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Office of Civilian Radioactive Waste Management

CHARACTERISTICS OF SPENT FUEL, HIGH-LEVEL WASTE, AND OTHER RADIOACTIVE WASTES WHICH MAY REQUIRE LONG-TERM ISOLATION

DECEMBER 1987

U.S. Department of Energy Office of Civilian Radioactive Waste Management Washington, D.C. 20585

Sec.

APPENDIX 2E

PHYSICAL DESCRIPTIONS OF LWR NONFUEL ASSEMBLY HARDWARE

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E-3/4

Introduction2E-5
BWR Channels2E-7
Control Elements2E-23
Guide Tube Plugs/Orifice Rods2E-81
Instrumentation2E-95
Neutron Poisons
Neutron Source Assemblies2E-171

INTRODUCTION

This appendix includes a two to three page Physical Description report for each Non-fuel Assembly (NFA) Hardware item identified from the current data. Information was obtained via subcontracts with these NFA hardware vendors: Babcock & Wilcox, Combustion Engineering and Westinghouse. Data for some NFA hardware are not available. For such hardware, the information shown in this report was obtained from the open literature. Efforts to obtain additional information are continuing.

NFA hardware can be grouped into six categories: BWR Channels, Control Elements, Guide Tube Plugs/Orifice Rods, Instrumentation, Neutron Poisons, and Neutron Sources. This appendix lists Physical Description reports alphabetically by vendor within each category.

Individual Physical Description reports can be generated interactively through the menu-driven LWR Non-Fuel Assembly Hardware Data Base system. These reports can be viewed on the screen, directed to a printer, or saved in a text file for later use. Special reports and compilations of specific data items can be produced on request.

Comments and requests are welcome. Please contact:

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BWR CHANNELS

Page: 1

General Electric Dresden, 60 Mil BWR Channel

Designed for: Fuel Assembly with array size: 6x6 Boiling Water Reactor

Dimensions:

Total Length:	120	inches
Total Weight:	30	pounds
Average Width:	4.410	inches

Channel Material:

Zircaloy-2

Life Expectancy: 3 cycles

General Electric Dresden, 60 Mil BWR Channel

Composition: Material Total Weight (kg) Zone

Zircaloy-2 13.600 In Core

Used at the Following Reactors: Reactor Number in Core

Dresden 1 488

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon /	ANF	6x6	GE	(assumed)
General	Electric	6x6	DRES-1	

Comment:

Length is an estimate based on drawing D-8; Docket 50-10, September 3, 1957. Weight is estimated.

Page: 1

General Electric Humboldt Bay BWR Channel

Designed for: Fuel Assembly with array size: 7x7 Boiling Water Reactor

Dimensions:

Total Length:	88.6	inches
Total Weight:	23.4	pounds
Average Width:	4.662	inches

Channel Material:

Zircaloy-2

Life Expectancy:

3 cycles

General Electric Humboldt Bay BWR Channel

Composition: Material Total Weight (kg) Zone Zircaloy-2 10.600 In Core

Used at the Following Reactors: Reactor Number in Core

Humboldt Bay 172

Used with Following Fuel Assembly Types: Vendor Array Version

Comment:

Weight is estimated.

2E-12

Page: 2

Physical Description Report General Electric BWR/2,3;80 Mil Thick BWR Channel Designed for: Fuel Assembly with array size: 7x7 Boiling Water Reactor Dimensions: Total Length: 162.125 inches Total Weight: 67 pounds Average Width: 5.438 inches Channel Material: Zircaloy-4

Life Expectancy: 3 cycles

Page: 1

General Electric BWR/2,3;80 Mil Thick BWR Channel

Composition: Material Total Weight (kg) Zone

Zircaloy-4 30.000 In Core

Used at the Following Reactors: Reactor Number in Core

Dresden 2	724
Dresden 3	724
Quad Cities 1	724
Quad Cities 2	724
Oyster Creek	560
Nine Mile Point l	532
Millstone l	580
Monticello	484

Used with Following Fuel Assembly Types: Vendor Array Version

Comment:

Weight is estimated.

Physical Description Report Page: 1 General Electric BWR/3, Long 80 Mil BWR Channel Designed for: Fuel Assembly with array size: 7x7 Boiling Water Reactor Dimensions: Total Length: 171.125 inches Total Weight: pounds 70 Average Width: 5.438 inches Channel Material: Zircaloy-4 Life Expectancy: 3 cycles

Physical Desc:	ription Report		Page			
General	Electric BWR/3,	Long 80 Mil BW	R Channel			
Composition: Material	Total Weight	(kg) Zone				
Zircaloy-4	32.000	In Core				
Used at the Following Reactors: Reactor Number in Core						
Pilgrim		580				
Used with Fol: Vendor	lowing Fuel Asse Arr	mbly Types: ay Version				

Comment:

Weight is estimated.

Page: 2

Physical Description Report Page: 1 General Electric BWR/4; 80 Mil Thick BWR Channel Designed for: Fuel Assembly with array size: 7x7 Boiling Water Reactor Dimensions: 166.9 inches Total Length: Total Weight: Average Width: pounds 69 5.438 inches Channel Material: Zircaloy-4 Life Expectancy: 3 cycles

Physical Description Report General Electric BWR/4; 80 Mil Thick BWR Channel Composition: Total Weight (kg) Material Zone Zircaloy-4 31.000 In Core Used at the Following Reactors: Reactor Number in Core Brunswick 1 560 Brunswick 2 560 Enrico Fermi 2 764 (assumed) Hatch 1 560 Hatch 2 560 Duane Arnold 368 Shoreham 560 Cooper Station 548 Susquehanna 1 764 (assumed) Susquehanna 2 764 (assumed) Limerick 1 764 (assumed) Limerick 2 764 (assumed) Peach Bottom 2 764 Peach Bottom 3 764 Fitzpatrick 560 Hope Creek 764 Browns Ferry 1 764 764 Browns Ferry 2 Browns Ferry 3 764 Vermont Yankee 368

Used with Following Fuel Assembly Types: Vendor Array Version

Comment:

Weight is estimated.

Page: 2

Physical Description Report Page: 1 General Electric BWR/4,5,100 Mil Thic BWR Channel Designed for: Fuel Assembly with array size: 7x7 Boiling Water Reactor Dimensions: Total Length: 166.9 inches Total Weight: 86 pounds Average Width: 5.438 inches Channel Material: Zircaloy-4

Life Expectancy:

2E-19

3

cycles

port	Page: 2
WR/4,5,100 Mil Th	nic BWR Channel
Weight (kg) 2	Zone
000 In	Core
eactors:	
Number in Core	
560 560 764 764 560 560 368 560 548 764	(assumed)
764 764 764 760 760 560 764 764 764 764 764 764 764	(assumed) (assumed) (assumed) (assumed)
	Dort VR/4,5,100 Mil T Veight (kg) DOO In Eactors: Number in Core 560 560 560 560 560 560 560 560

Used with Following Fuel Assembly Types: Vendor Array Version

Comment:

Weight is estimated.

2E-20

Physical Description Report Page: 1 General Electric BWR/6; 120 Mil Thick BWR Channel Designed for: Fuel Assembly with array size: 8x8 Boiling Water Reactor Dimensions: Total Length: 167.4 inches Total Weight: 104 pounds Average Width: 5.455 inches Channel Material: Zircaloy-4 Life Expectancy:

3-6

cycles

Physical Description Report Page: 2 General Electric BWR/6; 120 Mil Thick BWR Channel Composition: Material Total Weight (kg) Zone Zircaloy-4 46.000 In Core Used at the Following Reactors: Number in Core Reactor Perry 1 784 (assumed) 784 (assumed) Perry 2 River Bend 1 592 Clinton 592 Grand Gulf 1 784 Grand Gulf 2 784

Used with Following Fuel Assembly Types: Vendor Array Version

Comment:

Weight is estimated.

CONTROL ELEMENTS

Physical Description Report Babcock & Wilcox Standard Control Element Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 160 inches Total Weight: 130 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.440 inches Wall Thickness: Diametral Gap: Poison: Primary Material: Ag-In-Cd Poison Length: Pellet Diameter: Plenum Spring Material: St.Steel 302 Spider Material: St.Steel CF3M Number of Control Rods: 16 Life Expectancy: Design Variations:

Roddy, et. al., report a "Long Life" CRA from B&W. It is pressurized to 465 PSIG and uses Inc-625 cladding. B&W made no mention of this in their submittal.

Page: 1

Physical Description Report Page: 2 Babcock & Wilcox Standard Control Element Composition: Material Total Weight (kg) Zone St.Steel CF3M 3.200 Top St.Steel 304 0.070 Top Ag-In-Cd 43.120 In Core St.Steel 304 10.820 In Core St.Steel 302 0.850 In Core Used at the Following Reactors: Reactor Number in Core Arkansas 1 61 Oconee 1 61 Oconee 2 61 Oconee 3 61 Crystal River 3 61 Three Mile Island 1 61 Rancho Seco 53 Davis-Besse 61 Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 Mark B Babcock & Wilcox 15x15 Mark BZ

Physical Description Report						l
Combustion Engineerin	g SYS80	4 Rod Pa	rt Len	Control	Elemer	nt
Designed for: Fuel Assembly with Pressurized Water R	array si eactor	ize: 16x1	6			
Dimensions: Total Length: Total Weight:	253 95.0	inches pounds				
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap: Poison:	Incone] 0.816 0.035 0.009	625 inches inches inches				
Primary Material: Poison Length: Pellet Diameter:	Inconel 91 0.737	l 625 inches inches				
Plenum Spring Materia	1:	St.Steel	302			
Spider Material:		St.Steel	304			
Number of Control Rod	s:	4				
Life Expectancy:		4000 E	FPD			

Physical Description Report Page: 2 Combustion Engineering SYS80 4 Rod Part Len Control Element Composition: Material Total Weight (kg) Zone

Used at the Following Reactors: Reactor Number in Core Palo Verde 1 13

Palo Verde 213Palo Verde 313

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 SYS80

Comment:

Control Elements are 75" of Inconel 625 and 16" of B4C

Physical Description Report					Page:	1	
Combustion Engineerin	g SYS80	12Rod	Full	Len	Control	Eleme	nt
Designed for: Fuel Assembly with Pressurized Water R	array s eactor	ize: 16	5 x 16				
Dimensions:							
Total Length:	253	inch	ıes				
Total Weight:	192.2	pour	ıds				
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone 0.816 0.035 0.009	l 625 inch inch inch	ies ies ies				
Poison:		•					
Primary Material:	B4C (C	E) inch					
Pellet Diameter:	140 0.737	inch	les				
	01/07	1101					
Plenum Spring Materia	1:	St.Ste	el 30	02			
Spider Material:		st.ste	el 30	04			
Number of Control Rod	s:	12					
Life Expectancy:		4000	EFPI	D			

Physical Description Report Page: 2 Combustion Engineering SYS80 12Rod Full Len Control Element Composition: Material Total Weight (kg) Zone St.Steel 304 8.170 Top Inconel 625 53.620 Top B4C (CE) 20.900 Top St.Steel 304 Gas Plenum 0.680 Inconel 625 2.200 Gas Plenum B4C (CE) 1.600 Gas Plenum Used at the Following Reactors: Number in Core Reactor Palo Verde 1 48 Palo Verde 2 48 Palo Verde 3 48 Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 SYS80

Physical Description	Report		Physical Description Report				
Combustion Engineeri	ng San (Onofre Pa	rt Len	Control	Element		
Designed for: Fuel Assembly with Pressurized Water R	array s eactor	ize: 16x1	.6				
Dimensions:							
Total Length:	181	inches	6				
Total Weight:	92.0	pounds	5				
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone 0.816 0.035 0.009	l 625 inches inches inches	5				
Poison:							
Primary Material:	Incone	1 625					
Poison Length:	91.0	inches	5				
Pellet Diameter:	0.737	inches	5				
Plenum Spring Materia	1:	St.Steel	. 302				
Spider Material:		St.Steel	. 304				
Number of Control Rod	s:	5					
Life Expectancy:		4000 E	FPD				

Combustion Engineering San Onofre Part Len Control Element

Page: 2

Composition:

Material Total Weight (kg) Zone

Used at the Following Reactors: Reactor Number in Core

Waterford 3	8
San Onofre 2	8
San Onofre 3	8

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 Onofre Combustion Engineering 16x16 ANO2

Comment:

Control Elements are 16.0" of B4C and 75.0" of Inconel 625. Very similar to Part Length CEA'S used at ANO2.

Physical Description Report					Page:	1	
Combustion Engineering	ng San (Onofre F	ull	Len	Control	Eleme	nt
Designed for: Fuel Assembly with a Pressurized Water Ro	array s eactor	ize: 16x	16				
Dimensions: Total Length: Total Weight:	181 72	inche pound	es Is				
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone 0.816 0.035 0.009	l 625 inche inche inche	25 25 25				
Poison: Primary Material: Poison Length: Pellet Diameter:	B4C (C) 148.5 0.737	E) inche inche	25				
Plenum Spring Materia	1:	St.Stee	el 30	02			
Spider Material:		St.Stee	el 30	04			
Number of Control Rods	s:	5					
Life Expectancy:		4000	EFPI	D			
Design Variations:							

Four CEA'S have only four elements (no center element).

Physical Description Report Page: 2 Combustion Engineering San Onofre Full Len Control Element Composition: Material Total Weight (kg) Zone St.Steel 304 3.400 Top Inconel 625 15.500 Top B4C (CE) 8.710 Top Ag-In-Cd (CE) 1.100 Top St.Steel 304 0.230 Gas Plenum Inconel 625 0.910 Gas Plenum Ag-In-Cd (CE) 2.800 Gas Plenum Used at the Following Reactors: Reactor Number in Core Waterford 3 83 San Onofre 2 83 San Onofre 3 83 Used with Following Fuel Assembly Types: Vendor Array Version Combustion Engineering 16x16 Onofre Combustion Engineering 16x16 ANO2 Comment:

Control Elements are 136.0" of B4C and 12.5" of Ag-In-Cd.

Physical Description Report				1	
Combustion Engineer	ing ANO2	Part Length Control	Element		
Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor					
Dimensions: Total Length: Total Weight:	180.8 91.1	inches pounds			
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Inconel 0.816 0.035 0.009	625 inches inches inches			
Poison: Primary Material: Poison Length: Pellet Diameter:	Inconel 91 0.737	625 inches inches			
Plenum Spring Material	1:	St.Steel 302			
Spider Material:		St.Steel 304			
Number of Control Rods	5:	5			
Life Expectancy:		4000 EFPD			

Physical	Description	Report	Page:	2

Combustion Engineering ANO2 Part Length Control Element

Composition:

Material Total Weight (kg) Zone

Used at the Following Reactors: Reactor Number in Core

Arkansas 2

8

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 ANO2

Comment:

Poison elements are 16.0" of B4C and 75.0" of Inconel 625. Very similar to Part Length CEA'S used at Waterford 3 and San Onofre. Physical Description Report Page: 1 Combustion Engineering ANO2 Full Length Control Element Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: 180.8 inches Total Weight: 71.3 pounds Cladding: Material: Inconel 625 0.816 inches Outer Diameter: Wall Thickness: 0.035 inches Diametral Gap: 0.009 inches Poison: Primary Material: B4C (CE) 149.2 Poison Length: inches Pellet Diameter: 0.737 inches Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 5 Life Expectancy: 4000 EFPD

Combustion Engineering ANO2 Full Length Control Element

Composition:

Material	Total Weight	(kg)	Zone	
St.Steel 304	3.400		Тор Тор	
Inconel 625	15.400			
B4C (CE)	8.710		Тор	
Ag-In-Cd (CE)	0.860		Тор	
St.Steel 304	0.230		Gas Plenum	
Inconel 625	1.400		Gas Plenum	
B4C (CE)	0.050		Gas Plenum	
Ag-In-Cd (CE)	2.300		Gas Plenum	

Used at the Following Reactors: Reactor Number in Core

Arkansas 2

73

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 ANO2

Comment:

Center Element is 140" of B4C and 9.2" of Inconel 625. Outside elements are 135.5" of B4C and 12.5" of Ag-In-Cd.

Physical Description Report				Page:	1	
Combustion Engineerin	g St. L	ucie 2 Par	t Len	Control	Elemen	nt
Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor						
Dimensions:						
Total Length:	162.8	inches				
Total Weight:	83.0	pounds				
Cladding:	Theopo	1 625				
Material. Outer Diameter:		inches				
Wall Thickness:	0.035	inches				
Diametral Gap:	0.009	inches				
Poison:						
Primary Material:	Incone	1 625				
Poison Length:	82.5	inches				
Pellet Diameter:	0.737	inches				
Plenum Spring Materia	1:	St.Steel	302			
Spider Material:		St.Steel	304			
Number of Control Rod	s:	5				
Life Expectancy:		4000 EF	PD			

Physical Description Report Page: 2 Combustion Engineering St. Lucie 2 Part Len Control Element Composition: Material Total Weight (kg) Zone

Used at the Following Reactors: Reactor Number in Core

St. Lucie 2 8

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 Lucie 2

Comment:

1

Poison Elements are 14.0" of B4C and 68.5" of Inconel 625.
Physical Description Report Page: 1 Combustion Engineering St. Lucie 2 Full Len Control Element Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: 162.8 inches Total Weight: 65.8 pounds Cladding: Outer Diameter:Inconel 625Wall Thickness:0.816inchesDiametral Gap:0.009inches Material: Inconel 625 Poison: Primary Material: B4C (CE) Poison Length: 135.5 inches Poison Length: 135.5 Pellet Diameter: 0.737 inches Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 5 Life Expectancy: 4000 EFPD

Physical Description Report

Combustion Engineering St. Lucie 2 Full Len Control Element

Composition: Material Total Weight (kg) Zone St.Steel 304 3.400 Top Inconel 625 13.600 Top B4C (CE) 7.890 Top Ag-In-Cd (CE) 1.100 Top St.Steel 304 0.230 Gas Plenum Inconel 625 0.820 Gas Plenum Ag-In-Cd (CE) 2.800 Gas Plenum

Used at the Following Reactors: Reactor Number in Core

St. Lucie 2 83

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 Lucie 2

Comment:

Poison Elements are 123" of B4C and 12.5" of Ag-In-Cd.

