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Engineering Information Record

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NGNP Nuclear Heat Source System Boundaries and Interfaces

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Does this document contain assumptions requiring verification? ☐ YES ☒ NO

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Record of Revision

Revision No.	Date	Pages/Sections/ Paragraphs Changed	Brief Description / Change Authorization
000	3-19-09	ALL	Initial Release
001		Section 1.0	Placed acronyms in alphabetical order
		Section 2.0	3rd paragraph, 4th sentence "… at their physical …" was "… at its physical". Added a 4th paragraph.
		Section 3.0	Added "(Reference 1) to the 1st sentence.
		Figure 8.1-2	Updated the Figure to include RS component callouts
		Figure 8.2-1	Updated the Figure to only list components of the vessel system.
		Table 8.2-1	Other interfaces column, added radiological interface # 2. Included components column, "Cross vessel" was "Cross over vessel". Boundaries column, added boundary # 14.
		Section 8.3	Added reference to Figure 8.3-1 in the 2nd sentence
		Section 8.5	In the 1st sentence of the 3rd paragraph, "un-insulated portions of the RPV" was "un-insulated RPV". Inserted 3rd sentence into the 3rd paragraph.
		Figure 8.5-1	Added "Dedicated cooling system"
		Figure 8.6-1	Changed title from "FUEL HANDLING MACHINE GRAPPLE" to "FUEL HANDLING MACHINE GRAPPLING FEATURE"
		Section 8.8	"see Figure 8.6-2" was "see 8.6-3"
		Section 8.9	1st sentence " … and maintains the correct coolant chemistry." was "and maintains the required atmosphere."
		Section 8.10	Revised first sentence. Inserted the second sentence.
		Table 8.10-1	Added a general boundary in the Boundaries column
		Section 8.11	Reworded 1st paragraph and inserted new 4th paragraph
		Figure 8-19-1	"Water/Steam" was "Steam – Water"
		Table 8.19-1	In 2 places, "Power Conversion System at the pipe connections of the first dump valves." was "Power Conversion System at the pipe connection of the first dump valve."
		All	Minor grammatical corrections as deemed necessary
		All Tables as noted	All Tables that have no Included components listed, changed "None" to "TBD"

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1.0 LIST OF ACRONYMS

Acronym	Description
CHS	Component Handling System
CROIS	NHS Control Room Operator Interface System
DCC	Depressurized conduction cooldown
EACS	Essential AC electrical system
EDCS	Essential DC electrical system
FHS	Fuel Handling System
HSS	Helium Service System
HTR	High Temperature Reactor
IPS	Nuclear Heat Source Investment Protection System
MHTS	Main Heat Transport System
NCA	Neutron control assembly
NCMS	NHS Control & Monitoring System
NFHS	New Fuel Handling and Storage System
NGNP	Next Generation Nuclear Power
NHS	Nuclear Heat Source
NI	Nuclear island
NICWS	Nuclear Island Cooling Water System
NIHVAC	Nuclear Island Heating and Air Conditioning
PACS	Plant AC electrical system
PCC	Pressurized conduction cooldown
PCS	Power Conversion System
PDCS	Plant DC electrical system
PES	Plant Electrical System
PUP	Plant uninterruptible power supply
RCCS	Reactor Cavity Cooling System
RPS	Reactor Protection System
RPV	Reactor pressure vessel
RS	Reactor System
RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System
SCW	Site and Civil Works
SCWS	Shutdown Cooling Water Subsystem
SFSS	Spent Fuel Storage and Cooling System
SG	Steam generator
VS	Vessel System

2.0 INTRODUCTION

NGNP Background: The Next Generation Nuclear Power plant (NGNP) is a modular gas cooled High Temperature Reactor (HTR) electrical power plant. The power plant can also be used to generate steam for industrial process heat, or a combination of both electricity and process heat. The key attributes of the modular HTR that distinguish it from other reactor types are its fuel, a refractory fuel consisting of coated particles which are embedded in graphite moderator, and its helium coolant. These attributes not only provide for a high temperature capability that is unique among established reactor concepts but also offers fuel cycle flexibility. Additionally, these characteristics associated with limitations on power level and power density makes possible the development of a modular concept with inherent safety characteristics simpler than those employed by current light water reactor technology.

Objective: The objective of this document is to define the boundaries and interfaces of the major systems which make up the Nuclear Heat Source (NHS). Description of each system will be provided as needed to describe the boundaries and interfaces.

Document structure: For each major system of the NHS a brief verbal description of the system will be provided. Figures will be provided following the verbal description where deemed useful. After the description and Figures where used, a Table will be provided that lists the boundaries and interfaces. The boundaries will be described where possible at their physical location. The name of the system with which the boundary exists will be listed and the corresponding acronym listed in the interfaces. See Section 5.0 for additional information.

Document limitation: Changes were made to the system definitions of the NGNP Plant Design Requirements Document, 51-9106032-000 after the initial release of this document. In general, this does not significantly alter the NHS system boundaries and interfaces described herein. However, some nomenclature will have to be updated to make both documents fully consistent. Elimination of project funding precluded resolution of the detailed nomenclature at this time. Nonetheless, the boundaries provided in this document provide a reasonable starting point for initial conceptual design work.

3.0 SCOPE

The scope of information provided within this document pertains to the current AREVA-NP reference baseline design (Reference 1) for the NGNP project NHS systems. The NHS is considered to be limited to the primary (aka main) loop heat transport system and the secondary loop up to the first isolation valve from the steam generator and the first dump valve of the Steam/Water Dump System. The scope of this document does not include a detailed description of each of the NHS systems required for the NHS. A brief overview of each system will be provided sufficient to describe the system. The figures provided describe a NGNP general case and may not depict the exact details of a still immature AREVA-NP NGNP reference design. The accuracy of the component depictions does not affect the purpose of this document. A table will be provided for each system listing the boundaries and interfaces.

4.0 PURPOSE

The purpose of this document is to define the boundaries between the NHS systems required for the operation of the NHS and identify interfaces between those NHS systems. Where applicable, the boundary or interface will be described by the component or physical location on which the boundary or interface resides.

5.0 APPROACH

The systems which make up the NHS are listed in Section 8.0. A brief description is provided for each system that is meant to be generic as possible to provide flexibility as the plant design is refined. Specific components of the system are listed where needed to describe the system or interfaces of the system. The physical boundaries of each system are listed with the system name with which they bound. Specific interface points between systems that effect analysis or design are provided. Interface points may coincide with or help define boundaries but are not limited to physical boundaries. Five different interface categories are considered: physical, heat transfer, electrical & control, thermal hydraulic, and radiological. Thermal hydraulic is used to describe all heat balance and fluid flow considerations.

Two systems that are not part of the NHS are listed as boundaries. Those are Site & Civil Works (building structure) and Power Conversion System (secondary coolant loop).

6.0 ASSUMPTIONS

No assumptions were made in preparation of this document.

7.0 DESIGN INPUTS

None.

8.0 NUCLEAR HEAT SOURCE DESCRIPTION

The nuclear heat source is comprised of a graphite moderated nuclear reactor and heat transport system encased in pressure retaining vessels forming the main coolant loop. The reactor heats helium which is circulated through a steam generator where the heat is transferred to a secondary loop. The reactor core and the steam generator are located in separate pressure vessels connected together by a cross vessel. The heat generated from the reactor is transferred to the secondary loop to form steam. This steam can be used to drive an electrical generator via a steam turbine, used as process heat, or both. For the purpose of this document, the secondary loop is only considered up to the isolation valve. All auxiliary systems required for the function of the nuclear heat source systems such as controls, NIHVAC, refueling, etc. are included.

8.1 REACTOR SYSTEM

The purpose of the Reactor System is to generate heat for the power plant. The reactor is a prismatic block configuration; see Figures 8.1-1 and 8.1-2. The reference design is a graphite moderated helium cooled reactor. It is comprised of stacks of hexagonally shaped graphite blocks, see Figure 8.1-3. The blocks containing fissile material form a cylinder as shown in Figure 8.1-1 and are surrounded by reflector blocks, which contain no fissile material along the ID, OD, top and bottom. The stack is contained radially within a metallic core barrel. The reactor core rests atop a graphite core support assembly supported in turn by a metallic core support assembly. The reactor is controlled by neutron control equipment (neutron control and flux detection assemblies) which is considered part of the Reactor System. The Reactor System is considered to include all items contained within the reactor vessel, excluding the SCS circulator, SCS heat exchanger, and hot duct, up to the connection to the hot duct. The Reactor System also includes the reactor supports and reactor control elements. The reactor control elements include the neutron detectors that are external to the reactor vessel. See Table 8.1-1 for boundaries and interfaces.

