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TITLE

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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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.

E G Pierick
Manager, Advanced Programs
Advanced Technology

EG Pierick:bmp

## 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

| | Nominal | Tolerance |
|---|---|---|
| **Driver** | | |
| Outside Diameter - inches | 2.399 | ± 0.010 |
| Inside Diameter - inches | 1.718 | ± 0.010 |
| Zircaloy-2 Clad Thickness - mils | | |
| Outer | 35 | - 9 |
| Inner | 25 | - 9 |
| Length | 26.5 | ± 0.06* |
| Rework Length | 24.80 | ± 0.06 |
| | 21.88 | ± 0.06 |
| End Closure | Fully brazed, 90° Chevron | |
| End Cap | H-3-26019 | |
| Enrichment - Percent U-235 | 2.1 ± 0.006 | |
| 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.

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 | $Li_2O \cdot Al_2O_3$ |
| 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 |

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 $Li_6$ per Inch Target Material

| | |
|---|---|
| Base | .0883 |
| Spike | .0498 |
| Poison | 0.200 |

$Li_6$ Concentration Tolerances

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

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

$Li_6$/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.

| | 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.

| | 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 |
| Tons Uranium per Year | 878 | 737 |
| No. Fuel Assemblies per year (average length - 24") | 60,140 | 50,480 |
| 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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