Physical Description Report Page: 1 Combustion Engineering Part Length, Ver. 3 Control Element Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 161.3 inches Total Weight: 104.5 pounds Cladding: Material: Inconel 625 0.948 inches Outer Diameter: Wall Thickness: 0.040 inches 0.008 Diametral Gap: inches Poison: Primary Material: B4C (CE) Poison Length: 134 inches Pellet Diameter: 0.860 inches St.Steel 302 Plenum Spring Material: Spider Material: St.Steel 304 Number of Control Rods: 5 Life Expectancy: 4000 EFPD Elemental Geometry:

Outside Elements use 134" of St.Steel 304 as Poison.

Design Variations:

Six CEA'S have 3 all SS elements and 2 elements with 8" of Ag-In-Cd and 124" of B4C.

Physical Description Report Page: 2 Combustion Engineering Part Length, Ver. 3 Control Element Composition: Material Total Weight (kg) Zone Used at the Following Reactors: Reactor Number in Core Maine Yankee 12 Used with Following Fuel Assembly Types: Array Version Vendor Combustion Engineering 14x14 Std

Page: 1 Physical Description Report Combustion Engineering Part Length, Ver. 2 Control Element Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 161.3 inches Total Weight: 82.4 pounds Cladding: Material: Inconel 625 0.948 inches Outer Diameter: Wall Thickness: 0.040 inches 0.008 inches Diametral Gap: Poison: B4C (CE) Primary Material: Poison Length: 132 inches Pellet Diameter: 0.860 inches Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 5 4000 EFPD Life Expectancy: Elemental Geometry:

Center Element is 134" of B4C. Outside Elements are 124" of and 8" of Ag-In-Cd.

Design Variations:

Four CEA'S have one all Al2O3 element (center). Four CEA's have 10" of SS and 124" of Al2O3 in 2 corner fingers.

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Physical Des	scription Rep	ort		Page: 2
Combustion	Engineering	Part Length,	Ver. 2 Con	itrol Element
Composition: Material	: l Total W	eight (kg)	Zone	
		•		
Used at the Reactor	Following Re	actors: Number in Com	re	
St. Lucie	1	8		
Millstone	2	8		
Used with Fo Vendor	ollowing Fuel	Assembly Typ Array Vers	pes: sion	
Combustion	n Engineering	14x14 Std		

.

Physical Description Report						
Combustion Engineering	ng Part	Length, Ver. 1 Control	Element			
Designed for: Fuel Assembly with a Pressurized Water Re	array s eactor	ize: 14x14				
Dimensions: Total Length: Total Weight:	161.3 63.0	inches pounds	•			
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone: 0.948 0.040 0.008	l 625 inches inches inches				
Poison: Primary Material: Poison Length: Pellet Diameter:	B4C (C) 132 0.860	E) inches inches				
Plenum Spring Materia	L:	St.Steel 302				
Spider Material:		St.Steel 304				
Number of Control Rods	s:	5				
Life Expectancy:		4000 EFPD	,			
Elemental Geometry:						
Control oloment in						

Central element is 134" of Al2O3. Two Outside Elements are 124" of B4C and 8" of Ag-In-Cd. Two Outside Elements are 124" of Al2O3 and 8" of SS304.

Physical Description Report Page: 2 Combustion Engineering Part Length, Ver. 1 Control Element Composition: Material Total Weight (kg) Zone

Used at the Following Reactors: Reactor Number in Core Calvert Cliffs 1 12 Calvert Cliffs 2 12 Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 14x14 Std

Physical Description Report Page: 1 Combustion Engineering Full Length Control Element Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 161.3 inches Total Weight: 76.8 pounds Cladding: Inconel 625 Material: Outer Diameter: 0.948 inches Wall Thickness: 0.040 inches Diametral Gap: 0.008 inches Poison: Primary Material: B4C (CE) Poison Length: 134 inches Pellet Diameter: 0.860 inches Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 5 Life Expectancy: 4000 EFPD Design Variations:

Four CEA'S have 1 all SS element (center). Four CEA's have three all SS elements (center and 2 corner).

Physical Description Report

Combustion Engineering Full Length Control Element

Composition: Material	Total Weight	(kg)	Zone
St.Steel 304	3.200		Top
Inconel 625	15.400		Top
B4C (CE)	10.500		Top
st.steel 304	0.230		Gas Plenum
Inconel 625	2.300		Gas Plenum
B4C (CE)	0.500		Gas Plenum
Ag-In-Cd (CE)	2.800		Gas Plenum

Used at the Following Reactors: Reactor Number in Core

Calvert Cliffs	1	65
Calvert Cliffs	2	65
St. Lucie l		65
Maine Yankee		65
Millstone 2		65

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 14x14 Std

.

Comment:

Central Poison Element is 134" of B4C. Outside Poison Elements are 124" of B4C, 8" of Ag-In-Cd, & 2.6" of Inconel.

Physical Description Report							
Combustion Engineering Part Length Control Element							
Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor							
Dimensions:							
Total Length:	152	inches					
Total Weight:	63.0	pounds					
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone 0.948 0.040 0.008	l 625 inches inches inches					
Poison:		-					
Primary Material: Poison Length:	B4C (C	E) inches					
Pellet Diameter:	0.860	inches					
		2					
Plenum Spring Materia	1:	St.Steel 302					
Spider Material:		St.Steel 304					
Number of Control Rod	s:	5					
Life Expectancy:		4000 EFPD					

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Physical Description Report Combustion Engineering Part Length Control Element Composition: Total Weight (kg) Material Zone St.Steel 304 Top Inconel 625 Top B4C (CE) Top St.Steel 304 Gas Plenum Inconel 625 Gas Plenum B4C (CE) Gas Plenum Used at the Following Reactors: Number in Core Reactor Fort Calhoun 4

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 14x14 Ft.Cal.

Comment:

The Central Element has 128" of B4C Poison; Outside Elements have 32" of B4C Poison.

Physical Description Report P						
Combustion Engin	eering	Full Len	gth Control	Element		
Designed for: Fuel Assembly with Pressurized Water R	array s leactor	ize: l4x	:14			
Dimensions:						
Total Length:	152	inche	s			
Total Weight:	66.5	pound	ls			
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	Incone 0.948 0.040 0.008	l 625 inche inche inche	S S S			
Poison:						
Primary Material: Poison Longth:	B4C (C	E) incho	-			
Pellet Diameter:	0.860	inche	S			
			-			
Plenum Spring Material: St.Steel 302						
Spider Material: St.Steel 304						
Number of Control Rods: 5						
Life Expectancy:		4000	EFPD			

Physical Description Report

Page: 2

Combustion Engineering Full Length Control Element

Composition:

Total Weight (ko	g) Zone
3.200	Тор
13.600	Тор
10.800	Top
0.230	Gas Plenum
1.800	Gas Plenum
0.540	Gas Plenum
	Total Weight (kg 3.200 13.600 10.800 0.230 1.800 0.540

Used at the Following Reactors: Reactor Number in Core

Fort Calhoun

45

Used with Following Fuel Assembly Types: Vendor Array Version Combustion Engineering 14x14 Ft.Cal.

Physical Description Report Page: 1 Combustion Engineering Cruciform Blade Control Element Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 151 inches Total Weight: 214 pounds Cladding: Material: St.Steel 304 Outer Diameter: Wall Thickness: Diametral Gap: Poison: Primary Material: Ag-In-Cd (CE) Poison Length: 133 inches Pellet Diameter: Plenum Spring Material: Spider Material: St.Steel 304 Number of Control Rods: Life Expectancy: 20 cycles

.

Physical Description Report				
Combustion En	gineering Crucif	orm Blade Control	Element	
Composition: Material	Total Weight (k	g) Zone		
St.Steel 304 Ag-In-Cd (CE) St.Steel 304 Ag-In-Cd (CE)	26.300 64.320 1.900 4.540	Top Top Gas Plenum Gas Plenum		
Used at the Foll Reactor	owing Reactors: Number i	n Core		
Palisades	45			
Used with Follow Vendor	ing Fuel Assembl Array	y Types: Version		
Combustion Eng Exxon / ANF	ineering 15x15 15x15	Palis. CE		

Physical Description	Report		P
Westinghous	se Standa	rd Control Element	
Designed for: Fuel Assembly with a Pressurized Water R	array siz eactor	e: 14x14	
Dimensions: Total Length: Total Weight:	158.454 128.00	inches pounds	
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	St.Steel 0.435 0.0185	304 inches inches	
Poison: Primary Material: Poison Length: Pellet Diameter:	Ag-In-Cd 142.00	(WE) inches	
Plenum Spring Materia	l: c	arbon Steel	
Spider Material:	S	t.Steel 304	
Number of Control Rod	s: 1	6	
Life Expectancy:			

Physical Description Report Westinghouse Standard Control Element Composition: Total Weight (kg) Zone Material Carbon Steel 0.120 qoT 0.730 Top Inconel X-750 1.900 Gas Plenum St.Steel 308M Gas Plenum St.Steel 304 10.500 Gas Plenum Ag-In-Cd (WE) 45.400 Used at the Following Reactors: Number in Core Reactor Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) 14x14 TOP ROD Exxon / ANF (assumed) Westinghouse 14x14 Std/ZCA (assumed) 14x14 OFA Westinghouse (assumed)

14x14 Std/ZCB

l4xl4 Std/SC

Comment:

Westinghouse

Westinghouse

Drawing number is 108D134.

Page: 2

(assumed)

(assumed)

Page: 1 Physical Description Report Westinghouse Short, Ver. 1 Control Element Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 156.636 inches Total Weight: pounds 128.00 Cladding: Material: St.Steel 304 Outer Diameter: 0.435 inches Wall Thickness: 0.0185 inches Diametral Gap: Poison: Ag-In-Cd (WE) Primary Material: 118.00 Poison Length: inches Pellet Diameter: Plenum Spring Material: Carbon Steel Spider Material: St.Steel 304 Number of Control Rods: 16 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Short, Ver. 1 Control Element Composition: Material Total Weight (kg) Zone Carbon Steel 0.120 Top Inconel X-750 0.731 Top St.Steel 308M 2.100 Gas Plenum St.Steel 304 9.000 Gas Plenum Ag-In-Cd (WE) 37.700 Gas Plenum Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF 14x14 TOP ROD (assumed) 14x14 Std/ZCA 14x14 OFA 14x14 Std/ZCB Westinghouse (assumed) Westinghouse Westinghouse (assumed) (assumed) Westinghouse 14x14 Std/SC (assumed)

2E - 60

Comment:

Drawing number is 108D419. Correct total weight appears to be 109.2 pounds.

Physical Description Report Westinghouse Short, Ver. 2 Control Element Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 133.70 inches Total Weight: 109.00 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.435 inches Wall Thickness: 0.0185 inches Diametral Gap: Poison: Primary Material: Ag-In-Cd (WE) Poison Length: 118.37 inches Pellet Diameter: Plenum Spring Material: Inconel X-750 Spider Material: St.Steel 304 Number of Control Rods: 16 Life Expectancy:

2E-61

Physical Description Report Page: 2 Westinghouse Short, Ver. 2 Control Element Composition: Material Total Weight (kg) Zone Inconel X-750 0.910 Top St.Steel 304 9.480 Top Gas Plenum Ag-In-Cd (WE) 37.800 St.Steel 308M 1.300 Gas Plenum Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF Westinghouse 14x14 TOP ROD (assumed) 14x14 Std/ZCA (assumed) Westinghouse 14x14 OFA (assumed) Westinghouse 14x14 Std/ZCB (assumed) Westinghouse 14x14 Std/SC (assumed)

Physical Description Report Westinghouse Standard Control Element Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 156.6 inches Total Weight: 165.00 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.443 inches 0.020 inches Wall Thickness: Diametral Gap: Poison: Primary Material: Ag-In-Cd (WE) Poison Length: 142.00 inches Pellet Diameter: Plenum Spring Material: Carbon Steel Spider Material: St.Steel 304 Number of Control Rods: 20 Life Expectancy: Design Variations: Length ranges from 156.6 to 158.5 inches.

Westinghouse Standard Control Element Composition: Material Total Weight (kg) Zone Carbon Steel 0.150 Top 0.730 Inconel X-750 Top St.Steel 308M 2.500 Gas Plenum St.Steel 304 13.800 Gas Plenum Aq-In-Cd (WE) 58.700 Gas Plenum Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) Westinghouse 15x15 Std/SC (assumed)

Comment:

Drawing numbers are 5655D54 and 8823D53.

Physical Description Report

Physical Description Report Page: 1 Westinghouse Full Length, Ver. 1 Control Element Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 160.949 inches Total Weight: 149.00 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Wall Thickness: 0.0185 inches Diametral Gap: Poison: Primary Material: Ag-In-Cd (WE) Poison Length: 142.00 inches Pellet Diameter: Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 24 Life Expectancy:

Physical Description Report Page:					
Westinghou	ise Full Length,	Ver. 1 Control Element			
Composition: Material	Total Weight (kg) Zone			
St.Steel 302 St.Steel 308M St.Steel 304 Ag-In-Cd (WE)	0.520 1.600 13.000 51.800	Top Top Gas Plenum Gas Plenum			
Used at the Foll Reactor	owing Reactors: Number	in Core			
Farley 1 Farley 2 Harris Braidwood 1 Braidwood 2 Byron 1 Byron 2 Catawba 1 Catawba 2 McGuire 1 McGuire 2 Beaver Valley Vogtle 1 Vogtle 2 Wolf Creek Millstone 3 Diablo Canyon Diablo Canyon Diablo Canyon Trojan Salem 1 Salem 2 Summer Sequoyah 1 Watts Bar 1 Watts Bar 1 Watts Bar 2 Comanche Peak Callaway North Anna 1 North Anna 1 North Anna 2 Cook 2 Seabrook 1 Seabrook 2	1 2 1 2	(assumed) (assumed)			

2

Physical Description Report

Page: 3

Westinghouse Full Length, Ver. 1 Control Element

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	ofa	(assumed)

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Comment:

Drawing number is 1186F66.

Physical Description Report Page: 1 Westinghouse Full Length, Ver. 2 Control Element Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 160.949 inches Total Weight: 180.00 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Wall Thickness: 0.0185 inches Diametral Gap: Poison: Primary Material: Hafnium Poison Length: 142.00 inches Pellet Diameter: Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 24 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Full Length, Ver. 2 Control Element Composition: Material Total Weight (kg) Zone St.Steel 302 0.520 Top St.Steel 308M 1.100 Top Inconel-718 0.750 Top St.Steel 304 13.000 Gas Plenum Hafnium 65.300 Gas Plenum Used at the Following Reactors: Number in Core Reactor Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Voqtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed) Seabrook 2 (assumed)

Physical Description Report

Westinghouse Full Length, Ver. 2 Control Element

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	ofa	(assumed)

Comment:

Drawing number is 1549E40G02/G06. Clad thickness assumed from clad weight and thickness of other versions.

Physical Description Report					
Westinghouse Full Length, Ver. 3 Control Element					
Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor					
Dimensions: Total Length: 160.949 inches Total Weight: 149.00 pounds					
Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Wall Thickness: 0.0185 inches Diametral Gap:					
Poison: Primary Material: Ag-In-Cd (WE) Poison Length: 142.00 inches Pellet Diameter:					
Plenum Spring Material: St.Steel 302					
Spider Material: St.Steel 304					
Number of Control Rods: 24					
Life Expectancy:					

Physical Description Report Westinghouse Full Length, Ver. 3 Control Element Composition: Material Total Weight (kg) Zone St.Steel 302 0.520 TOD St.Steel 308M 1.100 Top Inconel-718 0.750 Top St.Steel 304 13.000 Gas Plenum Ag-In-Cd (WE) 51.800 Gas Plenum Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed) Seabrook 2 (assumed)

Physical Description Report

Page: 3

Westinghouse Full Length, Ver. 3 Control Element

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Clad thickness assumed from weight and clad thickness of other versions.

Physical Description Report Page: 1 Westinghouse Hybrid Control Element Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 160.960 inches Total Weight: 92.7 pounds Cladding: St.Steel 304 Material: Outer Diameter: 0.385 inches Wall Thickness: 0.038 inches Diametral Gap: Poison: Primary Material: B4C (WE) Poison Length: 142.00 inches Pellet Diameter: Plenum Spring Material: Inconel-718 Spider Material: St.Steel 304 Number of Control Rods: 24 Life Expectancy:

Physical Descrip	ption Repo	ort		
West	cinghouse	Hybrid	Control	Element
Composition:				
Material	Total We	aight ()	kg) :	Zone
Inconel-718	1.04	10	r	rop
B4C (WE)	4.00	50	f	rop
St.Steel 304	22.50	00	Gas	Plenum
St.Steel	1.10	00	Gas	Plenum
Ag-In-Cd (WE)	11.40	00	Gas	Plenum
Mand at the Fall	louing Do	atomat		
Deactor	LOWING Rea	lumbor ·	in Coro	
REACCOL	1	lumper .	In core	
Farley 1				(assumed)
Farley 2				(assumed)
Harris				(assumed)
Braidwood l			•	(assumed)
Braidwood 2				(assumed)
Byron l				(assumed)
Byron 2				(assumed)
Catawba 1				(assumed)
Catawba 2				(assumed)
McGuire 1				(assumed)
McGuire 2				(assumed)
Beaver Valley	1			(assumed)
Beaver Valley	2			(assumed)
Vogtle 1				(assumed)
Vogtle 2				(assumed)
Wolf Creek				(assumed)
Millstone 3				(assumed)
Diablo Canyon	1			(assumed)
Diablo Canyon	2			(assumed)
Trojan				(assumed)
Salem 1				(assumed)
Salem 2				(assumed)
Summer				(assumed)
Sequoyah 1				(assumed)
Watts Bar 1				(assumed)
Watts Bar 2	-			(assumed)
Comanche Peak	T			(assumed)
Comanche Peak	2			(assumed)
Callaway				(assumed)
North Anna 1				(assumed)
North Anna 2				(assumed)
COOK 2				(assumed)
Seabrook 1				(assumed)
Seaprook 2				(assumed)

Physical Description Report

Page: 3

Westinghouse Hybrid Control Element

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Control rods are 102.00" of B4C and 40" of Ag-In-Cd. Drawing number is 1187F30.
Physical Description Report Westinghouse Part Length Control Element Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: 160.949 inches Total Length: Total Weight: 100 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Wall Thickness: 0.0185 inches Diametral Gap: Poison: Primary Material: Ag-In-Cd (WE) Poison Length: 36.00 inches Pellet Diameter: Plenum Spring Material: St.Steel 302 Spider Material: St.Steel 304 Number of Control Rods: 24 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Part Length Control Element Composition: Material Total Weight (kg) Zone St.Steel 302 0.520 Top St.Steel 308M 1.600 Top St.Steel 304 12.000 Top Inconel-718 0.750 Top Ag-In-Cd (WE) 13.200 Gas Plenum Alum. Oxide 16.400 Gas Plenum Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) (assumed) Comanche Peak 1 Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed)

(assumed)

Seabrook 1

2E-78

2E-79/80

Physical Description Repo	ort		Page: 3
Westinghouse Pa	irt Leng	th Control H	lement
Used at the Following Rea Reactor N	lctors: Number i	(continued) n Core	
Seabrook 2		(as	sumed)
Used with Following Fuel Vendor	Assembl Array	y Types: Version	
Exxon / ANF Westinghouse Westinghouse	17x17 17x17 17x17	WE Std OFA	(assumed) (assumed) (assumed)
Comment:			

Control Rod has 106.00" of Al2O3 and 36.00" of B4C. Drawing number is 1182F87.