Figure 8.1-1 CORE PLAN VIEW

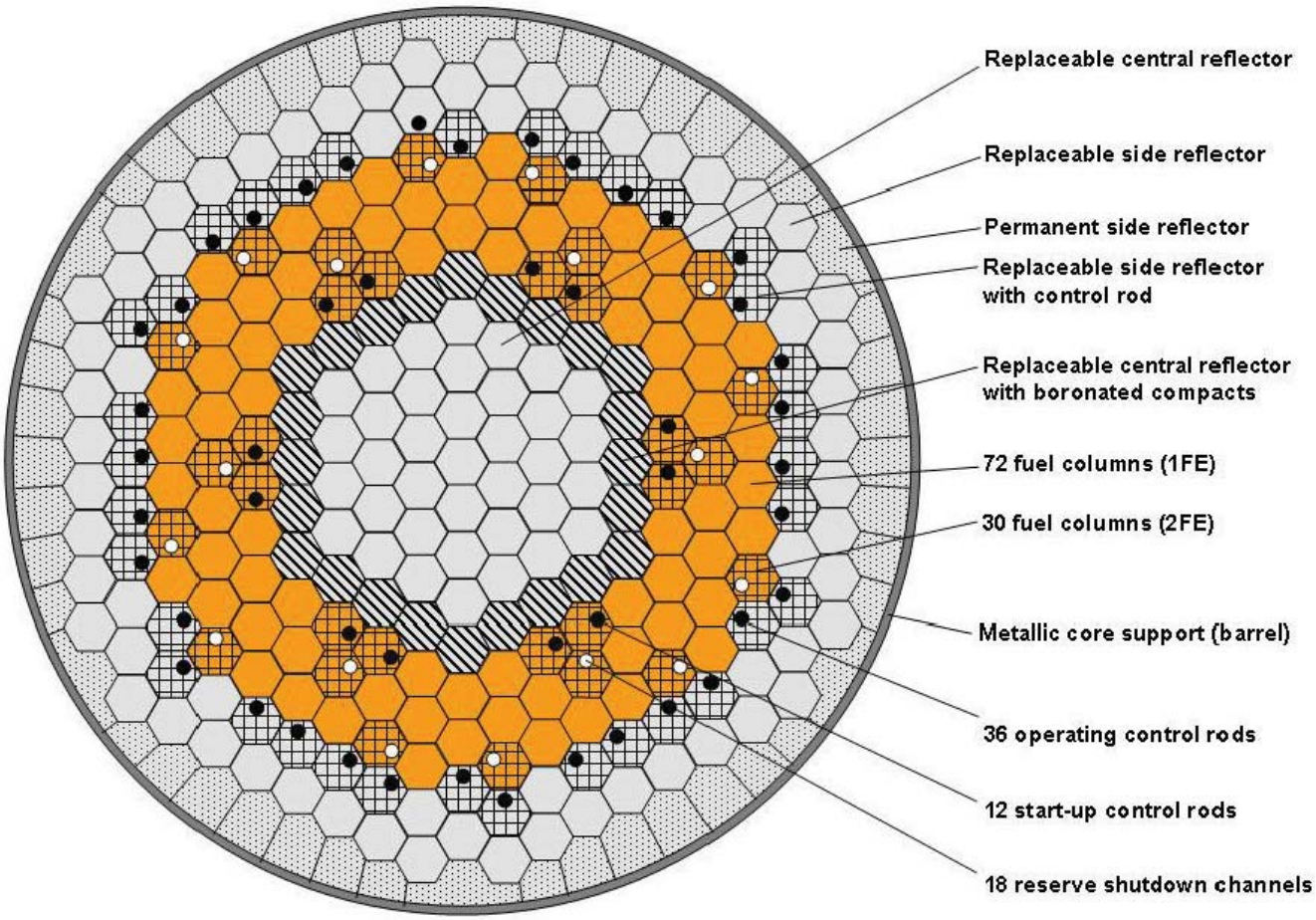


Figure 8.1-2 REACTOR SECTION VIEW

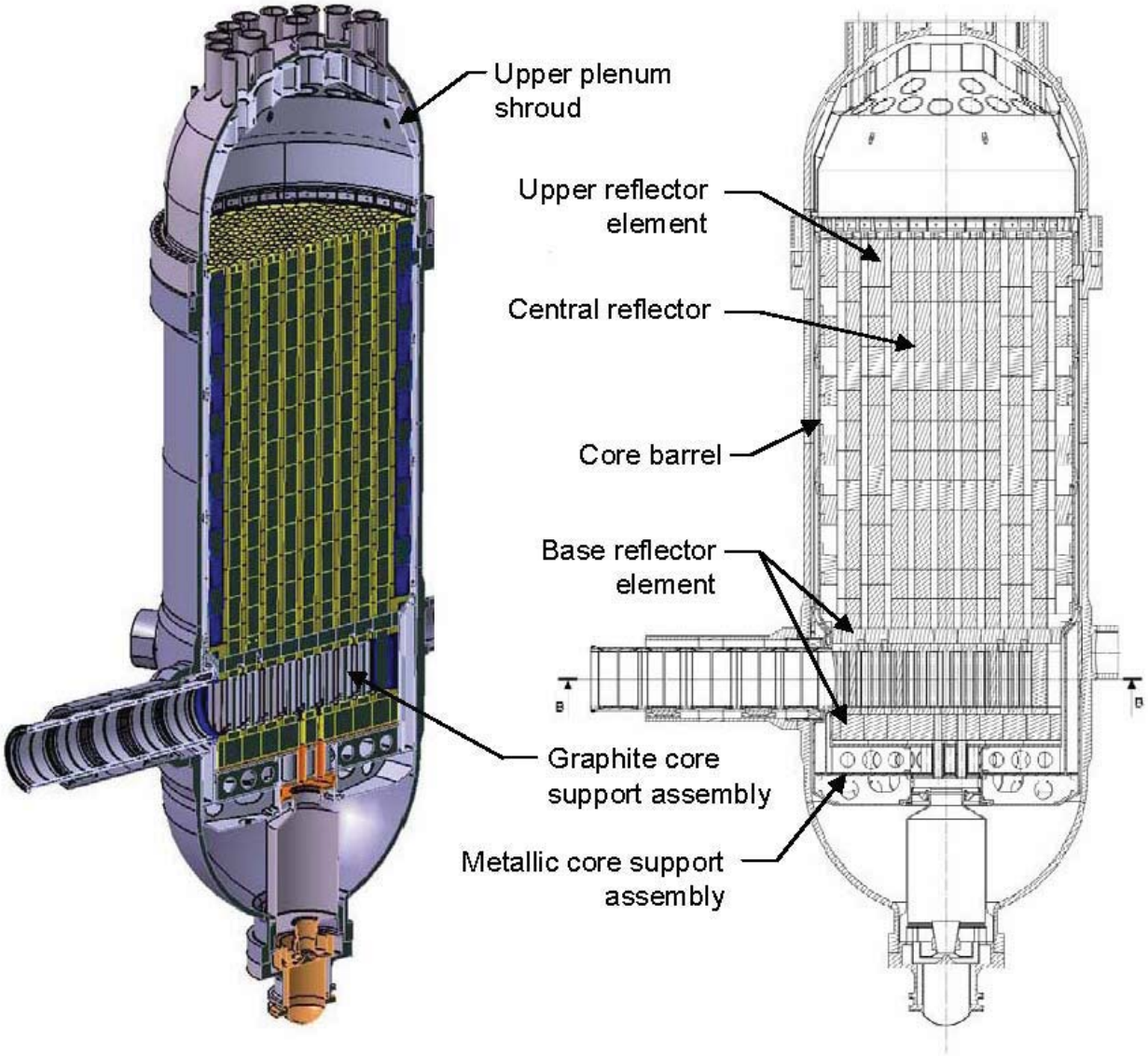


Figure 8.1-3 GRAPHITE BLOCK (ACTIVE ELEMENT)

