22 ± 0.06
	20.30 ± 0.06
Al End Cap Thickness	0.250 ± 0.010
Zr End Cap Thickness	0.200 ± 0.010
Longitudinal Gaps	
Thermal Expansion	100 mils
Assembly (total)	20 mils
Difference in Target and Driver (nominal)	60 mils
Length of Target Element	26.44 ± 0.06
Rework Length of Target Element	24.74 ± 0.06
	21.82 ± 0.06
Composition	$\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3$
Purity of Al_2O_3	99.9+
Purity Limits	
Antimony	30 ppm
Boron	2 ppm
Cadmium	2 ppm
Carbon (as carbonate)	5000 ppm
Chromium	200 ppm
Cobalt	10 ppm
Copper	200 ppm
Fluorine	25 ppm
Iron	500 ppm
Manganese	50 ppm
Silicon	250 ppm
Sulfur	500 ppm
Zinc	150 ppm
Zirconium	200 ppm

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-5-

RL-NRD-737

Target (continued)

Grams Li ₆ per cc - Base	0.00594 ± 0.000119
Grams Li ₆ per cc - Spike	0.00335 ± 0.000067
Grams Li ₆ per cc - Poison	0.01347 ± 0.000269

Grams Li₆ per Inch Target Material

Base	.0883
Spike	.0498
Poison	0.200

Li₆ Concentration Tolerances

Reactor Load - percent	± 2
Single Column - percent	± 5
Single Element - percent	± 10

Bulk Density - Percent of Theoretical Value	70 (min)
	85 (max)

Li₆/Li Weight Percent at 78% Bulk Density

Base	2.84
Spike	1.59
Poison (Natural Lithium)	6.43

Target Supports

Six conventional buggy supports
(0.315" wide) per target element,
symmetrically arrayed in sets of
three near each end of the element.
Buggy spring supports made with
20 mil Zircaloy-2 sheet.

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-6-

RL-NRD-737

4800 MW 4000 MW⁽¹⁾

OPERATING DATA

Inlet Process Water Temperature - F	390	386
Maximum Outlet Process Water Temperature - F	567	535
Maximum Fuel Temperature - C	548	492
Average Fuel Temperature - C	434	396
Average Pressure Drop Across Fuel Column - psi	177	177
Rear Riser Pressure - psia	1500	1500
Process Water Flow per Channel - #/hr	94,400	94,400
Total Process Water Flow - Millions #/hr	94.7	94.7
Core Length - ft	31	31
Maximum Tube Power - MW (full load)	5650	4700
Maximum Tube Power - MW (transition)	5940	4950
Heat Flux (Driver) - Btu/hr/sqft		
Inner Surface	785,000	659,000
Outer Surface	683,000	571,000
Maximum Heat Flux/Burnout Heat Flux	< 0.33	< 0.23
Tube Maximum Power Density - kw/ft	240	208
Reactor Average Power Density - kw/ft	151	131
Gas Volume Ratio in Target	3.5	3.4
Steam Pressure - psia	150	150

PHYSICS PARAMETERS

Shutdown Margin (Rods Only) - mk	17	20
Control Rod Strength - mk	77	77
Ball System Strength - mk	62	62
Maximum Cold Xenon-Free Reactivity - mk	60	57

(1) Fuel design capable of operation at reactor power level of 4800 MW.

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-7-

RL-NRD-737

4800 MW 4000 MW⁽¹⁾

PRODUCTION DATA

Fuel Enrichment - % U-235

In	2.10	2.10
Out	1.91	1.91

Fuel Exposure - MWD/T	1675	1664
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Tons Uranium per Year	878	737
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No. Fuel Assemblies per year (average length - 24")	60,140	50,480
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Conversion Ratio - g Pu equiv/MWD

Plutonium	0.554	0.548
Tritium	0.340	0.340

Production

Plutonium - kg/yr	815	672
Tritium - kg/yr expressed as Pu equiv	500	417
Total Production - kg Pu equiv/yr	1315	1089
Tritium - kg/yr	6.25	5.2

(1) Fuel design capable of operation at reactor power level of 4800 MW.

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-8-

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