2E-81/82

GUIDE TUBE PLUGS / ORIFICE RODS

Physical Description Report Babcock & Wilcox Standard Guide Tube Plug Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 16 inches Total Weight: 15.8 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.524 inches Spider Material: St.Steel CF3M Number of Orifice Rods: 16 Life Expectancy:

Physical Description Report Babcock & Wilcox Standard Guide Tube Plug Composition: Material Total Weight (kg) Zone St.Steel CF3M 3.500 Top St.Steel 304 0.070 Top St.Steel 304 3.400 Gas Plenum Used at the Following Reactors: Reactor Number in Core Arkansas 1 108 Oconee 1 108 Oconee 2 108 Oconee 3 108 Crystal River 3 72 Three Mile Island 1 108 Rancho Seco 108 Davis-Besse 57 Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 Mark B Babcock & Wilcox 15x15 Mark BZ

Comment:

Number used per core are the number shipped to the reactor, not the number actually used at a given moment.

Physical Description Report Page: 1 Westinghouse Water Displacement Guide Tube Plug Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 156 inches Total Weight: 20.5 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.437 inches Spider Material: St.Steel 304 Number of Orifice Rods: 16 Life Expectancy:

2E-85

Physical Description Report Page: 2 Westinghouse Water Displacement Guide Tube Plug Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Тор Inconel-718 0.420 Top St.Steel 304 0.530 Gas Plenum St.Steel 304 6.500 In Core Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) (assumed) Point Beach 1 Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF TOP ROD 14x14 (assumed) Westinghouse 14x14 (assumed) Std/ZCA (assumed) Westinghouse 14x14 OFA Westinghouse (assumed) 14x14 Std/ZCB

2E-86

Comment:

Westinghouse

This version has 12 Water Displacement Rods and 4 Thimble Plugs. Another version has 4 Water Displacement Rods and 12 Thimble Plugs. It weighs 13 pounds.

14x14 Std/SC

(assumed)

Physical Description Report Westinghouse Standard Guide Tube Plug Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 12.1 inches Total Weight: 9.5 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.491 inches Spider Material: St.Steel 304 Number of Orifice Rods: 16 Life Expectancy:

2E-87

Page: 1

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Physical Description Report Page: 2 Westinghouse Standard Guide Tube Plug Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Тор 0.420 Inconel-718 Top Gas Plenum St.Steel 304 2.200 Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Array Version Vendor Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF 14x14 TOP ROD 14x14 Std/ZCA (assumed) Westinghouse (assumed) (assumed) Westinghouse 14x14 OFA (assumed) Westinghouse 14x14 Std/ZCB Westinghouse 14x14 Std/SC (assumed)

Comment:

This Thimble Plug Assembly not specifically described by Westinghouse. It is described based on the commonly used parts for other 14x14 NFA hardware.

Physical Description Report Westinghouse Standard Guide Tube Plug Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 10.2 inches Total Weight: 10.8 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.498 inches Spider Material: St.Steel 304 Number of Orifice Rods: 20 Life Expectancy:

Physical Description Report Westinghouse Standard Guide Tube Plug Composition: Material Total Weight (kg) Zone St.Steel 304 1.800 TOD Inconel-718 0.420 Top St.Steel 304 2.700 Gas Plenum Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed)

Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) 15x15 Std/SC Westinghouse (assumed)

Comment:

Cook 1

This Thimble Plug Assembly not specifically described by Westinghouse. It is described based on the commonly used parts for 15x15 NFA hardware.

Page: 2

(assumed)

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Physical Description Report Westinghouse Standard Guide Tube Plug Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 11.8 inches Total Weight: 13.0 pounds Cladding: St.Steel 304 Material: Outer Diameter: 0.434 inches Spider Material: St.Steel 304 Number of Orifice Rods: 24 Life Expectancy:

2E-91

Physical Description Report Westinghouse Standard Guide Tube Plug Composition: Material Total Weight (kg) Zone St.Steel 304 2.300 Top Inconel-718 0.420 Top St.Steel 304 3.200 Gas Plenum Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Voqtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed) Seabrook 2 (assumed)

2E-93/94

Physical Description Report

Page: 3

Westinghouse Standard Guide Tube Plug

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

This Thimble Plug assembly not specifically described by Westinghouse. It is described based on commmonly used parts for 17x17 NFA hardware.

2E-95/%

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INSTRUMENTATION

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Physical Description Report Combustion Engineering System 80 Instrumentation Designed for: Fuel Assembly with array size: 10x10 Pressurized Water Reactor Dimensions: Total Length: 116 feet Total Weight: 34.3 pounds Number of Emitters or Detectors: 5 Emitter/Detector Material: Rhodium Housing: Material: Inconel 600 Outer Diameter: 0.450 inches Seal Plug: Material: St.Steel 347 Diameter: 1.747 inches Lead Wire Material: Sheathing: Inconel 600 Alum. Oxide Insulation: Life Expectancy: 1200 EFPD

Physical Description Report

Page: 2

Combustion Engineering System 80 Instrumentation

Composition: Material	Total Weight (ke	g) Zone
Inconel 600	0.200	Gas Plenum
Alum. Oxide	0.100	In Core
Inconel 600	1.400	In Core
Rhodium	0.005	In Core
Alum. Oxide	0.950	Bottom
Inconel 600	11.300	Bottom
St.Steel 347	1.600	Bottom
Used at the Foll Reactor	owing Reactors: Number in	n Core

Palo	Verde	1	e	51
Palo	Verde	2	e	51
Palo	Verde	3	e	51

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 SYS80

Physical Description Report Page: 1 Combustion Engineering Waterford Instrumentation Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: 38 feet 7.3 Total Weight: pounds Number of Emitters or Detectors: 5 Emitter/Detector Material: Rhodium Housing: Material: Inconel 600 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.383 inches Lead Wire Material: Sheathing: Inconel 600 Insulation: Alum. Oxide Life Expectancy: 1200 EFPD

Physical Description Report

Page: 2

Combustion Engineering Waterford Instrumentation

Composition: Material Total Weight (kg) Zone Alum. Oxide 0.230 Top Inconel 600 1.400 Top St.Steel 347 0.640 Top Inconel 600 0.050 Gas Plenum Alum. Oxide 0.150 In Core Inconel 600 0.910 In Core Rhodium 0.005 In Core

Used at the Following Reactors: Reactor Number in Core

Waterford 3

56

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 ANO2

Physical Description Report Combustion Engineering San Onofre Instrumentation Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: inches 37.0 Total Weight: 6.4 pounds Number of Emitters or Detectors: 5 Emitter/Detector Material: Rhodium Housing: Material: Inconel 600 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.250 inches Lead Wire Material: Sheathing: Inconel 600 Alum. Oxide Insulation: Life Expectancy: 1200 EFPD

Physical Description Report

Page: 2

Combustion Engineering San Onofre Instrumentation

Composition:

Material	Total Weight (kg)	Zone
Alum. Oxide	0.230	Тор
Inconel 600	1.300	Top
St.Steel 347	0.500	Top
Inconel 600	0.050	Gas Plenum
Alum. Oxide	0.100	In Core
Inconel 600	0.820	In Core
Rhodium	0.005	In Core

Used at the Following Reactors: Reactor Number in Core

San	Onofre	2	56
San	Onofre	3	56

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 Onofre

Physical Description Report Combustion Engineering ANO2 Instrumentation Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: 37.0 inches Total Length: Total Weight: 7.0 pounds Number of Emitters or Detectors: 5 Emitter/Detector Material: Rhodium Housing: Inconel 600 Material: Outer Diameter: 0.350 inches Seal Plug: St.Steel 347 Material: Diameter: 1.250 inches Lead Wire Material: Sheathing:Inconel 600Insulation:Alum. Oxide Life Expectancy: 1200 EFPD

Physical Description Report

Combustion Engineering ANO2 Instrumentation

Composition: Material Total Weight (kg) Zone Alum. Oxide 0.230 Top Inconel 600 1.400 Top Тор St.Steel 347 0.450 Inconel 600 0.050 Gas Plenum 0.150 Alum. Oxide In Core Inconel 600 0.860 In Core Rhodium 0.005 In Core

Used at the Following Reactors: Reactor Number in Core

Arkansas 2

44

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 ANO2

Physical Description Report Combustion Engineering St. Lucie 2 Instrumentation Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: 35 feet Total Weight: 7.0 pounds Number of Emitters or Detectors: 4 Emitter/Detector Material: Rhodium Housing: Material: Inconel 600 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.383 inches Lead Wire Material: Inconer Alum. Oxide Sheathing: Insulation: Life Expectancy: 1200 EFPD

Physical Description Report

Combustion Engineering St. Lucie 2 Instrumentation

Composition:

Material	Total Weight (kg)	Zone
St.Steel 347	0.640	Top
Alum. Oxide	0.140	Top
Inconel 600	1.500	Top
Inconel 600	0.050	Gas Plenum
Alum. Oxide	0.050	In Core
Inconel 600	0.770	In Core
Rhodium	0.005	In Core

Used at the Following Reactors: Reactor Number in Core

St. Lucie 2

56

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16x16 Lucie 2

Physical Description Report Combustion Engineering Calvert Cliffs Instrumentation Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length:41Total Weight:11.7 feet 11.7 pounds Number of Emitters or Detectors: 4 Emitter/Detector Material: Rhodium Housing: Material: St.Steel 304 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.515 inches Lead Wire Material: Sheathing: Inconel 600 Insulation: Alum. Oxide Life Expectancy: 1200 EFPD

Physical Description Report

Combustion Engineering Calvert Cliffs Instrumentation

Composition: Material	Total Weight (kg)	Zone
St.Steel 347	3.200	Ton
Inconel 600	0.500	qoT
Alum. Oxide	0.200	Top
St.Steel 304	0.090	Gas Plenum
Alum. Oxide	0.050	In Core
Inconel 600	0.200	In Core
St.Steel 304	1.100	In Core
Rhodium	0.005	In Core
lised at the Fol	lowing Reactors:	

Reactor Number in Core

Calvert	Cliffs	1	45
Calvert	Cliffs	2	45

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 14x14 Std

2E-108

Physical Description Report Page: 1 Combustion Engineering Millstone 2 Instrumentation Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: Total Weight: feet 38 12.7 pounds Number of Emitters or Detectors: 4 Emitter/Detector Material: Rhodium Housing: St.Steel 304 Material: Material:St.Steel 304Outer Diameter:0.350inches Seal Plug: Material: St.Steel 347 1.383 inches Diameter: Lead Wire Material: Sheathing: Inconel 600 Insulation: Alum. Oxide Life Expectancy: 1200 EFPD

Physical Description Report

Combustion Engineering Millstone 2 Instrumentation Composition: Material Total Weight (kg) Zone Тор St.Steel 347 3.400 Inconel 600 0.450 Top Alum. Oxide 0.200 Top St.Steel 304 0.140 Gas Plenum Alum. Oxide 0.095 In Core Inconel 600 0.200 In Core St.Steel 304 1.300 In Core Rhodium 0.005 In Core Used at the Following Reactors: Reactor Number in Core St. Lucie 1 45 Millstone 2 45 Used with Following Fuel Assembly Types: Vendor Array Version Combustion Engineering 14x14 Std Exxon / ANF (assumed) 14x14 CE Westinghouse 14x14 Model C

2E-110

Page: 1 Physical Description Report Combustion Engineering Ft. Calhoun Instrumentation Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 39 feet 11.6 Total Weight: pounds Number of Emitters or Detectors: 4 Emitter/Detector Material: Rhodium Housing: Material: St.Steel 304 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.383 inches Lead Wire Material: Sheathing: Inconel 600 Insulation: Alum. Oxide Life Expectancy: 1200 EFPD

1

Physical Description Report

Combustion Engineering Ft. Calhoun Instrumentation

Composition:	Motal Weight	(ka)	7000
Material	IOCAL WEIGHT	(xy)	2011e
'Alum. Oxide	0.200		Тор
Inconel 600	0.500		Top
St.Steel 347	3.300		Top
St.Steel 304	0.090		Gas Plenum
Alum. Oxide	0.050		In Core
Inconel 600	0.150		In Core
St.Steel 304	1.000		In Core
Rhodium	0.005		In Core

Used at the Following Reactors: Reactor Number in Core

Fort Calhoun 28

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 14x14 Ft.Cal.

Physical Description Report Page: 1 Combustion Engineering Palisades Instrumentation Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 37.0 feet Total Weight: 9.3 pounds Number of Emitters or Detectors: 5 Emitter/Detector Material: Rhodium Housing: Material: St.Steel 304 Outer Diameter: 0.350 inches Seal Plug: Material: St.Steel 347 Diameter: 1.500 inches Lead Wire Material: Sheathing: Inconel 600 Insulation: Alum. Oxide Life Expectancy: 1200 EFPD

Physical Description Report

Page: 2

Combustion Engineering Palisades Instrumentation

Composition:

Material	Total Weight (k	ig) Zone
St.Steel 347	2.500	Тор
Inconel 600	0.400	Top
Alum. Oxide	0.200	Top
St.Steel 304	0.091	Gas Plenum
Rhodium	0.005	In Core
St.Steel 304	0.910	In Core
Alum. Oxide	0.050	In Core
Inconel 600	0.150	In Core

Used at the Following Reactors: Reactor Number in Core

Palisades

43

- Used with Following Fuel Assembly Types: Vendor Array Version
 - Combustion Engineering 15x15 Palis. Exxon / ANF 15x15 CE

2E-115///6

NEUTRON POISONS

Babcock & Wilcox Gray Ax. Power Shap. Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 159.75 inches Rod Length: 155.56 inches Total Weight: 71 pounds Poison: Material: Inconel 600 Length: 63.00 inches Cladding: Material: St.Steel 304 Outer Diameter: 0.440 inches Wall Thickness: Diametral Gap: Spider Material: St.Steel CF3M Number of Burnable Poison Rods: 0 Number of Orifice Rods: 0 Life Expectancy:

Physical Description Report

2E-117
Physical Description Report Page: 2 Babcock & Wilcox Gray Ax. Power Shap. Neutron Poison Composition: Total Weight (kg) Material Zone St.Steel CF3M 3.400 Top St.Steel 304 0.070 Top St.Steel 304 13.500 In Core Inconel 600 15.300 In Core Used at the Following Reactors: Number in Core Reactor Arkansas 1 (assumed) Oconee 1 (assumed) Oconee 2 (assumed) Oconee 3 (assumed) Crystal River 3 (assumed) Three Mile Island 1 (assumed) Rancho Seco (assumed) Davis-Besse (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 Mark B (assumed)

15x15 Mark BZ

(assumed)

.

Babcock & Wilcox

Physical Description Report Page: 1 Babcock & Wilcox Burnable Poison Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: 154 inches Total Length: Rod Length: Total Weight: 148.375 inches 57 pounds Poison: Material: Al203 - B4C Length: Cladding: Material: Zircaloy-4 Outer Diameter: 0.43 inches Wall Thickness: Diametral Gap: Spider Material: St.Steel CF3M Number of Burnable Poison Rods: 16 Number of Orifice Rods: 0 Life Expectancy:

2E-119

Physical Description Report Babcock & Wilcox Burnable Poison Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel CF3M 3.500 Top St.Steel 304 0.060 Top Zircaloy-4 11.380 In Core St.Steel 304 0.940 In Core In Core Al203 - B4C 9.440 Used at the Following Reactors: Reactor Number in Core Arkansas 1 64 Oconee 1 60 Oconee 2 60 Oconee 3 60 Crystal River 3 60 Three Mile Island 1 68 Rancho Seco 64 Davis-Besse 56 Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 Mark B Babcock & Wilcox 15x15 Mark BZ

Physical Description	Page: 1						
Babcock & Wilcox	Axial Po	wer Shap. Neu	tron Poison				
Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor							
Dimensions: Total Length: Rod Length: Total Weight:	160 156 57	inches inches pounds					
Poison: Material: Length:	Ag-In-Cd 36	inches					
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	St.Steel 0.476	304 inches					
Spider Material:		St.Steel	CF3M				
Number of Burnable Poison Rods: 16							
Number of Orifice Rods:		0					
Life Expectancy:							

Physical Description Report Babcock & Wilcox Axial Power Shap. Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel CF3M 3.500 Top St.Steel 304 0.073 Top St.Steel 304 11.100 In Core Ag-In-Cd 10.610 In Core Used at the Following Reactors: Number in Core Reactor Arkansas 1 (assumed) Oconee 1 (assumed) Oconee 2 (assumed) Oconee 3 (assumed) Crystal River 3 (assumed) Three Mile Island 1 Rancho Seco Davis-Besse Used with Following Fuel Assembly Types: Vendor Array Version

Babcock & Wilcox15x15Mark BBabcock & Wilcox15x15Mark BZ

2E-122

Physical Description Report Westinghouse (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: 156.1 inches Total Length: Rod Length: 150.6 inches Total Weight: 17 pounds Poison: Borosil.Glass Material: Length: 142.7 inches Cladding: St.Steel 304 Material: Outer Diameter: 0.437 inches Wall Thickness: 0.018 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 12 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 1-16 Burnable Poison Rods. The weight of a version can be expressed as 9.27 + (1.92 * the number of Burnable Poison Rods). Radiological Characterizations are available for 4, 12, and 16 Rod versions.