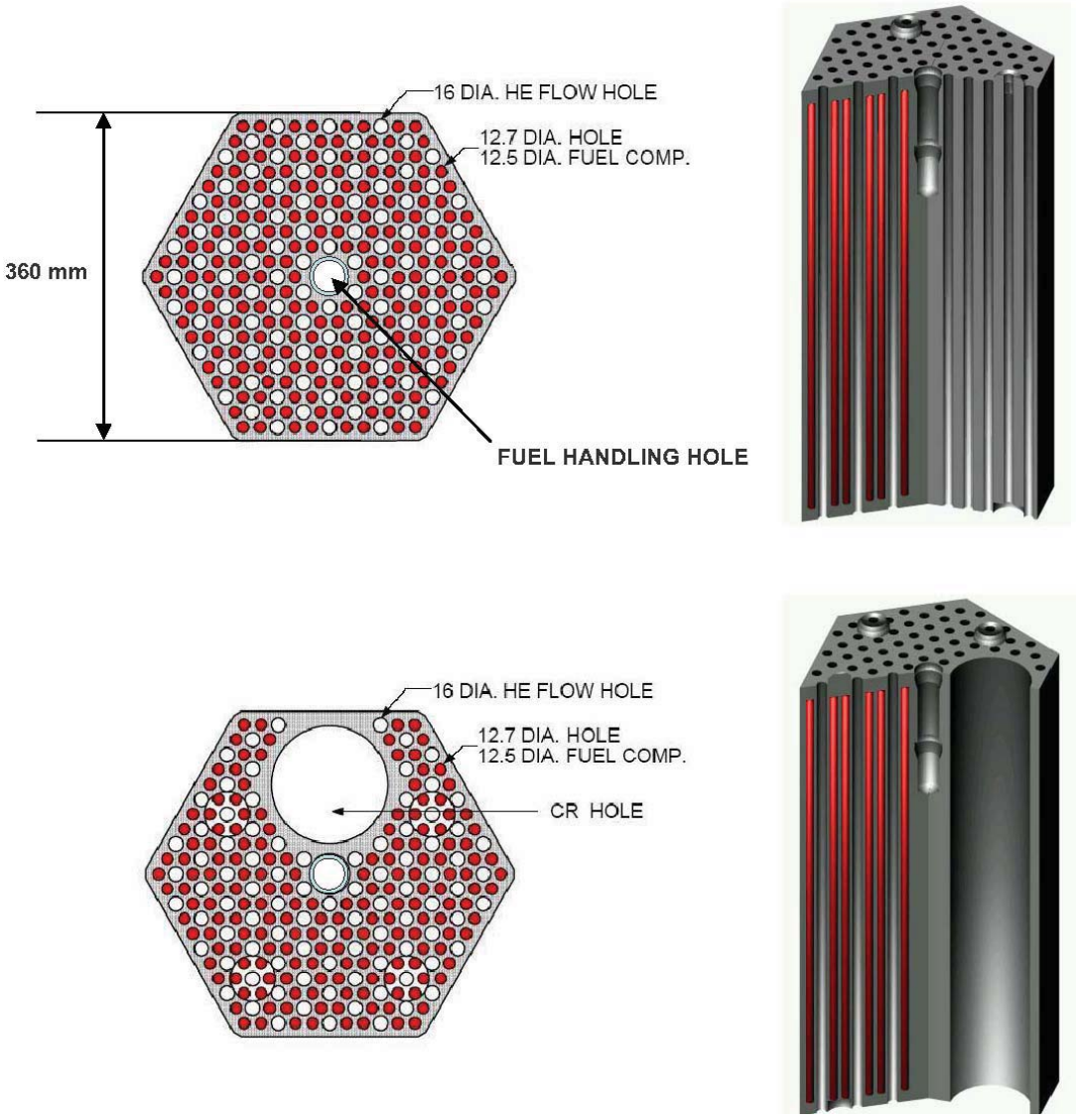


TABLE 8.1-1 REACTOR SYSTEM BOUNDARIES AND INTERFACES

System	Included components	Boundaries	Physical interfaces	Other interfaces
Reactor System		1) Vessel System at the seismic restraint keys and at support ring at lower head of vessel 2) Vessel System at penetrations for NCA and flux detectors 3)NHS Control and Monitoring System at all NCA connections that permit removal of the NCA 4) Reactor Protection System at borated graphite pellet hopper (NCA) connections 5) NHS Control and Monitoring System at neutron flux detector connections 6) Fuel Handling System at fuel & reflector elements 7) Main Heat Transport System at hot duct / core barrel connection 8) Shutdown Cooling System at duct connection to core support 9) NHS Investment Protection System at NCA controls for rod drop at shutdown 10) Site & Civil Works at	1) Seismic restraint on the core barrel with vessel (VS) 2) Contact point between vessel and core support structure (VS) 3) Hot duct connection at core barrel (MHTS) 4) Shutdown Cooling System duct connection to core support (SCS) 5) Handling feature (grappling hole) of the fuel and reflector elements (FHS) 6) Reactor core fuel and reflector elements are stored in the fuel storage well (SFSS) 7) Equipment for lifting and manipulating RS components must have adequate capacity and access (CHS) 8) Reactor fuel and reflector elements at handling features of the elements (NFHS)	<u>Heat transfer</u> 1) Heat transfer from core barrel/plenums to RPV (VS) 2) Reactor to primary coolant (MHTS) 3) NIHVAC cooling of NCA housing and heat transfer from NCA to housing (VS) <u>Electrical & control</u> 1) The interface of electrical and sensing devices is at the physical connection point with the device. 1) Connection to NCAs and flux detectors (NCMS) 2) Connection to NCAs for shutdown rod drop (IPS) 3) Connection to borated graphite pellet hopper (RPS) <u>Thermal hydraulic</u> 1) Coolant flow through core components and heat load (MHTS) 2) Shutdown Cooling

System	Included components	Boundaries	Physical interfaces	Other interfaces
		the detector wells for the sensing device of the external neutron flux detectors 11) Component Handling System at elements and components required to be removed		System flow path (SCS) 3) Heat balance between primary & secondary loops (PCS) <u>Radiological</u> 1) Upper plenum shroud includes neutron shielding 2) Reflector elements and core barrel/plenum provide neutron attenuation
	Upper reflector elements			
	Central reflector			
	Active core (elements)			
	Replaceable side reflector (elements)			
	Permanent side reflector (elements)			
	Core barrel			
	Upper Plenum shroud			
	Boronated graphite pellets			
	Base reflector elements			
	Graphite core support assembly			
	Metallic core support			
	Neutron Control Assemblies (NCA)			
	Outer neutron control assemblies			
	Inner neutron control assemblies			
	Ex-vessel neutron detector assemblies			
	Source range detector assemblies			
	In-vessel flux monitoring			

8.2 VESSEL SYSTEM

The Vessel System is considered to be all major components that retain the primary coolant during operation and their structural supports. Their primary function is pressure retention of the primary coolant. The boundary of the Vessel System supports is the structural embed plate with which they are connected to. Piping for instrumentation, helium purification, etc. are not included in the vessel system. The boundary with these system connections is the vessel nozzle with which they connect.

The primary components that make up the Vessel System are the reactor pressure vessel (RPV), steam generator (SG) vessel, and the cross over vessel, see Figure 8.2-1. Other components of the system are the main and shutdown circulator housings, the neutron control assembly (NCA) housings, pressure relief valve and associated vent, and the supports for these vessels. The supports and pressure relief valve are not shown in the Figure below. See Table 8.2-1 for boundaries and interfaces.

Figure 8.2-1 VESSEL SYSTEM COMPONENTS

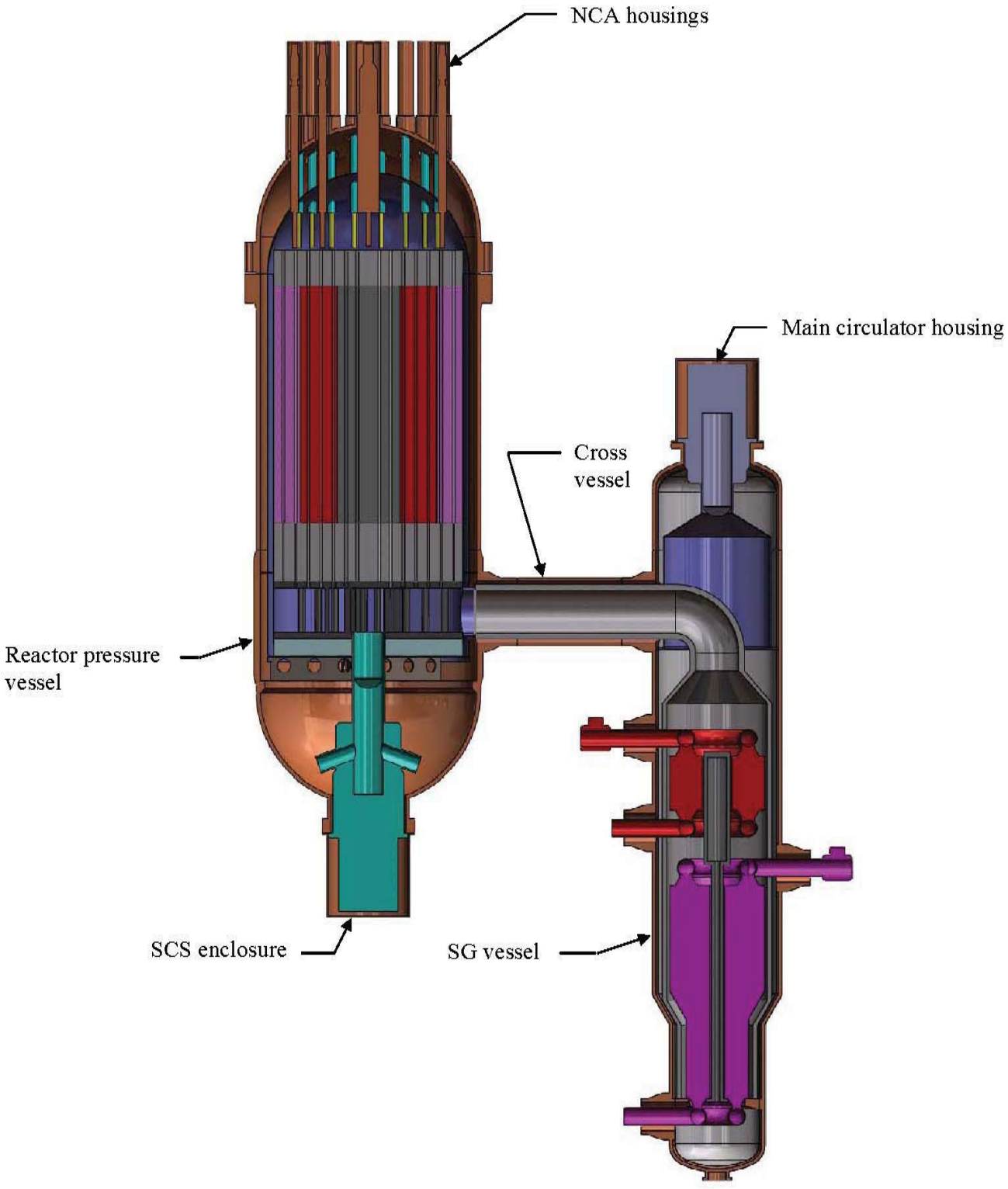


TABLE 8.2-1 VESSEL SYSTEM BOUNDARIES AND INTERFACES

VESSEL SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Vessel system		1) Reactor System at the seismic restraint keys and at support ring at lower head of vessel. 2) Reactor System at the NCA's physical connection 3) Reactor System at Neutron "flux" detector physical connections 4) Shutdown Cooling System (SCS) at bottom head and SCS closure 5) Site & Civil Works at the building /equipment interface 6) Fuel Handling System at the upper head NCA penetrations 7) Helium Service System at vessel nozzle 8) Main Heat Transport System at the main circulator physical connection 9) Main Heat Transport System at hot duct supports 10) Power Conversion System at feedwater inlet and steam outlet isolation valve 11) NHS Investment	1) Core barrel at the seismic restraint keys (RS) 2) Metallic core support structure at ring on lower head of vessel (RS) 3) NCA at upper head and NCA housing (RS) 4) Vessel support at concrete embeds (SCW) 5) Neutron flux detectors at both heads (RS) 6) Fuel handling machine at the upper head NCA penetrations (FHS) 7) Shutdown Cooling System piping penetration nozzles on SCS housing (SCS) 9) Hot duct supports at cross vessel ID (MHTS) 10) SG tube sheets at SG vessel (PCS)	<u>Heat transfer</u> 1) Primary coolant cooling the vessel(s) (MHTS) 2) Reactor core to vessel walls (RS) 4) Heat radiated from hot duct and conducted along supports to cross vessel (MHTS) 5) Core barrel and core supports to reactor vessel (RS) 6) From RPV to cavity concrete (SCW) <u>Radiological</u> 1) Neutron attenuation through vessel wall 2) Water drain at base of RPV and SGV (RWDS) <u>Electrical & control</u> 1) Connections to the relief valve controls(IPS, PES) 2) Connection to pressure, temperature, acoustic emissions sensors, etc. (NCMS)

VESSEL SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
	Reactor pressure vessel	Protection System at the pressure relief valve actuator controls 12) NHS Control and Monitoring System at pressure, temperature, acoustic emissions sensors, etc. 13) Plant Electrical System at the power connection of the valve actuator control 14) Radioactive Waste and Decontamination System at vessel nozzle of the RPV and SGV water drain		<u>Thermal hydraulic</u> 1) Coolant flow path formed by the vessels and other components within the NHS (MHTS, SCS) 2) NIHVAC cooling air flows across NCA housings (NIHVAC) 3) Heat load from reactor vessel to (RCCS)
	SCS enclosure			
	NCA housing			
	Vessel support			
	Seismic restraint (vessel ID)			
	Steam generator vessel			
	Main circulator housing			
	Vessel supports			
	Vessel OD insulation			
	Pressure relief valve			
	Cross vessel			

8.3 MAIN HEAT TRANSPORT SYSTEM

The main function of the Main Heat Transport System (MHTS) is to transfer heat from the reactor core to the secondary loop heat transfer system. The heat transfer fluid, helium, flows downward through the reactor core and out through the hot duct, see Figure 8.3-1. It flows from the hot duct into the SG upper plenum and is channeled over the SG tubes via the inner and outer shroud. After flowing across the SG tubes, the cooled helium flows along the annulus formed by the SG vessel and the outer shroud up to the main circulator. The main circulator forces the cooled helium through the annulus formed by the hot duct and the cross vessel. It then flows upward along the core barrel where it turns direction in the upper reactor plenum and flows back down into the reactor core. The flow path remains the same for each loop. There is a check valve just upstream of the circulator to prevent unwanted helium circulation. The major components of the Main Heat Transport System are the hot duct, steam generator, main helium circulator with check valve, all items such as the plenums that direct helium flow through the steam generator vessel, and supports for the items listed. The physical boundary of the system is the interface between supports and the permanently affixed features of the pressure containing vessel. See Table 8.3-1 for boundaries and interfaces.