Physical Description Report Westinghouse (4-Rod) Neutron Poison Composition: Total Weight (kg) Material Zone St.Steel 304 Top 1.700 Inconel-718 0.420 Top St.Steel 304 1.600 Gas Plenum St.Steel 304 2.500 In Core Borosil.Glass 1.500 In Core Used at the Following Reactors: Number in Core Reactor Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF 14x14 TOP ROD (assumed) Westinghouse 14x14 Std/ZCA (assumed) Westinghouse 14x14 OFA (assumed) 14x14 Std/ZCB 14x14 Std/SC Westinghouse (assumed) Westinghouse (assumed)

Comment:

Reference: BPA01, G01; page B-19 of WTSD-TME-148

Physical Description Report Westinghouse (12-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches 150.6 inches Rod Length: Total Weight: 32 pounds Poison: Material: Borosil.Glass 142.7 inches Length: Cladding: Material: St.Steel 304 Outer Diameter: 0.437 inches Wall Thickness: 0.018 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 12 Number of Orifice Rods: 4 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 1-16 Burnable Poison Rods. The weight of a version can be expressed as 9.27 + (1.92 * Number of Burnable Poison Rods). Radiological Characterizations available for 4,12, and 16 Rod versions.

Physical Description Report Westinghouse (12-Rod) Neutron Poison Composition: Total Weight (kg) Zone Material St.Steel 304 Top 1.700 0.420 Inconel-718 Top Gas Plenum St.Steel 304 0.540 In Core Borosil.Glass 4.500 St.Steel 304 7.500 In Core Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF 14x14 TOP ROD (assumed) Westinghouse 14x14 Std/ZCA (assumed) 14x14 OFA Westinghouse (assumed) Westinghouse 14x14 Std/ZCB (assumed) (assumed) Westinghouse 14x14 Std/SC

Comment:

Reference: BPA01, G03; page B-19 of WTSD-TME-148.

Physical Description Report Westinghouse BPA (16-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Rod Length: 150.6 inches Total Weight: 40 pounds Poison: Borosil.Glass Material: 142.7 inches Length: Cladding: Material: St.Steel 304 Outer Diameter: 0.437 inches Wall Thickness: 0.018 inches Diametral Gap: St.Steel 304 Spider Material: Number of Burnable Poison Rods: 16 Number of Orifice Rods: 0 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 1-16 Burnable Poison Rods. The weight of a version can be expressed as 9.27 + (1.92 * Number of Burnable Poison Rods). Radiological Characterizations available for 4, 12 and 16 Rod versions.

Westinghouse BPA (16-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel-718 0.420 Top St.Steel 304 9.900 In Core Borosil.Glass In Core 6.000 Used at the Following Reactors: Number in Core Reactor Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Array Version Vendor Babcock & Wilcox 14x14 (assumed) Exxon / ANF Exxon / ANF (assumed) 14x14 WE 14x14 TOP ROD (assumed)

Physical Description Report

EXXON / ANF14x14WE(assumed)Exxon / ANF14x14TOP ROD(assumed)Westinghouse14x14Std/ZCA(assumed)Westinghouse14x14OFA(assumed)Westinghouse14x14Std/ZCB(assumed)Westinghouse14x14Std/ZCB(assumed)Westinghouse14x14Std/ZCB(assumed)

Comment:

Reference: BPA01-G04; page B-19 of WTSD-TME-148

Physical Description Report Westinghouse WABA (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 153.6 inches Rod Length: 150.1 inches Total Weight: 15.6 pounds Poison: Material: B4C (WE) 134.0 Length: inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 12 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part with 4-16 Burnable Poison Rods. The weight of a version can be expressed as 9.56 + (1.54 * Number of Burnable Poison Rods). Radiological Characterizations available for 4, 12, and 16 Rod versions.

Physical Description Report Westinghouse WABA (4-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Тор Inconel-718 St.Steel 304 0.420 Тор Gas Plenum In Core In Core 1.600 Zircaloy-4 B4C (WE) 0.420 Used at the Following Reactors: Reactor Number in Core Prairie Island l Prairie Island 2 (assumed) (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14

Babcock & Wilcox14x14(assumed)Exxon / ANF14x14WE(assumed)Exxon / ANF14x14TOP ROD(assumed)Westinghouse14x14Std/ZCA(assumed)Westinghouse14x14OFA(assumed)Westinghouse14x14Std/ZCB(assumed)Westinghouse14x14Std/ZCB(assumed)Westinghouse14x14Std/SC(assumed)

Comment:

Reference: WABA-1, G01; page B-27 of WTSD-TME-148.

Physical Description Report Westinghouse WABA (12-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: inches 153.6 150.1 Rod Length: inches Total Weight: 27.7 pounds Poison: Material: B4C (WE) inches Length: 134.0 Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches 0.026 Wall Thickness: inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 12 Number of Orifice Rods: 4 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 4-16 Burnable Poison Rods. The weight of a version can be expressed as 9.56 + (1.54 * Number of Burnable Poison Rods). Radiological Characterizations available for 4, 12, and 16 Rod versions.

Physical Description Report Page: 2 Westinghouse WABA (12-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel-718 0.420 Top St.Steel 304 0.550 Gas Plenum Zircaloy-4 8.820 In Core In Core B4C (WE) 1.250 Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) 14x14 WE 14x14 WE 14x14 TOP ROD 14x14 Std/ZCA 14x14 OFA 14x14 Std/ZCB 14x14 Std/SC Exxon / ANF (assumed) Exxon / ANF (assumed) Westinghouse (assumed) Westinghouse (assumed) Westinghouse Westinghouse (assumed) (assumed)

Comment:

Reference: WABA-1, G03; page B-27 of WTSD-TME-148.

Physical Description Report Westinghouse WABA (16-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 153.6 inches 150.1 34.2 Rod Length: inches Total Weight: pounds Poison: Material: B4C (WE) Length: 134.0 inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 16 Number of Orifice Rods: 0 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 4-16 Burnable Poison Rods. The weigth of a version can be expressed as 9.56 + (1.54 * Number of Burnable Poison Rods). Radiological Characterizations available for 4, 12, and 16 Rod versions.

Physical Description Report Westinghouse WABA (16-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel-718 0.420 Тор Zircaloy-4 In Core 11.760 B4C (WE) 1.700 In Core Used at the Following Reactors: Number in Core Reactor Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF Exxon / ANF 14x14 WE (assumed) 14x14 WE 14x14 TOP ROD 14x14 Std/ZCA 14x14 OFA 14x14 Std/ZCB 14x14 Std/SC (assumed) Westinghouse Westinghouse (assumed) (assumed) Westinghouse (assumed) Westinghouse (assumed)

Comment:

Reference: WABA-1,G04; page B-27 of WTSD-TME-148.

Physical Description Report Westinghouse WABA (8-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: inches 153.7 Rod Length: 150.1 inches Total Weight: 22.8 pounds Poison: Material: B4C (WE) Length: 134.0 inches Cladding: Material: Zircaloy-4 0.381 inches Outer Diameter: Wall Thickness: 0.026 inches Diametral Gap: St.Steel 304 Spider Material: Number of Burnable Poison Rods: 8 Number of Orifice Rods: 12 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part with 4-20 Burnable Poison Rods. The weight of a version can be expressed as 10.84 + (1.55 * Number of Burnable Poison Rods).Radiological Characterizations are available for 8 and 20 Rod versions.

Physical Description Report Westinghouse WABA (8-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.800 Top Inconel-718 0.420 Top St.Steel 304 1.600 Gas Plenum In Core 5.900 Zircaloy-4 B4C (WE) 0.840 In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox st.stl. (assumed) 15x15 Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) (assumed) Westinghouse std/sc 15x15 Comment:

Reference: WABA2, GO1; page B-27 of WTSD-TME-148. Weights given in WTSD-TME-148 appear to be wrong.

Physical Description Report Westinghouse WABA (20-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 153.7 inches Rod Length: 150.1 inches Total Weight: 40.8 pounds Poison: Material: B4C (WE) Length: 134.0 inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 20 Number of Orifice Rods: 0 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 4-20 Burnable Poison Rods. The weight of a version can be expressed as 10.84 + (1.55 * Number of Burnable Poison Rods).Radiological Characterizations available for the 8 and 20 Rod versions.

2E - 138

Physical Description Report Westinghouse WABA (20-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.800 Top Inconel-718 0.420 Top Zircaloy-4 In Core 14.700 In Core B4C (WE) 2.090 Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) 15x15 Std/2C 15x15 OFA 15x15 Std/SC Westinghouse (assumed) Westinghouse (assumed) Westinghouse (assumed)

Comment:

Reference: WABA2, G09; page B-27 of WTSD-TME-148. Weights given in WTSD-TME-148 appear to be wrong.

rage: 2

Physical Description Report Westinghouse Short WABA (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 146.6 inches 143.1 Rod Length: inches Total Weight: 16.5 pounds Poison: Material: B4C (WE) Length: 114.0 inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 16 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part with 4-16 Burnable Poison Rods. The weight of a version can be expressed as 11.5 + (1.44 * Number of Burnable Poison Rods.) Radiological Characterizations are available for 4 and 12 Rod versions.

Westinghouse Short WABA (4-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.800 Top 0.420 Inconel-718 Top Gas Plenum St.Steel 304 2.200 In Core Zircaloy-4 2.600 B4C (WE) 0.360 In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 st.stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) Westinghouse (assumed) 15x15 Std/SC

Comment:

Reference: WABA-3, G04; page B-28 of WTSD-TME-148.

2E-140

Physical Description Report

Physical Description Report Westinghouse Short WABA (12-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 146.6 inches inches Rod Length: 143.1 Total Weight: 28 pounds Poison: Material: B4C (WE) Length: 114.0 inches Cladding: Material: Zircaloy-4 0.381 Outer Diameter: inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 12 Number of Orifice Rods: 8 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part wiht 4-16 Burnable Poison Rods. The weight of a version can be expressed as 11.5 + (1.44 * Number of Burnable Poison Rods). Radiological Characterizations are available for 4 and 12 Rod versions.

Physical Description Report Westinghouse Short WABA (12-Rod) Neutron Poison Composition: Total Weight (kg) Material Zone St.Steel 304 1.800 Тор Inconel-718 0.420 Top 1.090 7.900 Gas Plenum St.Steel 304 In Core Zircaloy-4 B4C (WE) In Core 1.090 Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) (assumed) Indian Point 2 Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox (assumed) 15x15 st.stl. Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) Westinghouse 15x15 Std/SC (assumed) Comment: Reference: WABA3, G06; page B-28 of WTSD-TME-148.

2E-142

Physical Description Report Westinghouse BPA (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Rod Length: 152.5 inches Total Weight: 20.4 pounds Poison: Material: Borosil.Glass Length: 142.7 inches Cladding: Material: St.Steel 304 Outer Diameter: 0.445 inches Wall Thickness: 0.020 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 16 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 4-20 Burnable Poison Rods. The weight of a version can be expressed as 12.35 + (2.07 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 12, and 20 Rod versions.

Physical Description Report Westinghouse BPA (4-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel-718 0.360 Top St.Steel 304 Gas Plenum 2.600 St.Steel 304 2.600 In Core Borosil.Glass 1.500 In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 st.stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse Std/ZC 15x15 (assumed) Westinghouse 15x15 OFA (assumed) Westinghouse 15x15 Std/SC (assumed)

Comment:

Reference: BPA10, G06; page B-21 of WTSD-TME-148

2E-144

Physical Description Report Westinghouse BPA (10-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Rod Length: 152.5 inches 33.7 Total Weight: pounds Poison: Material: Borosil.Glass Length: 142.7 inches Cladding: Material: St.Steel 304 Outer Diameter: 0.445 inches Wall Thickness: 0.020 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 10 Number of Orifice Rods: 10 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 4-20 Burnable Poison Rods. The weight of a version can be expressed as 12.35 + (2.07 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 10, and 20 Rod versions.

Physical Description Report Westinghouse BPA (10-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel-718 0.360 Top St.Steel 304 1.600 Gas Plenum St.Steel 304 6.600 In Core Borosil.Glass 3.760 In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15**x1**5 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) 15x15 OFA Westinghouse (assumed) Westinghouse 15x15 Std/SC (assumed) Comment: Reference: BPA10, G09; page B-21 of WTSD-TME-148

2E-146

1

Physical Description	Report		Page:
Westinghous	e BPA (20	-Rod) Neutron Poison	
Designed for: Fuel Assembly with Pressurized Water R	array siz eactor	e: 15x15	
Dimensions: Total Length: Rod Length: Total Weight:	156.1 152.5 53.6	inches inches pounds	
Poison: Material: Length:	Borosil. 142.7	Glass inches	
Cladding: Material: Outer Diameter: Wall Thickness: Diametral Gap:	St.Steel 0.445 0.020	304 inches inches	
Spider Material:		St.Steel 304	
Number of Burnable Poison Rods:		: 20	
Number of Orifice Rods:		0	
Life Expectancy:			
Design Variations:			

Westinghouse makes versions of this part with 4-20 Burnable Poison Rods. The weight of a version can be expressed as 12.35 + (2.06 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 10, and 20 Rod versions.

Physical Description Report Westinghouse BPA (20-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Тор Inconel-718 0.360 Top St.Steel 304 13.200 In Core Borosil.Glass 7.500 In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion l (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) 15x15 OFA 15x15 Std/SC Westinghouse (assumed) Westinghouse (assumed) Comment: Reference: BPA10, G03; page B-21 of WTSD-TME-148

Physical Description Report Page: 1 Westinghouse WABA (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 153.6 inches Rod Length: 150.0 inches Total Weight: 16.9 pounds Poison: Material: B4C (WE) Length: 134.0 inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 20 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part with 3-24 Burnable Poison Rods. The weight of a version can be expressed as 10.14 + (1.68 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 16, and 24 Rod versions. Physical Description Report Page: 2 Westinghouse WABA (4-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 2.300 Top Inconel-718 0.420 Top St.Steel 304 1.500 Gas Plenum 0.420 In Core B4C (WE) In Core Zircaloy-4 2.900 Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Voqtle 1 (assumed) Voqtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) (assumed) North Anna 2 (assumed) Cook 2 Seabrook 1 (assumed) (assumed) Seabrook 2

2E-150

Physical Description Report

Page: 3

Westinghouse WABA (4-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: WABA-4, G16; page B-28 of WTSD-TME-148

Physical Description Report Westinghouse WABA (16-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 153.6 inches Rod Length: 150.0 inches Total Weight: 37.1 pounds Poison: Material: B4C (WE) 134.0 Length: inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 inches Wall Thickness: 0.026 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 16 Number of Orifice Rods: 8 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 3-24 Burnable Poison Rods. The weight of a version can be expressed as 10.14 + (1.86 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 16, and 24 Rod versions.

Physical Description Report Westinghouse WABA (16-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 2.300 Top Inconel-718 0.420 Top St.Steel 304 0.580 Gas Plenum B4C (WE) 1.700 In Core Zircaloy-4 11.600 In Core Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed)

Seabrook 1 Seabrook 2 2E-153

Page: 2

(assumed)
Page: 3

Westinghouse WABA (16-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: WABA4, GO2; page B-28 of WTSD-TME-148

Physical Description Report Westinghouse WABA (24-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 153.6 inches Rod Length: 150.0 inches Total Weight: 50.5 pounds Poison: Material: B4C (WE) 134.0 Length: inches Cladding: Material: Zircaloy-4 Outer Diameter: 0.381 0.026 inches Wall Thickness: inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 24 Number of Orifice Rods: 0 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 3-24 Burnable Poison Rods. The weight of a version can be expressed as 10.14 + (1.86 * Number of Burnable Poison Rods).Radiological Characterizations available for 4, 16, and 24 Rod versions.

Physical Descrip	otion Report			Pa
Westing	house WABA	(24-Rod)	Neutron Poison	
Composition: Material	Total Weig	ht (kg)	Zone	
	2			
St.Steel 304	2.300		Top	
Inconel-718	0.420		Тор	
B4C (WE)	2.500		In Core	
Zircaloy-4	17.400		In Core	
Used at the Foll	owing React	org		
Reactor	Num	ber in Co	ore	
Farley 1			(assumed)	
Farley 2			(assumed)	
Harris			(assumed)	
Braidwood 1			(assumed)	
Braidwood 2			(assumed)	
Byron 1			(assumed)	
Byron 2			(assumed)	
Catawba l			(assumed)	
Catawba 2			(assumed)	
McGuire l			(assumed)	
McGuire 2			(assumed)	
Beaver Valley	1		(assumed)	
Beaver Valley	2		(assumed)	
Vogtle 1			(assumed)	
Vogtle 2			(assumed)	
Wolf Creek			(assumed)	
Millstone 3			(assumed)	
Diablo Canyon	1		(assumed)	
Diablo Canyon	2		(assumed)	
Trojan			(assumed)	
Salem 1			(assumed)	
Salem 2			(assumed)	
Summer			(assumed)	
Sequoyan I			(assumed)	
Watts Bar 1 Watta Bar 2			(assumed)	
Walls Bar 2	•		(assumed)	
Comanche Peak	⊥ ว		(assumed)	
Collaway	2		(assumed)	
Carraway North Anna J			(assumed)	
North Anna 2			(assumed)	
Cook 2			(assumed)	
Seabrook 1			(assumed)	
Seabrook 2			(assumed)	
DEADLOOK Z			(assumed)	

Page: 3

Westinghouse WABA (24-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17 <u>x</u> 17	WE	(assumed)
Westinghouse	17x17	std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: WABA4, G43; page B-29 of WTSD-TME-148

Physical Description Report Westinghouse BPA (4-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Rod Length: 152.4 inches Total Weight: 19.2 pounds Poison: Material: Borosil.Glass Length: 142.0 inches Cladding: St.Steel 304 Material: Outer Diameter: 0.385 inches Wall Thickness: 0.018 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 4 Number of Orifice Rods: 20 Life Expectancy:

Design Variations:

Westinghouse makes versions of this part with 2-24 Burnable Poison Rods. The weight of a version can be expressed as 13.09 + (1.52 * Number of Burnable Poison Rods).Radiological Characterizations available for 4,10,16 and 24 Rod versions.