Figure 8.3-1 MAIN HEAT TRANSPORT SYSTEM FLOW PATH

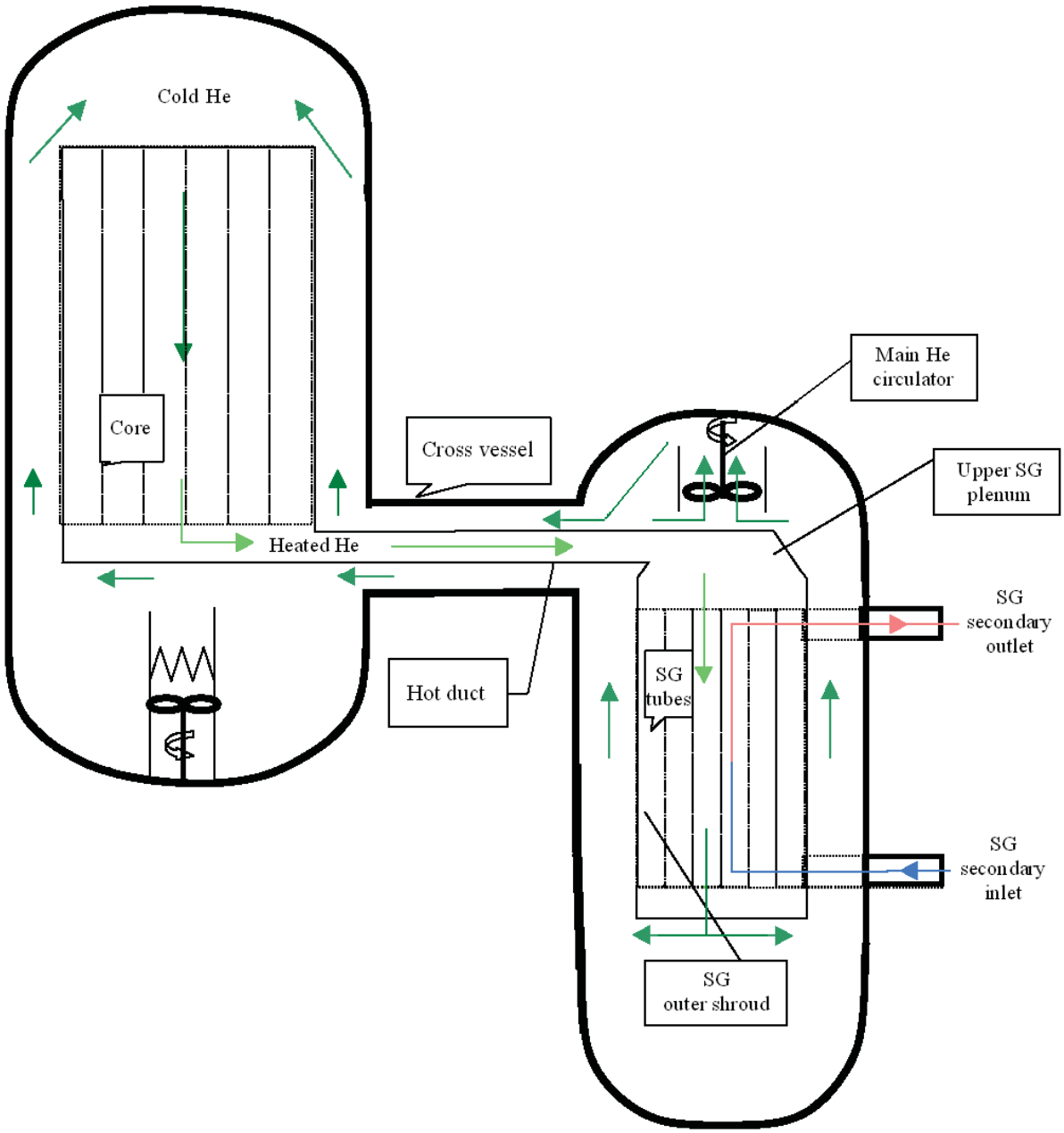


TABLE 8.3-1 MAIN HEAT TRANSPORT SYSTEM BOUNDARIES AND INTERFACES

MAIN HEAT TRANSPORT SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Main Heat Transport System		1) Power Conversion System at tube bundle 2) Vessel System at the main circulator and vessel circulator flange 3) Vessel System at SG supports on ID of SG vessel 4) Reactor System at the hot duct connection to core barrel 5) NHS Control and Monitoring System at Main circulator connections 6) NHS Control and Monitoring System at circulator motor control and fault monitoring (over-amp, vibration, etc.) 7) Reactor Protection System at main circulator motor controls 8) NI Cooling Water System: chills the circulator motor (optional) 9) Helium Service System: Helium purge and/or check valve operation (optional) 10) Helium Service System at main circulator (optional) 11) Fuel Handling System at seals to prevent coolant	1) Steam generator supports at SG vessel (VS) 2) Hot duct supports at cross vessel ID (VS) 3) Main circulator at connection to SG vessel (VS) 4) The cooling of circulator components can be done with chilled water (NICWS, optional) 5) Helium make-up and manipulator operation can be done with helium (HSS, optional) 6) Hot duct connection at core barrel (RS) 7) All equipment that may need replaced or removed must have adequate lifting / manipulating equipment and access (CHS)	<u>Heat transfer</u> 1) Across the SG tube wall (PCS) 2) Heat loss through the hot duct insulation and conduction along hot duct supports (VS) <u>Thermal hydraulic</u> 1) Coolant flow through the circulator, coolant ducts & plenums, vessels, and reactor (RS, VS) 2) Heat balance between primary & secondary loops (PCS) <u>Electrical & control</u> 1) Connections to the circulator and sensors (NCMS for control and monitoring, RPS for monitoring and shutdown, IPS shut down and close valve, PES for power supply) <u>Radiological</u> 1) Tritium transfer across tube bundle

MAIN HEAT TRANSPORT SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
		loss 12) NHS Investment Protection System at circulator controls to shut down circulator and close valve 13) Plant Electrical System at connection to circulator controls to supply power		
	Steam generator			
	Tube sheets			
	Tube bundle			
	Upper plenum w/ cross duct elbow			
	Inner & outer shroud			
	Lower plenum			
	Main helium circulator			
	Electric motor			
	Impeller			
	Main loop shutoff valve			
	Hot duct			
	Inner sleeve			
	Insulation			
	Outer sleeve			
	Duct supports			

8.4 SHUTDOWN COOLING SYSTEM

The purpose of the Shutdown Cooling System (SCS) is to remove heat from the reactor core during shutdown and when the MHTS is not working. This system consists of the shutdown cooling circulator, the shutdown cooling secondary heat removal loop, and the Shutdown Cooling System controls. The primary coolant (helium) is pulled through a heat exchanger by the SCS circulator where heat is rejected to the shutdown cooling water system (SCWS) and expelled to the atmosphere via a second heat exchanger. The SCWS consists of a dedicated self-contained loop for each reactor module. The SCS circulator contains a normally closed shut off valve similar to the check valve used in the main helium circulator. See Figure 8.4-1 below. See Table 8.4-1 for boundaries and interfaces.

Figure 8.4-1 SHUTDOWN COOLING SYSTEM

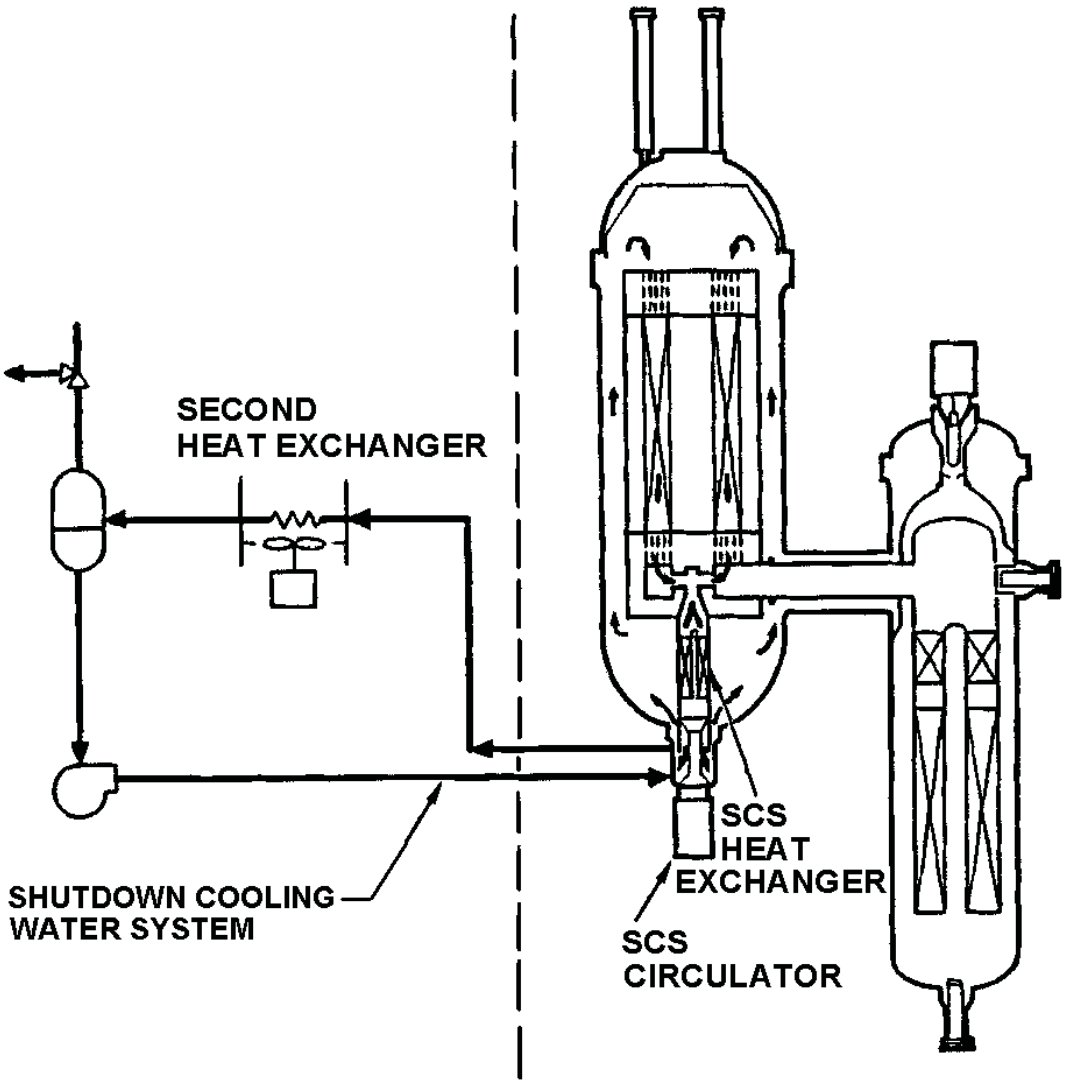


TABLE 8.4-1 SHUTDOWN COOLING SYSTEM BOUNDARIES AND INTERFACES

SHUTDOWN COOLING SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Shutdown Cooling System (SCS)		1) Vessel System at circulator connection to RPV 2) Reactor System at lower core support 3) NHS Control and Monitoring System at connections to circulator and sensors 4) NHS Investment Protection System at connections to circulator controls 5) NI Cooling Water System: provides motor cooling (optional) 6) Helium Service System at circulator (optional) 7) Site & Civil Works at the building / equipment interface 8) Plant Electrical System at circulator controls for power supply	1) SCS penetration in lower RPV head at attachment point of the SCS circulator (VS) 2) SCS duct connection to the reactor support structure (RS) 3) Concrete embeds for equipment placement (SCW) 4) Lifting equipment and access must be adequate for repair & replacement (CHS) 5) The cooling of circulator components can be done with chilled water (NICWS, optional) 7) Helium make-up and manipulator operation can be done with helium (HSS, optional)	<u>Electrical & control</u> 1) Connection to the circulator motor, sensors & bearings (NCMS for controls & monitoring, IPS for startup when needed, PES for electrical power) <u>Thermal hydraulics</u> 1) Coolant flow path formed by these systems (VS, RS) 2) Heat balance between primary and secondary loops of the (MHTS) <u>Heat transfer</u> 1) Across heat exchanger heat transfer surfaces from primary coolant (MHTS) <u>Radiological</u> 1) Monitor SCWS heat transfer fluid
	Shutdown cooling circulator			
	Motor			
	Shutdown cooling loop shut-off valve			
	Shutdown cooling heat exchanger			
	Shutdown cooling water system			

8.5 REACTOR CAVITY COOLING SYSTEM

The Reactor Cavity Cooling System (RCCS) performs two functions. It keeps the concrete of the reactor cavity within allowable limits and removes decay heat from the reactor core when neither the MHTS nor the SCS are working.

The cavity walls and floor are lined with water panels that form an air to water heat exchanger. The heated water in the chambers flow to a water storage tank and is constantly replaced by cooler water. There are two separate complete systems planned for each reactor cavity. The water in each storage tank is cooled by a dedicated cooling system. In the event that the dedicated tank cooling system is not functioning, the cavity cooling system rejects heat by vaporizing the water in the holding tanks.

When neither the MHTS nor the SCS are working, decay heat form the core is removed by conduction through the outer graphite reflectors and by radiation and natural convection from the un-insulated portions of the RPV to the water chambers lining the cavity walls and floor. The heat is then removed as described above. For the purpose of this discussion, the un-insulated portion of the RPV is the cylindrical segment between the upper and lower head. See Table 8.5-1 for boundaries and interfaces.

Figure 8.5-1 REACTOR CAVITY COOLING SYSTEM SCHEMATIC

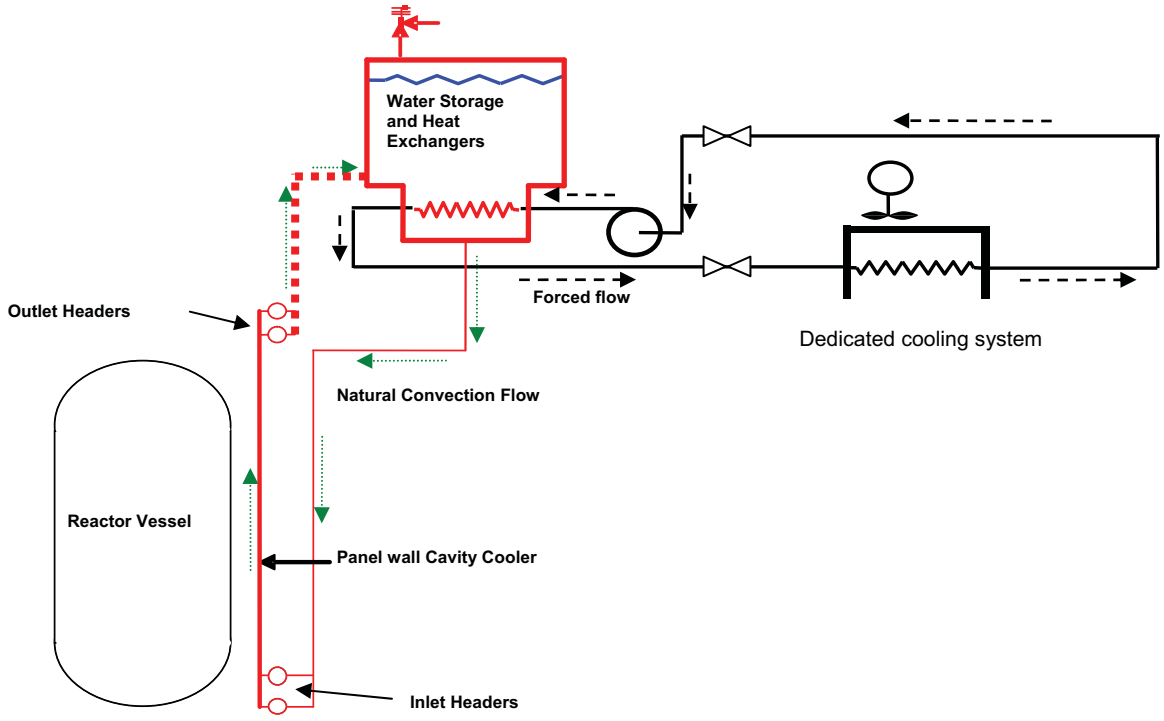


TABLE 8.5-1 RCCS BOUNDARIES AND INTERFACES

RCCS BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Reactor Cavity Cooling System (RCCS)		1) NHS Control and Monitoring System at sensors 2) Site & Civil Works at the building / equipment interface 3) Radioactive Waste and Decontamination System (liquid) at RPV cavity drain to sump 4) Plant Electrical System at tank chiller system power connections 5) NHS Control and Monitoring System at sensors in tank chiller system	1) Concrete embeds for all equipment supports & building steel as needed (SCW)	Heat transfer 1) This system is to prevent overheating RPV cavity concrete from heat generated by RPV (VS, SCW) Thermohydraulic 1) Heat load from RPV to the RCCS (VS) Radiological 1) Monitoring RCCS coolant and tank chiller coolant. Electrical & control 1) Power connection to equipment and controls (PES) 2) Monitoring status sensor connections(NCMS)
	RCCS cavity base cooling panels & piping			
	RCCS vertical cooling panels & piping			
	Cooling water tanks			
	Tank chiller system			
	RCCS cooling water chemistry			

8.6 FUEL HANDLING SYSTEM

The purpose of the Fuel Handling System is to replace used fuel and reflector elements within the reactor core. First, new fuel and reflector elements are moved to the fuel storage wells, see Figure 8.6-2. Then, the used elements are un-stacked from the core and placed into the storage well one sector at a time. Each element is grappled by the fuel handling machine using a handling feature like that shown in Figure 8.6-1. The element is then transferred vertically from the core through the vessel NCA openings. The fuel is then transferred to fuel transfer equipment which transports the elements to the fuel storage wells. The spent fuel and reflector elements are sent for processing in the Spent Fuel Storage and Cooling System. The process is then reversed to restack the partially spent elements using new elements where needed. See Table 8.6-1 for boundaries and interfaces.

Figure 8.6-1 FUEL HANDLING MACHINE GRAPPLING FEATURE

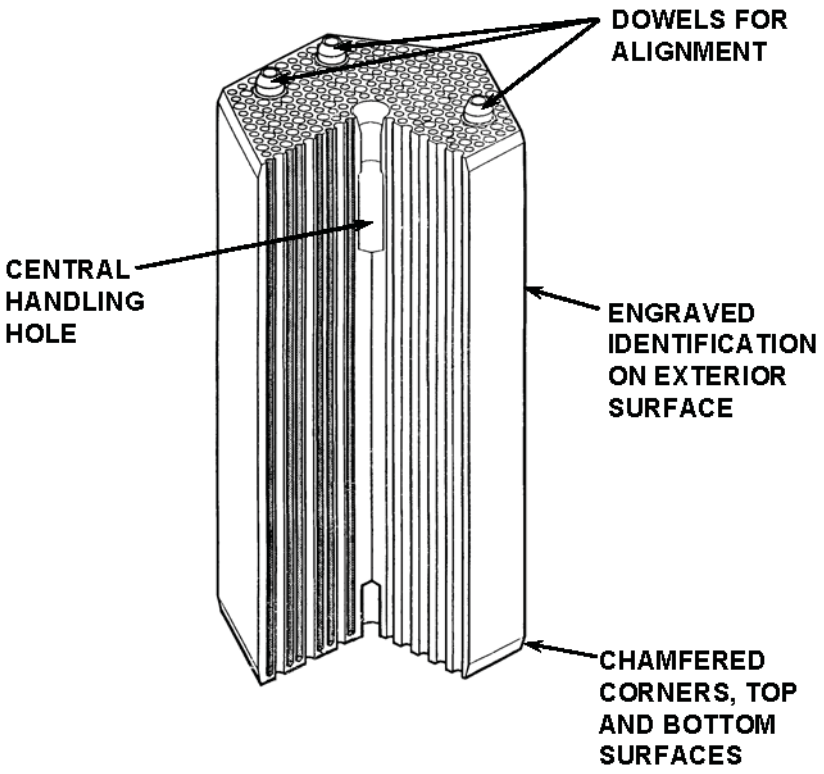
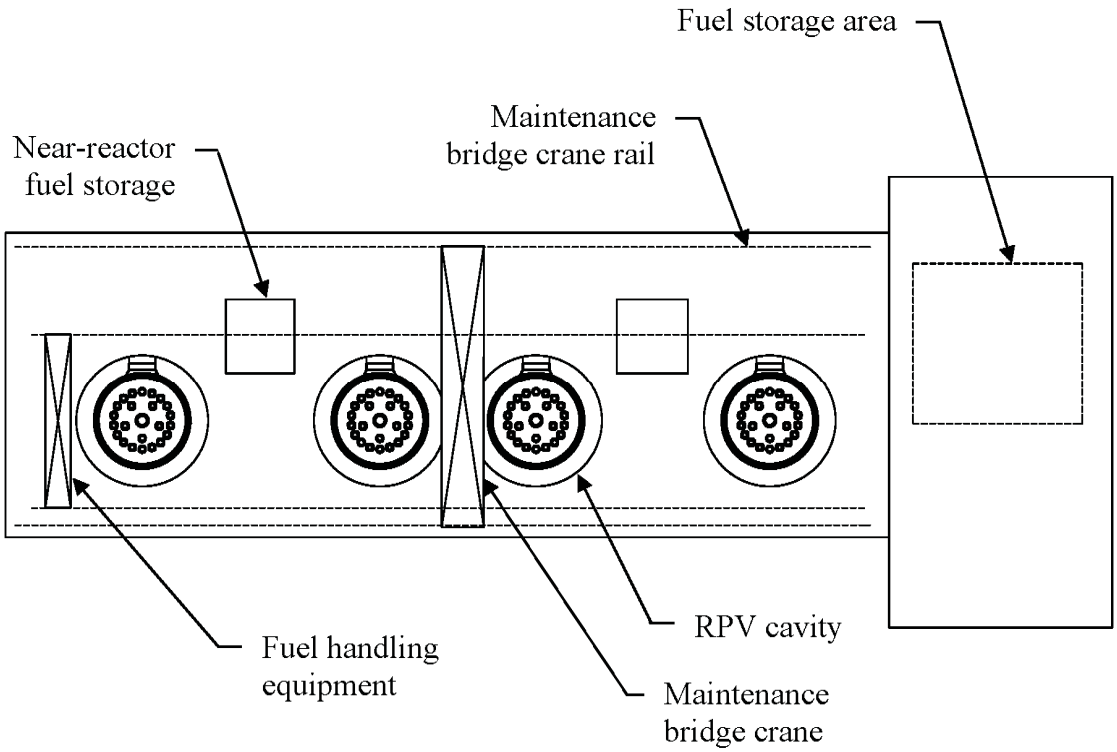