Physical Description Report Westinghouse BPA (4-Rod) Neutron Poison Composition: Total Weight (kg) Material Zone St.Steel 304 2.300 Top Inconel-718 0.420 Top St.Steel 304 2.630 Gas Plenum St.Steel 304 2.000 In Core In Core Borosil.Glass 1.300 Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Voqtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed)

Seabrook 2

(assumed)

2E-159

Physical Description Report

Page: 3

Westinghouse BPA (4-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: BPA16, G43; page B-23 of WTSD-TME-148

Report		Page
e BPA (10	-Rod) Neutron Poison	
array siz eactor	e: 17x17	
156.1 152.4 28.4	inches inches pounds	
Borosil. 142.0	Glass inches	
St.Steel 0.385 0.018	304 inches inches	
	St.Steel 304	
ison Rods	: 10	
s:	14	
	Report P BPA (10 Array size actor 156.1 152.4 28.4 Borosil. 142.0 St.Steel 0.385 0.018 ison Rods s:	Report BPA (10-Rod) Neutron Poison Array size: 17x17 Eactor 156.1 inches 152.4 inches 28.4 pounds Borosil.Glass 142.0 inches St.Steel 304 0.385 inches 0.018 inches St.Steel 304 ison Rods: 10 s: 14

Design Variations:

Westinghouse makes versions of this part with 2-24 Burnable Poison Rods. The weight of a version can be expressed as 13.09 + (1.52 * Number of Burnable Poison Rods).Radiological Characterizations available for 4,10,16 and 24 Rod versions.

: 1

Physical Descrip	otion Re	eport				
Westir	nghouse	BPA	(10	-Rod)	Neutron	Poison
Composition:	_					
Material	Total	Weig	nt	(kg)	Zone	
St.Steel 304	2	.300			Top	
Inconel-/18	0	.420			Top	
St.Steel 304	Ţ	.800			Gas Plei	lum
Borosil.Glass	3	.200			In Core	5
Used at the Foll	owing 1	React	ors	:		
Reactor		Num	ber	in Co	ore	
Farley 1					(as	sumed)
Farley 2					(as	sumed)
Harris					(as	ssumed)
Braidwood l					(as	ssumed)
Braidwood 2					(as	ssumed)
Byron 1					(as	ssumed)
Byron 2					(as	ssumed)
Catawba 1 Catawba 2					(as	sumed)
McGuire 1					(as	ssumed)
McGuire 2					(a:	ssumed)
Beaver Vallev	1				(as	ssumed)
Beaver Valley	2				(as	ssumed)
Vogtle 1					(as	ssumed).
Vogtle 2					(as	ssumed)
Wolf Creek					(as	ssumed)
Millstone 3					(as	ssumed)
Diablo Canyon	Ţ				(as	ssumed)
Diabio Canyon	2				(as	ssumed)
Salem 1					(d:	ssumed)
Salem 2					(a:	ssumed)
Summer					(as	ssumed)
Sequoyah 1					(as	ssumed)
Watts Bar 1					(as	ssumed)
Watts Bar 2					(as	ssumed)
Comanche Peak	1				(as	ssumed)
Comanche Peak	2				(as	ssumed)
Callaway					(as	ssumed)
North Anna 1					(as	ssumed)
North Anna 2 Cook 2					(as	soumed)
Seabrook 1					(a: (a:	ssumed)
Seabrook 2					(as	ssumed)

Physical Description Report

Page: 3

Westinghouse BPA (10-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: BPA-16, G06; page B-22 of WTSD-TME-148

2E - 164

Physical Description Report Westinghouse BPA (16-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Rod Length: 152.4 inches Total Weight: 37.5 pounds Poison: Material: Borosil.Glass Length: 142.0 inches Cladding: St.Steel 304 Material: Outer Diameter: 0.385 inches Wall Thickness: 0.018 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 16 Number of Orifice Rods: 8 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 2-24 Burnable Poison Rods. The weight of a version can be expressed as 13.09 + (1.52 * Number of Burnable Poison Rods).Radiological Characterizations available for 4,10,16 and 24 Rod versions.

Physical Description Report Westinghouse BPA (16-Rod) Neutron Poison Composition: Material Total Weight (kg) Zone St.Steel 304 2.300 Top Inconel-718 0.420 Top St.Steel 304 1.000 Gas Plenum St.Steel 304 8.100 In Core Borosil.Glass 5.100 In Core Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed) Seabrook 1 (assumed) Seabrook 2 (assumed)

Page: 3

Westinghouse BPA (16-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: BPA-16, G01; page B-22 of WTSD-TME-148

Physical Description Report Westinghouse BPA (24-Rod) Neutron Poison Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.7 inches Rod Length: 152.4 inches Total Weight: 49.6 pounds Poison: Material: Borosil.Glass Length: 142.0 inches Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Wall Thickness: 0.018 inches Diametral Gap: Spider Material: St.Steel 304 Number of Burnable Poison Rods: 24 Number of Orifice Rods: 0 Life Expectancy: Design Variations:

Westinghouse makes versions of this part with 2-24 Burnable Poison Rods. The weight of a version can be expressed as 13.09 + (1.52 * Number of Burnable Poison Rods).Radiological Characterizations available for 4,10,16 and 24 Rod versions.

Physical Description Report	Ра
Westinghouse BPA	(24-Rod) Neutron Poison
Composition:	
Material Total Weig	ht (kg) Zone
St.Steel 304 2.300	Тор
Inconel-718 0.420	Top
St.Steel 304 12.100	In Core
Borosil.Glass 7.600	In Core
Used at the Following React Reactor Num	ors: ber in Core
Farley l	(assumed)
Farley 2	(assumed)
Harris	(assumed)
Braidwood l	(assumed)
Braidwood 2	(assumed)
Byron l	(assumed)
Byron 2	(assumed)
Catawba l	(assumed)
Catawba 2	(assumed)
McGuire 1	(assumed)
McGuire 2	(assumed)
Beaver Valley 1	(assumed)
Beaver Valley 2	(assumed)
Vogtle 1	(assumed)
Vogtle 2	(assumed)
Wolf Creek	(assumed)
Millstone 3	(assumed)
Diablo Canyon 1	(assumed)
Diablo Canyon 2	(assumed)
Trojan	(assumed)
Salem 1	(assumed)
Salem 2	(assumed)
Summer	(assumed)
Sequoyah 1	(assumed)
Watts Bar 1	(assumed)
Watts Bar 2	(assumed)
Comanche Peak 1	(assumed)
Comanche Peak 2	(assumed)
Callaway	(assumed)
North Anna 1	(assumed)
North Anna 2	(assumed)
	(assumed)
Seaprook 1	(assumed)
Seabrook 2	(assumed)

2E-169/170

Page: 3

Westinghouse BPA (24-Rod) Neutron Poison

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: BPA-16, G14; page B-22 of WTSD-TME-148.

2E-171/172

NEUTRON SOURCE ASSEMBLIES

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Physical Description Report Babcock & Wilcox Primary Source Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 145.75 inches Total Weight: 1 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.440 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: N/A Primary Source: Material: Am-Be Copper Length: 0.5 inches Strength: Secondary Source: Material: N/A Length: Spacers: N/A Material: Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 0 Life Expectancy:

Physical Description Report Page: 2 Babcock & Wilcox Primary Source Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 0.440 In Core 0.009 In Core Am-Be Copper Used at the Following Reactors: Reactor Number in Core Arkansas 1 Oconee 1 (assumed) Oconee 2 (assumed) Oconee 3 (assumed) Crystal River 3 Three Mile Island 1 (assumed) Rancho Seco (assumed) Davis-Besse Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 Mark B Babcock & Wilcox 15x15 Mark BZ (assumed)

2E-174

Physical Description Report Page: 1 Babcock & Wilcox Regenerative Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 144 inches Total Weight: 46.3 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.440 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel CF3M Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: Spacers: Material: Length: Number of Orifice Rods: Number of Burnable Poison Rods: Number of Source Rods, primary and secondary: 8 Number of Primary Source Rods only: Number of Secondary Source Rods only: 8 Life Expectancy:

Page: 2

Babcock & Wilcox Regenerative Neutron Source

Rod Configuration Feature:

Assumed Cladding and End Plug weight of 1.3 pounds per Rod.

Page: 3 Physical Description Report Babcock & Wilcox Regenerative Neutron Source Composition: Total Weight (kg) Zone Material St.Steel CF3M 3.500 Top St.Steel 304 0.040 Top 4.700 In Core St.Steel 304 12.700 In Core Antimony-Be Used at the Following Reactors: Number in Core Reactor Arkansas 1 2 - 32 Oconee 1 Oconee 2 2 Oconee 3 2-3 Crystal River 3 2 Three Mile Island 1 2-3 Rancho Seco 2-3 Davis-Besse 2-3 Used with Following Fuel Assembly Types: Vendor Array Version 15x15 Mark B Babcock & Wilcox

15x15 Mark BZ

Babcock & Wilcox

Physical Description Report Combustion Engineering Standard Neutron Source Designed for: Fuel Assembly with array size: 16x16 Pressurized Water Reactor Dimensions: Total Length: Total Weight: 99.0 inches 8.2 pounds Cladding: Material: St.Steel 316 Outer Diameter: 0.812 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 316 Primary Source: Material: Pu-Be Length: 6 inches Strength: Secondary Source: Material: Antimony-Be Length: 15.65 inches Spacers: Material: St.Steel 316 Length: 5.95 inches Number of Orifice Rods: 0 Number of Burnable Poison Rods: . 0 Number of Source Rods, 1 primary and secondary: Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 0 Life Expectancy: 3500 EFPD

Physical Description Report

Page: 2

Combustion Engineering Standard Neutron Source

Composition: Material	Total Weight	(kg)	Zone
St.Steel 316	0.040		Top
Inconel 600	0.090		Top
St.Steel 316	0.090		Gas Plenum
St.Steel 316	3.600		In Core
Inconel 600	0.090		In Core
Plutonium	0,140		In Core
Antimony	0.140		In Core
Beryllium	0.230		In Core

Used at the Following Reactors: Reactor Number in Core

Palo Verde 1	2
Palo Verde 2	2
Palo Verde 3	2
Arkansas 2	2
St. Lucie 2	2
Waterford 3	2
San Onofre 2	2
San Onofre 3	2

Used with Following Fuel Assembly Types: Vendor Array Version Combustion Engineering 16x16 Onofre Combustion Engineering 16x16 Lucie 2

Combustion Engineering 16x16 Lucie 2 Combustion Engineering 16x16 ANO2 Combustion Engineering 16x16 SYS80

Comment:

Uncertainity as to how many Secondary Source and Spacer Pellets per Rod. One each per Rod assumed.

Physical Description Report Combustion Engineering 128 Inch Core Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: 100 Total Length: inches Total Weight: 10.6 pounds Cladding: Material: St.Steel 316 0.875 inches Outer Diameter: Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 316 Primary Source: Material: Pu-Be Length: 10.75 inches Strength: Secondary Source: Material: Antimony-Be Length: 15.65 inches Spacers: Material: St.Steel 316 Length: 2.10 inches Number of Orifice Rods: 0 Number of Burnable Poison Rods: 0 Number of Source Rods, 1 primary and secondary: Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 0 Life Expectancy: 4000 EFPD

Combustion Engineering 128 Inch Core Neutron Source

Composition: Material	Total Weight (k	g) Zone
St.Steel 316	0.320	Top
CE Ni Alloy	0.050	Top
St.Steel 316	0.050	Gas Plenum
St.Steel 316	2.900	In Core
CE Ni Alloy	0.050	In Core
Plutonium	0.090	In Core
Antimony	0.090	In Core
Beryllium	0.200	In Core

Used at the Following Reactors: Reactor Number in Core

Fort Calhoun

2

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion	Engineering	14x14	Ft.Cal.
Exxon / ANI	5	14x14	Ft.Cal

Comment:

Uncertainity as to number of Secondary Source and Spacer Pellets per Rod. One per Rod assumed.

Physical Description Report Page: 1 Combustion Engineering 137 Inch Core Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 106 Total Weight: 10.9 inches pounds Cladding: Material: St.Steel 316 Outer Diameter: 0.875 inches Diametral Gap: 0.035 inches Poison Material: N/A Spider/Plunger Material: St.Steel 316 Primary Source: Material: Pu-Be 10.75 inches Length: Strength: Secondary Source: Material: Antimony-Be Length: 15.65 inches Spacers: Material: St.Steel 316 Length: 2.10 inches Number of Orifice Rods: 0 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 0 Life Expectancy: 4000 EFPD

Physical Description Report

Page: 2

Combustion Engineering 137 Inch Core Neutron Source

Composition:

Total Weight (kg)	Zone
0.400	Top
0.090	Тор
0.090	Gas Plenum
3.800	In Core
0.090	In Core
0.140	In Core
0.140	In Core
0.230	In Core
	Total Weight (kg) 0.400 0.090 0.090 3.800 0.090 0.140 0.140 0.230

Used at the Following Reactors: Reactor Number in Core

Calvert Cliffs	l	2
Calvert Cliffs	2	2
St. Lucie 1		2
Maine Yankee		2
Millstone 2		2

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering	14x14	Std	
Exxon / ANF	14x14	CE	
Westinghouse	14x14	Model	С

Comment:

Uncertainity as to number of Secondary Source and Spacer Pellets per Rod. One per Rod assumed. Physical Description Report Combustion Engineering Sustaining Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 117 inches Total Weight: 4.5 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.340 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 72 inches Spacers: Material: N/A Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 1 Life Expectancy: 4000 EFPD

Page: 2

Combustion Engineering Sustaining Neutron Source

Composition:

Material	Total Weight (kg)	Zone
St.Steel 304	0.680	Тор
St.Steel 304	0.050	Gas Plenum
St.Steel 304	1.100	In Core
Antimony	0.090	In Core
Beryllium	0.090	In Core

Used at the Following Reactors: Reactor Number in Core

Palisades

2

Used with Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 15x15 Palis. Exxon / ANF 15x15 CE

Physical Description Report Page: 1 Combustion Engineering Start-up Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 117 inches Total Weight: 4.5 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.340 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: Pu-Be Length: 12.0 inches Strength: Secondary Source: Material: Antimony-Be Length: 60.0 inches Spacers: Material: N/A Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 0 Life Expectancy: 4000 EFPD

2E-186

Page: 2

Combustion Engineering Start-up Neutron Source

Rod Configuration Feature:

This Neutron Source has two 30" Sb-Be Pellets, separated by a 12" Po-Be Pellet.

Combustion Engineering Start-up Neutron Source

Composition: Material Total Weight (kg) Zone St.Steel 304 0.680 Тор St.Steel 304 0.050 Gas Plenum St.Steel 304 1.100 In Core Plutonium 0.050 In Core In Core Antimony 0.090 Beryllium 0.090 In Core

Used at the Following Reactors: Reactor Number in Core

Palisades

2

Used with Following Fuel	Assembly	y Types:
Vendor	Array	Version
Combustion Engineering	15x15	Palis.
Exxon / ANF	15x15	CE

(assumed)

Physical Description Report Page: 1 Westinghouse Primary, Version 1 Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 125.3 inches Total Weight: 48 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Californium Length: Strength: 2-6E+08 curies Secondary Source: Material: Antimony-Be Length: Spacers: Material: N/A Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 3 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Primary, Version 1 Neutron Source Composition: Total Weight (kg) Material Zone St.Steel 304 Тор 3.520 Inconel X-750 Тор 0.230 St.Steel 304 10.100 In Core Borosil.Glass 4.500 In Core Californium In Core Antimony-Be In Core Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14x14 (assumed) Exxon / ANF 14x14 WE (assumed) Exxon / ANF 14x14 TOP ROD (assumed) Westinghouse Westinghouse Westinghouse 14x14 Std/ZCA (assumed) 14x14 OFA 14x14 Std/ZCB (assumed) (assumed) Westinghouse 14x14 Std/SC (assumed)

2E-190

Comment:

Reference: SA-16, G06; page B-9 of WTSD-TME-148.

Page: 1 Physical Description Report Westinghouse Primary, Version 2 Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: 158.3 Total Length: Total Weight: inches pounds 48 Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Californium Length: 1.65 inches Strength: 2-6E+08 curies Secondary Source: Material: Antimony-Be Length: Spacers: Material: Alum. Oxide Length: 145.4 inches Number of Orifice Rods: 0 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 3 Life Expectancy:
Physical Descript	ion Report		Page
Westinghou	lse Primary, Ve	rsion 2 Neutror	a Source
Composition: Material	Total Weight (kg) Zone	
St.Steel 304 Inconel X-750 St.Steel 304 Borosil.Glass Antimony-Be	3.520 0.230 10.200 4.500 1.600	Top Top In Core In Core In Core	
Used at the Following Reactors: Reactor Number in Core			
Prairie Island Prairie Island Ginna Point Beach 1 Point Beach 2 Kewaunee	1 2	(assu (assu (assu (assu (assu (assu	umed) umed) umed) umed) umed)
Used with Followi Vendor	ng Fuel Assemb Array	ly Types: Version	
Babcock & Wilco Exxon / ANF Exxon / ANF Westinghouse Westinghouse Westinghouse	0x 14x14 14x14 14x14 14x14 14x14 14x14 14x14	WE TOP ROD Std/ZCA OFA Std/ZCB	(assumed) (assumed) (assumed) (assumed) (assumed) (assumed)
Comment:			

Reference: SA-16, G08; page B-9 of WTSD-TME-148.