Figure 8.6-2 FUEL HANDLING SYSTEM PLAN VIEW



The Figure above depicts a multiple (4) module configuration. The number of modules may vary.

TABLE 8.6-1 FUEL HANDLING SYSTEM BOUNDARIES AND INTERFACES

FUEL HANDLING SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Fuel Handling System		1) Site & Civil Works at the building / equipment interface 2) Reactor System at reflector and fuel elements 3) Vessel System at access (NCA) openings 4) Plant Electrical System at equipment motors & control connection 5) Spent Fuel Storage and Cooling System at fuel hand-off in the fuel storage wells 6) Component Handling System: used to move and install equipment 7) Main Heat Transport System at seals to prevent coolant loss	1) At NCA vessel penetrations (VS) 2) Reactor upper plenum shroud access for fuel handling equipment (RS) 3) Fuel and reflector elements with fuel handling equipment (RS) 4) Fuel storage well with fuel handling equipment (SFSS) 5) Concrete structural embeds & building steel (SCW) 6) Equipment must be handled with the Component Handling Equipment (CHS)	<u>Electrical & control</u> 1) Power connection to equipment and controls (PES) <u>Radiological</u> 1) Radiation shielding for workers during all aspects of fuel movement and any potential equipment repair scenario 2) Control of contamination on equipment 3) Criticality control of fuel elements
	Fuel handling control station			
	Fuel handling machine			
	Fuel elevator			
	Fuel server			

8.7 SPENT FUEL STORAGE AND COOLING SYSTEM

This system receives the irradiated fuel and reflector elements from the reactor core, packages them into containers, and provides intermediate storage until they are shipped off. The elements are removed from the core and placed into the fuel storage wells as described in Section 8.6. The spent elements are transferred to the fuel canning facility where they are sealed into containers. The containers will then be relocated to a spent fuel cooling facility where it will be stored until their decay heat has decreased to the point that they can be safely loaded into large capacity shipping and storage cask. The spent fuel elements are stored in tubes surrounded by water to remove the decay heat. The cooling water used for decay heat removal is part of the NI Cooling Water System. As an option, a long term dry cask storage facility could be added to store the shipping and storage casks on site. This option could be added at a later date. See Table 8.7-1 for boundaries and interfaces.

TABLE 8.7-1 SPENT FUEL STORAGE AND COOLING SYSTEM BOUNDARIES AND INTERFACES

SPENT FUEL STORAGE AND COOLING SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Spent Fuel Storage and Cooling System		1) Plant Electrical System at equipment & controls 2) Site & Civil Works at the building / equipment interface 3) Radioactive Waste and Decontamination System (liquid) at storage well drain to sump 4) Fuel Handling System at exchange point between systems (fuel storage well) 5) New Fuel Handling and Storage System at hand-off point with Spent Fuel Storage and Cooling System 6) NHS Control and Monitoring System at device connection	1) Concrete structural embeds & building steel (SCW) 2) Interface between equipment and the Component Handling System equipment such as the overhead crane. (CHS) 3) The fuel storage well must accommodate the fuel handling equipment for pick-up and off-loading of fuel and reflector elements (FHS, NFHS) 4) Interface with Component Handling Equipment to ensure feasible repair & replacement (CHS) 5) Reactor core fuel and reflector elements (RS) 6) Interface with radiological waste at system drain pipe connection (RWDS)	<u>Radiological</u> 1) Control of contamination 2) Radiation shielding for workers at all points of system 3) Criticality control of spent fuel 4) Radiation and contamination monitoring at select points throughout the system <u>Electrical & control</u> 1) Power connection to system equipment and controls (NCMS for monitoring, PES for power supply) <u>Thermal hydraulics</u> 1) Decay heat from spent fuel provides a heat load to the (NICWS) 2) Decay heat from spent fuel provides a heat load to the (NIHVAC)
	Fuel storage well			
	Spent fuel canning facility			
	Spent fuel cooling system			
	Spent fuel cask loading facility			

8.8 NEW FUEL HANDLING AND STORAGE SYSTEM

The purpose of the New Fuel Handling and Storage System is to receive and inspect new fuel and reflector elements. Then the elements are delivered to the fuel storage well (see Figure 8.6-2). The new elements are then installed into the reactor core using the Fuel Handling System. The new fuel elements would be transported to the fuel storage well via the same transport equipment used to move the spent elements from the fuel storage well to the fuel canning facility. See Table 8.8-1 for boundaries and interfaces.

TABLE 8.8-1 NEW FUEL HANDLING AND STORAGE SYSTEM BOUNDARIES AND INTERFACES

NEW FUEL HANDLING AND STORAGE SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
New Fuel Handling and Storage System	TBD	1) Spent Fuel Handling System at hand-off point of new elements to the fuel transport equipment of the spent Fuel Handling System 2) Plant Electrical System at power connection to equipment & controls 3) Site & Civil Works at the building /equipment interface	1) Interface with structural embeds & building steel (SCW) 2) Interface with spent fuel handling equipment at hand-off point of new elements (SFSS) 3) Interface with Component Handling Equipment to ensure feasible repair & replacement of equipment (CHS) 4) Reactor fuel and reflector elements at handling features of the elements (RS)	<u>Radiological</u> 1) Radiation shielding for workers 2) Criticality control <u>Electrical & control</u> 1) Power connection to system equipment and controls (PES)

8.9 HELIUM SERVICE SYSTEM

The Helium Service System purifies the primary coolant and maintains the correct coolant chemistry. The recycled coolant is compressed and transferred to helium storage tanks. The system helps control primary coolant pressure and replaces small quantities of helium lost to leakage. The helium is returned back into the system as a purge gas at specific points of the Main Heat Transport System. The purification system components can be modular to allow real time repair and replacement. See Table 8.9-1 for boundaries and interfaces.