Page: 1 Physical Description Report Westinghouse Primary, Version 3 Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 158.3 inches Total Weight: 48 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Pu-Be Length: Strength: 50 curies Secondary Source: Material: Antimony-Be Length: Spacers: Material: N/A Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 3 Life Expectancy:

2E-193

Physical Description Report Page: 2 Westinghouse Primary, Version 3 Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.520 Top Inconel X-750 0.230 Тор St.Steel 304 10.200 In Core Borosil.Glass 4.500 In Core Antimony-Be In Core Pu-Be In Core Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 14×14 (assumed) Exxon / ANF Exxon / ANF Westinghouse Westinghouse 14x14 WE (assumed) 14x14 TOP ROD 14x14 Std/ZCA 14x14 OFA 14x14 Std/ZCB (assumed) (assumed) (assumed) Westinghouse (assumed)

Comment:

Reference: SA-16, G07; page B-9 of WTSD-TME-148.

Physical Description Report Page: 1 Westinghouse Secondary, 116 Inch Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 116.2 inches Total Weight: 22.2 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 65.0 inches Spacers: Material: St.Steel 304 Length: 1.19 inches Number of Orifice Rods: 12 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Secondary, 116 Inch Neutron Source Composition: Total Weight (kg) Material Zone St.Steel 304 3.520 Top Inconel X-750 0.230 Top St.Steel 304 2.300 Gas Plenum St.Steel 304 1.600 In Core 1.900 In Core Antimony-Be Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) (assumed) San Onofre 1 Point Beach 1 (assumed) Point Beach 2 (assumed) (assumed) Kewaunee Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox (assumed) 14x14 Exxon / ANF 14x14 WE (assumed) 14x14 TOP ROD 14x14 Std/ZCA Exxon / ANF (assumed) Westinghouse (assumed) (assumed) Westinghouse **14x14 OFA** 14x14 Std/ZCB Westinghouse (assumed) Westinghouse 14x14 Std/SC (assumed)

Comment:

Reference: SA-07, G04; page B-7 of WTSD-TME-148.

Physical Description Report Page: 1 Westinghouse Secondary, 137 Inch Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 137.5 inches Total Weight: 23.8 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 80.0 inches Spacers: Material: St.Steel 304 Length: 1.19 inches Number of Orifice Rods: 12 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Westinghouse Secondary, 137 Inch Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.520 Top Inconel X-750 0.230 Top St.Steel 304 2.300 Gas Plenum St.Steel 304 2.000 In Core Antimony-Be 2.200 In Core Used at the Following Reactors: Reactor Number in Core Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) Point Beach 1 (assumed) Point Beach 2 (assumed) Kewaunee (assumed)

Used with Following Fuel Assembly Types: Vendor Array Version

14x14		(assumed)
14x14	WE	(assumed)
14x14	TOP ROD	(assumed)
14x14	std/ZCA	(assumed)
14x14	OFA	(assumed)
14x14	Std/ZCB	(assumed)
14x14	std/sc	(assumed)
	14x14 14x14 14x14 14x14 14x14 14x14 14x14	14x14 14x14 WE 14x14 TOP ROD 14x14 Std/ZCA 14x14 OFA 14x14 Std/ZCB 14x14 Std/SC

Comment:

Reference: SA-07, G03; page B-7 of WTSD-TME-148.

Westinghouse Secondary, 143 Inch Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: inches 143.2 pounds Total Weight: 22.9 Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: inches 72 Spacers: Material: St.Steel 304 1.19 inches Length: Number of Orifice Rods: 12 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4

Physical Description Report

Life Expectancy:

Physical Descript	ion Report		Page
Westinghous	se Secondary,	143 Inch No	eutron Source
Composition: Material	Total Weight	(kg) Zo	one
St.Steel 304 Inconel X-750 St.Steel 304 St.Steel 304 Antimony-Be	3.520 0.230 2.300 2.300 2.100	To To Gas I In (In (op op Plenum Core Core
Used at the Following Reactors: Reactor Number in Core			
Prairie Island Prairie Island Ginna San Onofre 1 Point Beach 1 Point Beach 2 Kewaunee	1 2		(assumed) (assumed) (assumed) (assumed) (assumed) (assumed)
Used with Followi Vendor	ing Fuel Asser Arra	mbly Types: ay Version	
Babcock & Wilco Exxon / ANF Exxon / ANF Westinghouse Westinghouse Westinghouse Westinghouse	14x: 14x:	14 14 WE 14 TOP ROD 14 Std/ZCA 14 OFA 14 Std/ZCB 14 Std/SC	(assumed) (assumed) (assumed) (assumed) (assumed) (assumed) (assumed)
Comment:			1

Reference: SA-07, GO1; page B-7 of WTSD-TME-148.

Physical Description Report Westinghouse Secondary, 157 Inch Neutron Source Designed for: Fuel Assembly with array size: 14x14 Pressurized Water Reactor Dimensions: Total Length: 156.9 inches Total Weight: 27.7 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.43 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 72 inches Spacers: Material: St.Steel 304 Length: 1.19 inches Number of Orifice Rods: 12 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Page: 2 Physical Description Report Westinghouse Secondary, 157 Inch Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.520 Top Inconel X-750 0.230 Top St.Steel 304 2.300 Gas Plenum St.Steel 304 2.300 In Core In Core Antimony-Be 2.100 Used at the Following Reactors: Number in Core Reactor Prairie Island 1 (assumed) Prairie Island 2 (assumed) Ginna (assumed) San Onofre 1 (assumed) (assumed) Point Beach 1 Point Beach 2 (assumed) Kewaunee (assumed) Used with Following Fuel Assembly Types: Array Version Vendor Babcock & Wilcox 14x14 (assumed) Exxon / ANF Exxon / ANF 14x14 WE 14x14 TOP ROD (assumed) (assumed) Westinghouse 14x14 Std/ZCA (assumed) Westinghouse Westinghouse 14x14 OFA (assumed) 14x14 Std/2CB 14x14 Std/SC (assumed) Westinghouse (assumed)

2E-202

Comment:

Reference: SA-07, Gll; page B-7 of WTSD-TME-148.

Physical Description Report Westinghouse Primary, Version 1 Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 158.2 inches Total Weight: 52 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.44 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Pu-Be Length: 1.65 inches Strength: 50 curies Secondary Source: Material: Antimony-Be Length: 121.75 inches Spacers: Material: N/A Length: Number of Orifice Rods: 4 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 3 Life Expectancy:

Page: 2 Physical Description Report Westinghouse Primary, Version 1 Neutron Source Composition: Total Weight (kg) Material Zone St.Steel 304 3.500 goT Gas Plenum St.Steel 304 0.760 In Core Borosil.Glass 4.500 St.Steel 304 In Core 9.800 Antimony-Be In Core In Core Pu-Be Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) 15x15 WE Exxon / ANF (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) 15x15 Std/SC Westinghouse (assumed) Comment: Reference: SA-18, GO1; page B-10 of WTSD-TME-148.

2E - 204

Physical Description Report Westinghouse Primary, Version 2 Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 158.2 inches Total Weight: pounds 52 Cladding: Material: St.Steel 304 Outer Diameter: 0.44 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Polonium-Be Length: Strength: 200 curies Secondary Source: Material: Antimony-Be Length: 121.75 inches Spacers: Material: N/A Length: Number of Orifice Rods: 4 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 3 Life Expectancy:

Physical Description Report Westinghouse Primary, Version 2 Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.500 Top St.Steel 304 0.760 Gas Plenum In Core Borosil.Glass 4.500 St.Steel 304 9.800 In Core In Core Antimony-Be Polonium-Be In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) (assumed) Surry 1 Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 st.stl. (assumed) 15x15 WE Exxon / ANF (assumed) Westinghouse 15x15 Std/ZC 15x15 OFA (assumed) (assumed) Westinghouse 15x15 Std/SC Westinghouse (assumed) Comment:

Reference: SA-15, G02; on page B-9 of WTSD-TME-148

Physical Description Report Westinghouse Primary, Version 3 Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 156.1 inches Total Weight: 34 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.44 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Californium Length: 2-12E+08 curies Strength: Secondary Source: Material: N/A Length: Spacers: Ag-In-Cd Material: Length: Number of Orifice Rods: 7 Number of Burnable Poison Rods: 12 Number of Source Rods, l primary and secondary: Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 0 Life Expectancy:

Physical Description Report Westinghouse Primary, Version 3 Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 1.700 Top Inconel X-750 0.360 Top St.Steel 304 0.950 Gas Plenum Borosil.Glass 4.500 In Core St.Steel 304 8.000 In Core Californium In Core Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) 15x15 Std/SC Westinghouse (assumed)

Comment:

Reference: SA-06, G01; on page B-6 of WTSD-TME-148.

2E-208

Physical Description Report Page: 1 Westinghouse Secondary, 116 Inch Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Weight: Total Length: 116.2 inches 27.9 pounds Cladding: Unknown Material: Outer Diameter: 0.47 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 94.75 inches Spacers: Material: N/A Length: Number of Orifice Rods: 16 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Westinghouse Secondary, 116 Inch Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.500 Top St.Steel 304 Gas Plenum 3.050 Unknown In Core Antimony-Be In Core Used at the Following Reactors: Number in Core Reactor Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version

Babcock & Wilcox	15x15	st.stl.	(assumed)
Exxon / ANF	15x15	WE	(assumed)
Westinghouse	15x15	std/zc	(assumed)
Westinghouse	15x15	OFA	(assumed)
Westinghouse	15x15	std/sc	(assumed)

Comment:

Reference: SA-09, G02; on page B-8 of WTSD-TME-148. Some information on weight of Source cladding not available; weights of similar Rods used instead.

2E-210

Physical Description Report Westinghouse Secondary, 143 Inch Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: 143.2 inches Total Weight: 25.2 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.431 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 72 inches Spacers: Material: St.Steel 304 Length: 1.19 inches Number of Orifice Rods: 16 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Westinghouse Secondary, 143 Inch Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 3.520 Top Inconel X-750 0.500 Top St.Steel 304 3.000 Gas Plenum St.Steel 304 2.300 In Core Antimony-Be In Core 2.100 Used at the Following Reactors: Number in Core Reactor Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) Westinghouse 15x15 OFA (assumed) Westinghouse 15x15 Std/SC (assumed)

Comment:

Reference: SA-17, GO4; page B-10 of WTSD-TME-148.

Physical Description Report Westinghouse Secondary, 157 Inch Neutron Source Designed for: Fuel Assembly with array size: 15x15 Pressurized Water Reactor Dimensions: Total Length: Total Weight: 156.1 inches 19 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.431 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 67.1 inches Spacers: N/A Material: Length: Number of Orifice Rods: 16 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Page: 2 Westinghouse Secondary, 157 Inch Neutron Source Composition: Total Weight (kg) Material Zone St.Steel 304 1.700 Top St.Steel 302 0.360 Top Gas Plenum St.Steel 304 2.200 St.Steel 304 2.300 In Core In Core Antimony-Be 1.900 Used at the Following Reactors: Reactor Number in Core Robinson 2 (assumed) Zion 1 (assumed) Zion 2 (assumed) Indian Point 2 (assumed) Turkey Point 3 (assumed) Turkey Point 4 (assumed) Indian Point 3 (assumed) Surry 1 (assumed) Surry 2 (assumed) Haddam Neck (assumed) Cook 1 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Babcock & Wilcox 15x15 St.Stl. (assumed) Exxon / ANF 15x15 WE (assumed) Westinghouse 15x15 Std/ZC (assumed) 15x15 OFA Westinghouse (assumed) Westinghouse 15x15 Std/SC (assumed) Comment:

Reference: SA-06, G03; page B-6 of WTSD-TME-148. Other Secondary Source Assemblies with 156 inch length are listed, but the total weights seem to be greater than the sum of the weights of the parts.

Physical Description Report Page: 1 Westinghouse Primary, Version 1 Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: 156.0 inches Total Length: Total Weight: pounds 39 Cladding: St.Steel 304 Material: Outer Diameter: 0.385 inches Diametral Gap: Borosil.Glass Poison Material: Spider/Plunger Material: St.Steel 304 Primary Source: Californium Material: Length: 2-12E+08 curies Strength: Secondary Source: Material: Antimony-Be Length: 88.0 inches Spacers: Alum. Oxide Material: Length: Number of Orifice Rods: 8 Number of Burnable Poison Rods: 12 Number of Source Rods, 4 primary and secondary: Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 3 Life Expectancy:

2E-215

Physical Description Report Westinghouse Primary, Version 1 Neutron Source Composition: Total Weight (kg) Material Zone St.Steel 304 2.400 Top Inconel-718 0.640 Top 0.580 Gas Plenum St.Steel 304 St.Steel 304 In Core Borosil.Glass In Core Alum. Oxide In Core Californium In Core In Core Antimony-Be Used at the Following Reactors: Number in Core Reactor Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed)

Physical Description Report Westinghouse Primary, Version 1 Neutron Source Used at the Following Reactors: (continued) Number in Core Reactor Cook 2 (assumed) Seabrook 1 (assumed) Seabrook 2 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Exxon / ANF 17x17 WE (assumed) Westinghouse 17x17 Std (assumed) Westinghouse 17x17 OFA (assumed)

Comment:

Reference: SA-02, GO1; page B-5 of WTSD-TME-148.

Physical Description Report Page: 1 Westinghouse Primary, Version 2 Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.0 inches Total Weight: 34.2 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Californium Length: 1.7 inches Strength: 2-12E+08 curies Secondary Source: Material: N/A Length: Spacers: Alum. Oxide Material: Length: 145 inches Number of Orifice Rods: 11 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 0 Life Expectancy:

Physical Description Report

Page: 2

Westinghouse Primary, Version 2 Neutron Source

Design Variations:

Westinghouse makes versions of this part with 12-23 Burnable Poison Rods. The weight of a version can be expressed as 15.80 + (1.54 * Number of Burnable Poison Rods).Radiological Characterizations are available for 12 and 23 Rod versions. Physical Description Report Westinghouse Primary, Version 2 Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 2.300 Top 0.420 Inconel-718 Top St.Steel 304 1.400 Gas Plenum St.Steel 304 4.500 In Core Borosil.Glass 3.800 In Core Alum. Oxide In Core Californium In Core Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) (assumed) Diablo Canyon 2 Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) Cook 2 (assumed)

Physical Description Report Westinghouse Primary, Version 2 Neutron Source Used at the Following Reactors: (continued) Reactor Number in Core Seabrook 1 (assumed) Seabrook 2 (assumed) Used with Following Fuel Assembly Types: Vendor Array Version Exxon / ANF 17x17 WE (assumed) Westinghouse 17x17 Std (assumed) Westinghouse 17x17 OFA (assumed)

Comment:

Reference: SA-19, G04; page B-10 of WTSD-TME-148.

Physical Description Report Westinghouse Primary, Version 3 Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156 inches Total Weight: 51 pounds Cladding: St.Steel 304 Material: Outer Diameter: 0.385 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: Californium Length: 1.7 inches Strength: 2-12E+08 curies Secondary Source: Material: N/A Length: Spacers: Material: Alum. Oxide inches Length: 145 Number of Orifice Rods: 0 Number of Burnable Poison Rods: 23 Number of Source Rods, primary and secondary: 1 Number of Primary Source Rods only: 1 Number of Secondary Source Rods only: 0 Life Expectancy:

Physical Description Report

Page: 2

Westinghouse Primary, Version 3 Neutron Source

Design Variations:

Westinghouse makes versions of this part with 12-23 Burnable Poison Rods. The weight of a version can be expressed as 15.80 + (1.54 * Number of Burnable Poison Rods).Radiological Characterizations are available for 12 and 23 Rod versions.

Physical Descript	ion Report			Pa
Westinghou	ise Primary,	Version 3	Neutron	Source
Composition:				
Material	Total Weigh	t (kg)	Zone	
St.Steel 304	2.300		TOD	
Inconel-718	0.420		TOD	
St.Steel 304	12.000	I	In Core	
Borosil.Glass	7.300	I	n Core	
Alum. Oxide		I	n Core	
Californium		I	n Core	
Used at the Follo	wing Reactor	rs:		
Reactor	Numb	er in Core	5	
Farley l			(assu	med)
Farley 2			(assu	med)
Harris			(assu	med)
Braidwood l			(assu	med)
Braidwood 2			(assu	med)
Byron l			(assu	med)
Byron 2			(assu	med)
Catawba 1			(assu	med)
Catawba 2			(assu	med)
McGuire I			(assu	med)
MCGuire 2 Resume Valley			(assu	med)
Beaver Valley 1			(assu	mea)
Negtle 1			(assu	med)
Vogtie 1 Vogtie 2			(assu	mea)
Wolf Crock			(assu	med)
Millstone 3			(assu	med)
Diablo Canvon l	l		(assu	med)
Diablo Canyon 2	L >		(assu	med)
Trojan	4		(2550)	med)
Salem 1			(assu)	med)
Salem 2			(assu)	med)
Summer			(assu)	med)
Seguovah 1			(assu)	med)
Watts Bar 1			(assu	med)
Watts Bar 2			(assu	međ)
Comanche Peak 1	L		(assu	med)
Comanche Peak 2	2		(assu	med)
Callaway			(assu	med)
North Anna 1			(assu	med)
North Anna 2			(assu	med)
Cook 2			(assu	med)
Seabrook l			(assu	med)

Physical Description Report Westinghouse Primary, Version 3 Neutron Source Used at the Following Reactors: (continued) Number in Core Reactor 1 Seabrook 2 (assumed) Used with Following Fuel Assembly Types: Array Version Vendor Exxon / ANF 17x17 WE (assumed) Westinghouse 17x17 Std (assumed) Westinghouse 17x17 OFA (assumed)

Comment:

Reference: SA-19, G02; page B-10 of WTSD-TME-148.

Physical Description Report Westinghouse Secondary; on Spider Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 157 inches Total Weight: 24.2 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Diametral Gap: Poison Material: N/A Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 88.0 inches Spacers: Material: N/A Length: Number of Orifice Rods: 20 Number of Burnable Poison Rods: 0 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Physical Description Report Westinghouse Secondary; on Spider Neutron Source Composition: Material Total Weight (kg) Zone St.Steel 304 2.600 Top Top Inconel-718 0.200 4.400 Gas Plenum St.Steel 304 St.Steel 304 2.000 In Core In Core Antimony-Be 1.600 Used at the Following Reactors: Reactor Number in Core Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) Catawba 2 (assumed) McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Vogtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) (assumed) Diablo Canyon 2 Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) (assumed) Sequoyah 1 (assumed) Watts Bar 1 Watts Bar 2 (assumed) (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway North Anna 1 (assumed) (assumed) North Anna 2 (assumed) Cook 2

Seabrook 1

Seabrook 2

Page: 2

(assumed)

(assumed)
Physical Description Report

Westinghouse Secondary; on Spider Neutron Source

Used with Following F	Tuel Assembly Types:	
Vendor	Allay Verbion	
Exxon / ANF	17x17 WE	(assumed)
Westinghouse	17x17 Std	(assumed)
Westinghouse	17x17 OFA	(assumed)

Comment:

On this Secondary Source Assembly, the Source Rods and Thimble Plugs are mounted on a spider rather than a Holddown Assembly. Reference: SA-05, G01; page B-6 of WTSD-TME-148. Physical Description Report Westinghouse Secondary, 12 BP Rods Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.0 inches Total Weight: 39.4 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 88.0 inches Spacers: Material: N/A Length: Number of Orifice Rods: 8 Number of Burnable Poison Rods: 12 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

Page: 1

Physical Description Report

Page: 2

Westinghouse Secondary, 12 BP Rods Neutron Source

Design Variations:

Westinghouse makes versions of this part with 8-20 Burnable Poison rods. The weight of a version can be expressed as 20.7 + (1.5 * Number of Burnable Poison Rods). Radiological characterizations are available for 12 and 26 Rod versions.

Physical Description Report Westinghouse Secondary, 12 BP Rods Neutron Source Composition: Total Weight (kg) Zone Material Top St.Steel 304 2.300 Inconel-718 0.420 Top St.Steel 304 Gas Plenum 1.000 St.Steel 304 In Core 7.800 In Core Borosil.Glass 3.800 In Core Antimony-Be 1.900 Used at the Following Reactors: Number in Core Reactor Farley 1 (assumed) Farley 2 (assumed) Harris (assumed) Braidwood 1 (assumed) Braidwood 2 (assumed) Byron 1 (assumed) Byron 2 (assumed) Catawba 1 (assumed) (assumed) Catawba 2 McGuire 1 (assumed) McGuire 2 (assumed) Beaver Valley 1 (assumed) Beaver Valley 2 (assumed) Vogtle 1 (assumed) Voqtle 2 (assumed) Wolf Creek (assumed) Millstone 3 (assumed) Diablo Canyon 1 (assumed) Diablo Canyon 2 (assumed) Trojan (assumed) Salem 1 (assumed) Salem 2 (assumed) Summer (assumed) Sequoyah 1 (assumed) Watts Bar 1 (assumed) Watts Bar 2 (assumed) Comanche Peak 1 (assumed) Comanche Peak 2 (assumed) Callaway (assumed) North Anna 1 (assumed) North Anna 2 (assumed) (assumed) Cook 2 Seabrook 1 (assumed)

Page: 3

Physical Description Report	Page:	4
Westinghouse Secondary,12 BP Rods Neutron S	ource	
Used at the Following Reactors: (continued) Reactor Number in Core		
Seabrook 2 (assumed)	
Used with Following Fuel Assembly Types: Vendor Array Version		
Exxon / ANF17x17WE(asWestinghouse17x17Std(asWestinghouse17x17OFA(as	sumed) sumed) sumed)	

Comment:

Reference: SA-01, G21; page B-4 of WTSD-TME-148.

Physical Description Report Westinghouse Secondary, 20 BP Rods Neutron Source Designed for: Fuel Assembly with array size: 17x17 Pressurized Water Reactor Dimensions: Total Length: 156.0 inches Total Weight: 50.6 pounds Cladding: Material: St.Steel 304 Outer Diameter: 0.385 inches Diametral Gap: Poison Material: Borosil.Glass Spider/Plunger Material: St.Steel 304 Primary Source: Material: N/A Length: Strength: Secondary Source: Material: Antimony-Be Length: 88.0 inches Spacers: Material: N/A Length: Number of Orifice Rods: 0 Number of Burnable Poison Rods: 20 Number of Source Rods, primary and secondary: 4 Number of Primary Source Rods only: 0 Number of Secondary Source Rods only: 4 Life Expectancy:

.

Page: 1

Physical Description Report

Page: 2

Westinghouse Secondary, 20 BP Rods Neutron Source

Design Variations:

Westinghouse makes versions of this part with 8-20 Burnable Poison Rods. The weight of a version can be expressed as 20.7 + (1.5 * Number of Burnable Poison Rods). Radiological Characterizations are available for 12 and 20 Rod versions. Physical Description Report

Page: 3

Westinghouse Secondary, 20 BP Rods Neutron Source

Composition: Material	Total Weight (kg)	Zone
St.Steel 304	2.300	Тор
St.Steel 304	11.900	In Core
Borosil.Glass Antimony-Be	6.400 1.900	In Core In Core

Used at the Following Reactors: Reactor Number in Core

Farley 1 Farley 2 Harris Braidwood 1 Braidwood 2 Byron 1 Byron 2 Catawba 1 Catawba 2
McGuire 1
McGuire 2
Beaver Valley 1
Beaver Valley 2
Vogtle 1 Vogtle 2
Vogile 2 Wolf Crock
Milletone 3
Diablo Canvon 1
Diablo Canvon 2
Trojan
Salem 1
Salem 2
Summer
Sequoyah l
Watts Bar 1
Watts Bar 2
Comanche Peak 1
Comanche Peak 2
North Anna 1
North Anna 2
Cook 2
Seabrook 1
Seabrook 2

(assumed)
(assumed)
(accumed)
(assumed)
\~~~~~~~~~

Physical Description Report

Page: 4

Westinghouse Secondary, 20 BP Rods Neutron Source

Used with Following Fuel Assembly Types: Vendor Array Version

Exxon / ANF	17x17	WE	(assumed)
Westinghouse	17x17	Std	(assumed)
Westinghouse	17x17	OFA	(assumed)

Comment:

Reference: SA-01, G25; page B-4 of WTSD-TME-148.

APPENDIX 2F

USER'S GUIDE TO THE LWR NONFUEL ASSEMBLY

HARDWARE DATA BASE

2**f**-3/4

CONTENTS

1.0	Introduction	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2F-5
2.0	Data and Data Sources	•	•	•	•	•	٠	•	•	•	•	•	•	•	•	•	•	•	•	•	2 F- 5
3.0	Requirements	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2F-6
4.0	Reporting Capabilities	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	2F-6
5.0	Operating Instructions	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	2F-7
	Installation System Startup Sample Session	• •	•	•	•	•	•	•	• •	• • •	• • •	•	• • •	• • •	• • •	• •	• •		• •	•	2F-7 2F-7 2F-8

1.0 Introduction

The User's Guide is for the LWR NFA Hardware Data Base system, a part of the Characteristics Data Base being developed under the Waste Systems Data Development Program sponsored by the DOE Office of Civilian Radioactive Waste Management. The LWR NFA Hardware Data Base provides access, at the personal computer level, to the following information about non-fuel assembly (NFA) hardware used in light-water reactors: physical descriptions of NFA hardware, identification of particular assembly types and reactors that utilize the hardware, and radiological descriptions of NFA hardware.

The LWR NFA Hardware Data Base is a user-oriented, menu-driven system. Each menu is instructive about its use. Section 5 of this guide provides a sample session with the data base to assist the user.

2.0 Data and Data Sources

Physical description data were obtained directly from the following non-fuel assembly hardware manufacturers: Babcock and Wilcox, Combustion Engineering, and Westinghouse. Information on other NFA hardware was obtained from reports in the open literature. Efforts to obtain additional information on these fuel assemblies is ongoing.

Radiological data were obtained from the computer code ORIGEN2 by using a methodology similar to that described in Section 2.7.3, Methodology for Radiological Characterization, of the Characteristics of Potential Repository Wastes report. The data are provided for use of the hardware in two types of reactors: pressurized-water and boiling-water reactors. Data for each type of hardware are provided at several representative lengths of exposure. Lengths of exposure are based on number of cycles in the reactor; an average cycle corresponds to a burnup of about 11,000 megawatt days per metric ton of initial heavy metal. Twenty-four decay time frames are provided, which range from discharge to one million years after discharge. The data were calculated for each different material of construction in up to four neutron exposure zones. Data for low-level waste classification are presented. Data are available in four different units: curies, watts, grams, and photon spectra.

3.0 Requirements

The LWR NFA Hardware Data Base is designed for use on IBM personal computers or compatibles. It was developed by using dBASE III Plus, a product of Ashton-Tate. Clipper and Plink86, products of Nantucket Corporation, were used to translate the data base system into an executable file. As a result of this translation, dBASE III Plus is not required to use the data base system. Only some version of personal computer DOS is necessary to run the data base.

The LWR NFA Hardware Data Base requires approximately 3 megabytes of storage and thus is designed to run on Bernoulli Box drives (trademark of iOmega Corporation) or fixed drives. If a math coprocessor chip is installed, the LWR NFA Hardware Data Base will utilize it for faster calculations.

4.0 Reporting Capabilities

Two types of reports are provided by the LWR NFA Hardware Data Base. Both reports are available on the screen and optionally on the printer. Additionally, either report may be directed to a text file for later use.

The Physical Description reports provide detailed information about the physical characteristics of a particular variety of NFA hardware, including dimensions, vendor, limited quantitative data, and materials of construction. Where available, the reactors and assembly types which use the hardware are identified. <u>Radiological</u> <u>Description</u> reports are provided for each piece of NFA hardware by isotope in units of curies, watts, and grams (only the long-lived, radioactive isotopes and isotopic totals are reported). The photon spectra (number of photons versus energy), also provided, are reported by energy.

5.0 Operating Instructions

Installation: Instructions for installation of the data base are included with the LWR NFA Hardware Data Base. If you receive the data base on Bernoulli cartridge, the drive the data base runs from will be C: D:, or E:, dependent on your computer's configuration. If you install (copy) the data base onto a fixed drive, the designated drive will be C:. If you receive the demonstration diskette, the data base will run from A: or B:, and no subdirectory will be used. In the example startup below, the data base is in drive D: and the subdirectory is NFA. If your configuration varies from this chosen example, substitute the correct drive and directory.

System Startup: To use the data base, first start up your computer as usual. The LWR NFA Hardware Data Base must be run from the drive and subdirectory that it is residing on. In other words, if the data base was installed on (copied to) a Bernoulli cartridge and that cartridge is inserted in drive D: of your Bernoulli drive, the current drive and subdirectory must be "D: NFA" to operate the tory when shipped. If you elect to change the subdirectory name, you must now use that new name in place of NFA.)

To ensure that this is the current subdirectory, you must first issue the following commands, pressing the enter key after each command:

> D: cd NFA

(do not issue this for the demonstration diskette)

You should receive the response:

D: NFA>

(for the demonstration diskette
 this will be A:> or B:>)

If you do not receive this response, type in:

prompt \$p\$g

and press the enter key. If you still do not receive this response, verify the drive designation and subdirectory. (For the demonstration diskette, the command "cd NFA" is not necessary.) If you still have problems, review the installation procedure.

To initiate the use of the data base, type:

NFA and press the enter key.

The remaining pages detail a sample session with the LWR NFA Hardware Data Base.

NFA and press the enter key

The remaining pages detail a sample session with the LWR NFA Hardware Data Base.



This message will appear on the screen while the LWR NFA Hardware Data Base is being loaded into memory. It will take a few seconds to complete this operation. You are logged into the LWR NFA HARDWARE DATA BASE SYSTEM sponsored by the United States Department of Energy Office of Civilian Radioactive Waste Management Press any key to continue . . .

When this introductory screen appears on your terminal, the LWR NFA Hardware Data Base is loaded and running. To begin using the data base, press any key.

Select Physical/Radiological Reports on NFA Hardware by 1. Type and vendor of Non-fuel Assembly Hardware 2. Associated Light-water Reactor 3. Associated Fuel Assembly Model X. Exit the NFA Hardware Data Base NFA01 Select 1-3, or X 1

2F-11

Description:

NFA hardware can be reported three different ways: category and manufacturer of NFA hardware, use at a specific reactor, or use with a specific fuel assembly type.

Instructions:

Select 1 to choose a NFA hardware report(s) by category and vendor of hardware. Select 2 to choose report(s) by reactor or select 3 to choose by type of assembly. To end session with the LWR NFA Hardware Data Base, select X at this screen. Press the enter key after making your selection.

In this example, option 1 is chosen to select a NFA hardware report by hardware category.

2F-12

Select the	e type of NFA hardware for the report
	 Control Elements Neutron Poisons Neutron Sources
	 Instrumentation BWR Channels Guide Tube Plugs
R.	Return to previous menu
х.	Exit the NFA Hardware Data Base
	NFA02

Description:

NFA hardware falls into the above six categories.

Instructions:

Select the category of NFA hardware by number. Select R to return to the initial screen (NFA01) or <u>X</u> to exit the data base. Press the enter key.

In this example, <u>1</u> is selected for Control Elements.



Description:

This screen lists the four vendors that manufacture control elements. The list on this screen will vary according to which hardware category was selected on screen NFA02.

Instructions:

Select the vendor by number. Select R to return to previous screen or X to exit the data base. Press the enter key after making a selection.

In this example, <u>2</u> is chosen to select Combustion Engineering Control Elements.

2F-14

Select from this list of Combustion Engineering Control Elements for the Physical/Radiological Description Reports 1. 16 x 16 SYS80 4 Rod Part Len 2. 16 x 16 SYS80 12 Rod Full Len 3. 16 x 16 San Onofre Part Len 4. 16 x 16 San Onofre Full Len 5. 16 x 16 ANO2 Part Length 6. 16 x 16 ANO2 Full Length 7. 16 x 16 St. Lucie 2 Part Len 8. 16 x 16 St. Lucie 2 Full Len 9. 14 x 14 Part Length, Ver. 1 10. 14 x 14 Part Length, Ver. 2 14 x 14 Part Length, Ver. 3 11. 12. 14 x 14 Full Length 13. 14 x 14 Ft. Calhoun, Part Len 14. 14 x 14 Ft. Calhoun, Full Len 15. 15 x 15 Palisades Crucifrom A. Individual reports on ALL of the above hardware R. Return to previous menu X. Exit the NFA Hardware Data Base NFA04 Select 1-15, A, R, or X 2

Description:

This screen lists control elements manufactured by Combustion Engineering and the type of fuel assembly for which the hardware was designed. This screen will vary dependent on the hardware category and vendor selected on menus NFA02 and NFA03.

Instructions:

Select a specific hardware item by number. For individual reports on all hardware listed here, select <u>A</u>. Select <u>R</u> to return to NFA03, "Select Vendor" screen, or <u>X</u> to exit the data base system and return to DOS. Press the enter key after making your selection.

In this example, 2 is entered to select a report(s) on a Full Length, 12 Rod Control Element used in a Combustion Engineering 16 x 16 System 80 fuel assembly. 2F-15



Description:

At this point the hardware item to report on has been selected. Two types of reports are available. If ALL was selected on the previous screen, the selection of type of report will be for all that hardware; selection will not be made on an individual basis.

Instructions:

Select 1 to receive a Physical Description Report, 2 to receive a Radiological Description Report, or 3 to receive both reports. From this screen, select R to return to the first or main menu (NFA01), not the previous menu. Select X to exit the data base. Press enter key after making selection.

In this example, <u>3</u> is entered to select both a Physical Description Report and a Radiological Description Report for a Full Length, 12 Rod Control Element used in a Combustion Engineering 16 x 16 System 80 fuel assembly.

Select Type of Output for Physical Description Report: Screen, Printer, or File [S/P/F]? <u>S</u>

NFA06

Description:

All reports can be generated on the screen, sent to the printer, or sent to a text file for later use. Here the type of output for Physical Description Reports is chosen. Type of output for Radiological Description Reports will be chosen separately. (Both must be chosen because option 3 was selected on the previous screen for both kinds of reports.)

Instructions:

Select <u>S</u> for screen output. The report will pause until any key is pressed when the screen is full. Select <u>P</u> for output to printer. The printer should be online and have at least 80 columns. Select <u>F</u> for a text file. You will be prompted for the name of the file to be written.

In this example, <u>S</u> is chosen for a Physical Description Report on the screen. Because both physical and radiological reports were selected, the decay time frame and type of output must be chosen for the radiological report before the physical report is printed.

	Select Time Frame for Radiological Description Report		
1. 0	9. 50 1	۱7.	2,000
2. 1	10. 100 1	L8.	5,000
3. 2	11. 200 1	19.	10,000
4. 5	12. 300 2	20.	20,000
5. 10	13. 350 2	21.	50,000
6. 15	14. 500 2	22.	100,000
7. 20	15. 1,000 2	23.	500,000
8. 30	16. 1,050 2	24.	1,000,000
	X. Exit the NFA Hardware Data Base (all numbers are in years)		
	Select 1-24, or X _4		NFA07

Description:

This screen instructs you to select the length of time after discharge to use for the Radiological Description Report. All times are in years after discharge from the reactor.

Instructions:

Select 1 for at discharge, and so on, up to 24 for one million years after discharge. Select X to exit the data base (no reports will be printed). Press the enter key after making your selection.

In this example, 4 is chosen to select 5 years after discharge.

Select Type of Output for Radiological Description Report: Screen, Printer, or File [S/P/F]? P NFA06

Description:

The options for the Radiological Description Report are the same as those offered for the Physical Description Report. However, different types of output may be chosen for the different reports.

Instructions:

Select <u>S</u> for screen, <u>P</u> for printer, and <u>F</u> for file. Press the enter key after making your selection.

In this example, \underline{P} is chosen for a printed Radiological Description Report.

Physical Description Report						
g SYS80	12 Rod Fu	ll Len	Control	Element		
ray size	e: 16 x 10	5				
ctor						
253	inches					
192.2	pounds					
Incone: 0.816 0.035 0.009	l 625 inches inches inches					
	tion Rep g SYS80 ray size tor 253 192.2 Incone: 0.816 0.035 0.009	tion Report g SYS80 12 Rod Fui ray size: 16 x 16 tor 253 inches 192.2 pounds Inconel 625 0.816 inches 0.035 inches 0.009 inches	tion Report g SYS80 12 Rod Full Len ray size: 16 x 16 tor 253 inches 192.2 pounds Inconel 625 0.816 inches 0.035 inches 0.009 inches	tion Report Page g SYS80 12 Rod Full Len Control ray size: 16 x 16 ctor 253 inches 192.2 pounds Inconel 625 0.816 inches 0.035 inches 0.009 inches		

Press any key to continue viewing Physical Description Report . . .

Physical Description Report

Page 1 (continued)

Combustion Engineering SYS80 12 Rod Full Len Control Element Poison: Primary Material: Boron Carbide (CE) Poison Length: 148 inches Pellet Diameter: 0.737 inches Plenum Spring Material: St. Steel 302 Spider Material: St. Steel 304 Number of Control Rods: 12

Life Expectancy: 4000 EFPD

Press any key to continue viewing Physical Description Report . . .

Physical Description	Report	Page 2
----------------------	--------	--------

Combustion Engineering SYS80 12 Rod Full Len Control Element

Composition:

Material		Total Weight(kg)	Neutron Zone
St.Steel 304		8.17	Тор
Inconel 625		53.62	Тор
Boron Carbide	(CE)	20.90	Тор
St.Steel 304		0.68	Gas Plenum
Inconel 625		2.20	Gas Plenum
Boron Carbide	(CE)	1.60	Gas Plenum
Boron Carbide St.Steel 304 Inconel 625 Boron Carbide	(CE) (CE)	20.90 0.68 2.20 1.60	Top Gas Plenum Gas Plenum Gas Plenum

Used at the Following Reactors: Reactor Number in Core

Palo	Verde	1	48
Palo	Verde	2	48
Palo	Verde	3	48

Press any key to continue viewing Physical Description Report . . .

Physical Description Report Page 2 (continued)

Combustion Engineering SYS80 12 Rod Full Len Control Element

Used with the Following Fuel Assembly Types: Vendor Array Version

Combustion Engineering 16 x 16 System 80

Report complete. Press any key to continue . . .

Radiological Description Report

Page 1

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Combustion Engineering SYS80 12 Rod Full Len Control Element

ISOTOPIC COMPOSITION

Used for 7 cycles (77,000 MWd/MTIHM) 5 years after discharge Volume of metal: 0.018100 Cu. Meters Weight: 87.170 kg

Isotope	Grams	Watts	Curies	Curies/m3	Class C Limit	Class C Ratio
C-14	5. <u>348E-</u> 04	6. <u>994E-</u> 07	2.384E-05	5.311E-03	80	0.6
Ni-59	2.474E-01	7.447E-07	1.876E-02	4.179E+02	220	1.9
Ni-63	3.583E-02	2.227E-04	2.211E+02	4.926E+04	7000	7.0
Co-60	9.512E-03	1.659E-03	1.068E+01	2.397E+03	N/A	N/A
Nb-94	9.760E-03	1.865E-05	1.831E+00	4.097E+02	0.2	220
Total	5.490E+00	1.535E+00	8.349E+03	2.465E+06	N/A	N/A

Used for 10 cycles (111,000 MWd/MTIHM) 5 years after discharge Weight: 87.170 kg Volume of metal: 0.018100 Cu. Meters

					Class C	Class C
Isotope	Grams	Watts	Curies	Curies/m3	Limit	Ratio
C-14	5. <u>348E-</u> 04	6. <u>994E-</u> 07	2. <u>384E-0</u> 5	5.311E-03	80	0.6
Ni-59	2.474E-01	7.447E-07	1.876E-02	4.179E+02	220	1.9
Ni-63	3.583E-02	2.227E-04	2.211E+02	4.926E+04	7000	7.0
Co-60	9.512E-03	1.659E-03	1.068E+01	2.397E+03	N/A	N/A
Nb-94	9.760E-03	1.865E-05	1.831E+00	4.097E+02	0.2	220
Total	5.490E+00	1.535E+00	8.349E+03	2.465E+06	N/A	N/A

NOTE: The data presented here is only for the purpose of illustrating the form of the Radiological Description Report. It is not intended to be used for any purpose other than that illustration. Combustion Engineering SYS80 12 Rod Full Len Control Element

PHOTON SPECTRA

	<i>,</i> ,	Photons/second	Photons/second
Mean	Energy(MeV)	(77,000 MWd/MTIHM)	(110,000 MWd/MTIHM)
	0.0100	2.162E+10	3.569E+10
	0.0250	3.674E+09	6.063E+09
	0.0375	2.088E+09	3.444E+09
	0.0575	2.397E+09	3.874E+09
	0.0850	9.237E+08	1.524E+09
	0.1250	3.548E+08	7.851E+08
	0.2250	1.167E+08	1.925E+08
	0.3750	3.272E+07	5.396E+07
	0.5750	1.879E+06	3.099E+06
	0.8500	6.411E+08	9.650E+08
	1.2500	7.960E+11	1.313E+12
	1.7500	2.253E+01	2.768E+01
	2.2500	4.219E+06	6.956E+06
	2.7500	1.306E+04	2.152E+04

(Materials modeled to obtain this report)

Material	Total Weight (kg)	Zone
St.Steel 304	8.17	Тор
Inconel 625	53.62	Тор
Boron Carbide (CE)	20.90	Top
St.Steel 304	0.68	Gas Plenum
Inconel 625	2.20	Gas Plenum
Boron Carbide (CE)	1.60	Gas Plenum

NOTE: The data presented here is only for the purpose of illustrating the form of the Radiological Description Report. It is not intended to be used for any purpose other than that illustration. 2F-25

Select Type of Report						
	Report Selection Criteria:					
	Combustion Engineering 16 x 16					
,	SYS80 12 Rod Full Length Control Element					
	1. Physical Description Report					
	2. Radiological Description Report					
	3. Both Physical and Radiological Description					
	R. Return to MAIN menu (NFA01)					
	X. Exit the NFA Hardware Data Base					
	Select 1-3, R, or X <u>R</u> NFA05					

Description:

Reports have been run for these criteria. You may select more reports (with same or different output types) or begin again at the first screen, NFA01, by selecting the return option.

Instructions:

Select <u>1</u> to receive a Physical Description Report, <u>2</u> to receive a Radiological Description Report, or <u>3</u> to receive both reports. Select <u>R</u> to return to the first menu. Press the enter key after making your selection.

In this example, R is selected.

Select Physical/Radiological Reports on NFA Hardware by 1. Type and vendor of Non-fuel Assembly Hardware 2. Associated Light-water Reactor 3. Associated Fuel Assembly Model X. Exit the NFA Hardware Data Base NFA01 Select 1-3, or X 2

Description:

NFA hardware can be reported three different ways: category and manufacturer of NFA hardware, use at a specific reactor, or use with a specific fuel assembly type.

Instructions:

Select 1 to choose a NFA hardware report(s) by category and vendor of hardware. Select 2 to choose report(s) by reactor or select 3 to choose by type of assembly. To end session with the LWR NFA Hardware Data Base, select X at this screen. Press the enter key after making your selection.

In this example, option 2 is chosen to select a NFA hardware report by associated reactor.

2F-26

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Type up to three letters beginning with the name	
of the reactor you wish to select <u>P</u>	
Press <f10> for a list of reactor names from which to choose.</f10>	
Press <enter> to return the main menu.</enter>	
NFA08	

Description:

This screen asks for the first one to three characters of a reactor's name. A list of reactor names matching those letters will then be generated. For a complete list of reactor names, press the F10 key on your keyboard. To return to the last menu, press the enter key only.

Instructions:

Enter up to 3 characters beginning with a reactor name(s) and press the enter key. Press the F10 key to look at all the names. In this example, P is entered.

Choose a specific reactor from this list 1. Palisades 2. Palo Verde 1 3. Palo Verde 2 4. Palo Verde 3 5. Pathfinder 6. Peach Bottom 2 7. Peach Bottom 3 8. Perry 1 9. Perry 2 10. Pilgrim 11. Point Beach 1 12. Point Beach 2 13. Prairie Island 1 14. Prairie Island 2 R. Return to previous menu X. Exit the NFA Hardware Data Base Select 1-14, R, or X 2

Description:

This screen lists the reactors matching the selected criteria. Choose, by number, one reactor from the list to see what NFA hardware is used at that reactor.

Instructions:

Select a number or R to return; choose X to exit.

In this example, 2 is selected for Palo Verde 1.



Description:

All NFA hardware known or assumed to be used at Palo Verde 1 is listed on this screen.

Instructions:

Select any one hardware element by number to the left. Select individual reports on all hardware listed with an <u>A</u>. Select <u>R</u> to return to the last menu or X to exit the data base.

In this example, <u>2</u> is selected for a Full Length, 12 Rod Control Element designed for a Combustion Engineering 16 x 16 System 80 assembly.


Description:

At this point the hardware item to report on has been selected. Two types of reports are available. If ALL was selected on the previous screen, the selection of type of report will be for all that hardware.

Instructions:

Select 1 for Physical Description Report, 2 for Radiological Description Report, or 3 for both reports. Select R to return to the first menu or X to exit the data base.

In this example, 1 is selected.

Select Type of Output for	
Physical Description Report:	
Screen, Printer, or File [S/P/F]? P	
	NFA06

All reports can be generated on the screen, sent to the printer, or sent to a text file for later use. Here the type of output for Physical Description Reports is chosen.

Instructions:

Select <u>S</u> for screen output. The report will pause until any key is pressed when the screen is full. Select <u>P</u> for output to printer. The printer should be online and have at least 80 columns. Select <u>F</u> for a text file. You will be prompted for the name of the file to be written.

In this example, <u>P</u> is chosen for a printed Physical Description Report.

Physical Descrip	tion Report	Page 1
Combustion Engineerin	g SYS80 12 Rod Full Len	Control Element
Designed for: Fuel Assembly with ar Pressurized Water Rea	ray size: 16 x 16 ctor	
Dimensions:		
Total Length:	253 inches	
Total Weight:	192.2 pounds	
Cladding:		
Material:	Inconel 625	
Outer Diameter:	0.816 inches	
Wall Thickness:	0.035 inches	
Diametral Gap:	0.009 inches	
Poison:		
Primary Material:	Boron Carbide (CE)	
Poison Length:	148 inches	
Pellet Diameter:	0.737 inches	
Plenum Spring Material:	St. Steel 302	
Spider Material:	St. Steel 304	
Number of Control Rods:	12	
Life Expectancy:	4000 Effective Fu	ll Power Days

Institut protection report ingo b	Physical	l Description	Report	Page 2
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Combustion Engineering SYS80 12 Rod Full Len Control Element

Composition: Material Total Weight(kg) Neutron Zone St.Steel 304 8.17 Тор Top Inconel 625 53.62 Boron Carbide (CE) Top 20.90 Gas Plenum St.Steel 304 0.68 Inconel 625 2.20 Gas Plenum Boron Carbide (CE) 1.60 Gas Plenum Used at the Following Reactors: Reactor Number in Core Palo Verde 1 48 Palo Verde 2 48 Palo Verde 3 48 Used with the Following Fuel Assembly Types: Vendor Array Version Combustion Engineering System 80 16 x 16

Select Type of Report Report Selection Criteria: Combustion Engineering 16 x 16 SYS80 12 Rod Full Len Control Element 1. Physical Description Report 2. Radiological Description Report 3. Both Physical and Radiological Description R. Return to the MAIN menu (NFA01) X. Exit the NFA Hardware Data Base NFA05

Description:

At this point, a Physical Description Report has just been printed.

Instructions:

Select <u>1</u> to rerun the same report, <u>2</u> to run a Radiological Description Report, or <u>3</u> for both reports. Select <u>X</u> to exit the data base. Select <u>R</u> to return to the main menu, and select other NFA hardware for reports. Press the enter key after making a selection.

In this example, R is selected to return to main menu.

Select Physical/Radiological Reports on NFA Hardware by 1. Type and vendor of Non-fuel Assembly Hardware 2. Associated Light-water Reactor 3. Associated Fuel Assembly Model X. Exit the NFA Hardware Data Base

Select 1-3, or X 3

NFA01

Description:

NFA hardware can reported three different ways: category and manufacturer of NFA hardware, use at a specific reactor, or use with a specific fuel assembly type.

Instructions:

Select 1 to choose a NFA hardware report(s) by category and vendor of hardware. Select 2 to choose report(s) by reactor or select 3 to choose by type of assembly. To end session with the LWR NFA Hardware Data Base, select X at this screen. Press the enter key after making your selection.

In this example, option 3 is chosen to select a NFA hardware report by associated fuel assembly model.

Select Fuel Assembly Vendor		
 · · · · · · · · · · · · · · · · · · ·		
1. Allis Chalmers		
2. Babcock and Wilcox		
3. Combustion Engineering		
4. Exxon/ANF		
5. General Electric		
6. Westinghouse		
R. Return to previous menu		
X. Exit the NFA Hardware Data Base		
 Select 1-6, R, or X 3	NFA13	

Description:

This screen lists manufacturers of fuel assemblies used in lightwater reactors. After selecting a manufacturer, you will select from a list of the models of fuel assemblies made by that manufacturer and then view the NFA hardware used with a specific fuel assembly model.

Instructions:

Select desired vendor by number. Select \underline{R} to return to the previous screen or X to exit.

In this example, 3 is selected for Combustion Engineering.

Selec	t Cor	nbustion Eng	gineering Fuel Assembl	У	
		Array	Version		
	1. 2. 3. 4. 5. 6. 7. 8.	14 x 14 14 x 14 15 x 15 15 x 16 16 x 16 16 x 16 16 x 16 16 x 16	Standard Ft. Calhoun Palisades Yankee Rowe St. Lucie 2 Arkansas Nucl. 2 System 80 San Onofre	•	
	R.	Return to	previous menu		
	X.	Exit the N	IFA Hardware Data Base		
		Select 1-8,	R, or X <u>7</u>	NFA14	

Description:

This screen lists the Combustion Engineering fuel assembly models for which information on NFA hardware usage is available.

Instructions:

Select an assembly type by number. Select R to return to vendor selection screen or X to exit to DOS. Press the enter key after making a selection.

In this example, $\frac{7}{10}$ is selected for a Combustion Engineering 16 x 16 System 80 assembly.

NFA Hardware Used in Combustion Engineering 16 x 16 System 80 Assemblies 1. CE Control Elements/SYS80 4 Rod Full Len 2. CE Control Elements/SYS80 12 Rod Full Len 3. CE Instrumentation/System 80 4. CE Neutron Sources/Standard A. All of the above hardware R. Return to previous menu X. Exit the NFA Hardware Data Base NFA14

Select 1-5, A, R, or X 1

Description:

This screen displays the NFA hardware known or assumed to be used with Combustion Engineering's 16 x 16 System 80 fuel assemblies.

Instructions:

Select a hardware element by number or A for individual reports on each hardware element. Select R to return to the previous screen or X to exit to DOS.

In this example, 1 is selected.

Select Type of Report Report Selection Criteria: Combustion Engineering 16 x 16 SYS80 12 Rod Full Len Control Element 1. Physical Description Report 2. Radiological Description Report 3. Both Physical and Radiological Description R. Return to the MAIN menu (NFA01) X. Exit the NFA Hardware Data Base NFA05

Description:

At this point, the hardware item to report on has been selected. Two types of reports are available. If ALL was selected on the previous screen, the selection of type of report will be for all that hardware; selection will not be made on an individual basis.

Instructions:

Select <u>1</u> for a Physical Description Report, <u>2</u> for a Radiological Description Report, or <u>3</u> for both reports.

In this example, 2 is selected.

	Radiological Description	Report	
1. 0	9. 50	17.	2,000
2. 1	10. 100	18.	5,000
3. 2	11. 200	19.	10,000
4. 5	12. 300	20.	20,000
5. 10	13. 350	21.	50,000
6. 15	14. 500	22.	100,000
7. 20	15. 1,000	23.	500,000
8. 30	16. 1,050	24.	1,000,000
	X. Exit the NFA Hardware D (all numbers are in ye	oata Base ears)	
s.			NE307

This screen instructs you to select the length of time after discharge to use for the Radiological Description Report. All times are in years after discharge from the reactor.

Instructions:

Select 1 for at discharge, and so on, up to 24 for one million years after discharge. Select X to exit the data base (no reports will be printed). Press the enter key after making your selection.

In this example, <u>16</u> is chosen to select 1,050 years after discharge.

Select Type of Output for Radiological Description Report: Screen, Printer, or File [S/P/F]? F NFA06

The options for the Radiological Description Report are the same as those offered for the Physical Description Report. However, different types of output may be chosen for the different reports.

Instructions:

Select <u>S</u> for screen, <u>P</u> for printer, or <u>F</u> for file. Press the enter key after making your selection.

In this example, F is chosen to send the Radiological Description Report to a text file.

Report Selection Criteria
Combustion Engineering 16 x 16
SYS80 12 Rod Full Len Control Element
Radiological Description Report
1,050 Years After Discharge
Select name of file to send report to: CE16SY80
(up to 8 characters file name) (default extension is .txt)
NFN16
NTALO

This screen asks for the name of a file to receive the requested report. That file will be created and will contain the text of the requested radiological report.

Instructions:

Select up to 8 characters for the file name, a period and up to 3 characters for the extension. If you do not select the extension, "txt" will be used. Press the enter key.

In this example, CE16SY80 is entered for the file name. The Radiological Description will be stored in a file, "CE16SY80.TXT."

Select Type of Report Report Selection Criteria: Combustion Engineering 16 x 16 SYS80 12 Rod_Full Len Control Element 1. Physical Description Report 2. Radiological Description Report 3. Both Physical and Radiological Description R. Return to the MAIN menu (NFA01) X. Exit the NFA Hardware Data Base NFA05 Select 1-3, R, or X X

Description:

At this point, a Radiological Description Report has just been sent to the selected file.

Instructions:

Select 1 to run a Physical Description Report, 2 to rerun the Radiological Description Report, or 3 for both reports. Select X to exit the data base. Select \overline{R} to return to the main menu, and select other NFA hardware for reports. Press the enter key after making a selection.

In this example, \underline{X} is selected to conclude the sample session with the LWR NFA Hardware Data Base.