TABLE 8.9-1 HELIUM SERVICE SYSTEM BOUNDARIES AND INTERFACES

HELIUM SERVICE SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Helium Service System	TBD	1) NI Cooling Water System at equipment connection 2) Main Heat Transport System at main circulator (optional) 3) Shutdown Cooling System at the SCS circulator (optional) 4) Vessel System at penetration nozzles 5) NHS Control and Monitoring System at device connection 6) Plant Electrical System at equipment power connection 7) Site & Civil Works at the building /equipment interface 8) NHS Control and Monitoring System at sensor connections for HSS monitoring	1) Main He circulator for possible valve actuation (MHTS) 2) Shutdown He circulator for possible valve actuation (SCS) 3) RPV penetration nozzles for make-up (VS) 4) Structural concrete embeds & building steel (SCW) 5) Chilled water to equipment for cooling (NICWS)	<u>Radiological</u> 1) Control of contamination and possibly shielding for workers from irradiated particulates removed from the helium <u>Electrical & control</u> 1) Electrical power and sensor connections (NCMS for monitoring, PES for power input) <u>Thermal hydraulics</u> 3) Cooled helium added to Main Heat Transport System coolant (MHTS) 4) NI Cooling Water System water is used to cool HSS equipment (NICWS) <u>Heat transfer</u> 1) Cooled helium in injected into the primary coolant stream cools the vessel nozzle (VS)

8.10 NI HVAC SYSTEM

The Nuclear Island Heating, Ventilation, and Air Conditioning System (NIHVAC) is responsible for the overall HVAC of the NI. It is composed of several discrete systems for different areas including clean and potentially contaminated areas. The system is made up of conventional industrial equipment. The system will also help remove contamination from the air. The systems shall be designed to maintain appropriate temperatures for personnel and equipment. See Table 8.10-1 for boundaries and interfaces.

TABLE 8.10-1 NI HVAC SYSTEM BOUNDARIES AND INTERFACES

NI HVAC SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
NI HVAC System	TBD	General Boundaries correspond to the specific areas being ventilated. Specific boundaries conform to the actual HVAC equipment boundaries up to the air intake and exhaust point. Detailed boundaries will be defined as the design progresses. 1) Plant Electrical System at equipment connection 2) NHS Control and Monitoring System at device connection 3) Site & Civil Works at the building / equipment interface 4) NI Cooling Water System at air chillers (optional)	1) Concrete structural embeds & building steel (SCW) 2) Chilled water to air handlers (NICWS)	<u>Thermal hydraulics</u> 1) The NIHVAC system is used to cool the NCA housings (VS) 2) Decay heat from spent fuel provides a heat load to the NIHVAC system (SFSS) <u>Electrical & control</u> 1) Power connection for system equipment (PES for power input, NCMS for monitoring system) <u>Radiological</u> 1) Control of contamination and dose from potentially contaminated system filters 2) Filtering air to trap some radioactive particulates

8.11 PLANT ELECTRICAL SYSTEM

The Plant Electrical System (PES) consists of four subsystems, the plant AC electrical system (PACS), the Plant Essential AC Electrical System (EACS), Plant DC Electrical System (PDCS), and Plant Essential DC Electrical System (EDCS). The PES boundaries are the low voltage bushings of the unit transformers and the high voltage bushings of the unit startup auxiliary transformers. See Table 8.11-1 for boundaries and interfaces.

Major distribution equipment of the PACS include the unit and startup auxiliary transformers, isolated phase bus duct, switchgear, unit substations, motor control centers, and distribution panel boards. The components are located as close to the point of utilization as possible.

When the plant is on-line, the normal source of power is the unit generator. When the plant is shut down or the normal power source is unavailable, power is delivered from offsite via the switchyard and is capable of starting and running all normal and essential loads.

The Plant AC Electrical System (PACS) delivers power generated by the plant offsite to the transmission network through the unit transformer(s) and receives power from the network through the unit startup auxiliary transformer(s).

The Essential AC Electrical System (EACS) includes a plant uninterruptible power (PUP) supply with capacity to supply all control, instrumentation, and plant protection AC loads which must not lose power via redundant channels. There is one PUP per unit and is powered by a dedicated essential DC electrical system. The PACS supplies emergency AC/DC lighting for all areas needed for safe shutdown and fire fighting and access/egress routes thereto. The EACS supplies emergency AC lighting for the control room.

The Plant DC Electrical System (PDCS) supplies DC voltage to the plant control and instrumentation loads. The system includes storage batteries, battery chargers, and distribution switchgear.

The Essential DC Electrical System (EDCS) supplies DC voltage to the “Safety Related” DC plant loads. The system includes storage batteries, battery chargers, and distribution switchgear. The EDCS power supply is fully independent of other modules.

TABLE 8.11-1 PLANT ELECTRICAL SYSTEM BOUNDARIES AND INTERFACES

PLANT ELECTRICAL SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Plant Electrical System		1) All systems using electrical power: At the connection with each electrical device. See interfaces for system list. 2) Site & Civil Works at building / support interface. 3) Site & Civil Works at switchyard: Low voltage bushings of the unit transformers (outbound voltage) 4) Site & Civil Works at switchyard: High voltage bushings of the unit startup auxiliary transformers (inbound voltage)	1) Structural concrete embeds & building steel (SCW)	Electrical & control 1) At each electrical device or device controller to supply power (RCCS, FHS, SFSS, NFHS, HSS, NIHVAC, CHS, RPS, IPS, PMCS, SWDS)
	Plant AC electrical system (PACS) link to grid			
	Startup auxiliary transformer			
	Unit transformer			
	Isolated phase bus duct			
	Switchgear			
	Unit substations			
	Motor control centers			
	Distribution panel boards			
	Backup power generator(s)			
	Essential AC electrical system			
	Plant uninterruptible power supply			
	Essential DC electrical system			
	Storage batteries			
	Battery chargers			
	Distribution switchgear			
	Plant DC electrical system			
	Storage batteries			
	Battery chargers			
	Distribution switchgear			

8.12 NI COOLING WATER SYSTEM

The NI Cooling Water System removes heat from plant components such as:

- Helium purification train components
- Main helium circulator
- Nuclear Island HVAC
- Other equipment as necessary

The nuclear island NI Cooling Water System is completely separate from the balance of plant cooling water system to prevent the spread of radiological contamination. Each reactor module cooling water loop consists of pumps, chillers, a surge tank, filter / de-mineralizer train, piping, instruments, and controls as needed. See Table 8.12-1 for boundaries and interfaces.

TABLE 8.12-1 NI COOLING WATER SYSTEM BOUNDARIES AND INTERFACES

NI COOLING WATER SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
NI Cooling Water System		The boundary for all equipment interfaces are at the connection point on the equipment 1) NIHVAC systems at air handlers 2) Helium Service System at helium system component 3) Main Heat Transfer System at the equipment connection 4) Vessel System at the vessel penetration 5) Site & Civil Works at the building /equipment interface	1) Helium services purification train (HSS) 2) Main & SCS helium circulators (MHTS, SCS) 3) NIHVAC air handlers (NIHVAC) 4) Concrete structural embeds & building steel (SCW)	Thermal hydraulic 1) The NI Cooling Water System provides cooling capacity to equipment in the following systems (HSS, MHTS, SCS, NIHVAC) 2) Decay heat from spent fuel provides a heat load to the NI Cooling Water System (SFSS) Radiological 1) Contamination control (NI system only) Electrical & control 1) Power connection for system equipment (PES)
	Pump(s)			
	Chiller(s)			
	Surge tank			
	Filter / de-mineralizer train			
	Piping			
	Instrumentation			
	Controls			

8.13 COMPONENT HANDLING SYSTEM

Maintenance and repair of the NHS requires lifting and handling equipment for all components that are expected to be replaced or moved. This handling equipment includes cranes, special temporary handling/manipulating equipment, temporary equipment storage areas, building access for replacement components, and interface with external transportation facilities. A “flight path” and temporary resting area will be developed for each item expected to be replaced. Floor loading shall be considered where needed along the flight path. See Table 8.13-1 for boundaries and interfaces.

TABLE 8.13-1 COMPONENT HANDLING SYSTEM BOUNDARIES AND INTERFACES

COMPONENT HANDLING SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Component Handling System		1) Reactor System at elements and components required to be removed 2) Site & Civil Works at the building / support interface 3) Plant Electrical System at the equipment connection 4) Fuel Handling System : must be able to manipulate & install this equipment 5) The Component Handling Equipment boundary is limited to the point at which mobile equipment can access the intended load. 6) Fuel Handling System is installed and maneuvered by Component Handling System equipment	1) Must lift and manipulate the Fuel Handling System equipment (FHS) 2) Must lift and/or manipulate specific NHS equipment requiring special handling or lifting capabilities. Equipment list to be developed. (VS, RS, MHTS, SCS, RWDS) 3) Site & Civil Works at all temporary resting locations for components and their lift rigging (SCW)	Electrical & control 1) Power connection for system equipment (PES)
	Core service tools			
	Auxiliary service cask			
	Service tools for Reactor System			
	Reserve shutdown vacuum tool			
	Neutron detector service equipment			

8.14 REACTOR PROTECTION SYSTEM

The Reactor Protection System (RPS) is the system that ensures that off-site radiological dose rates do not exceed allowable limits. Each reactor module has an independent RPS. The RPS is designed to operate automatically but can be initiated by an operator. See Table 8.14-1 for boundaries and interfaces. This system performs the following functions:

- Reactor trip utilizing the control rods, which initiate rapid reduction in reactor power following reactivity excursions or loss of core cooling.
- Reactor trip utilizing the reserve shutdown control equipment, which acts as a diverse reactor trip system and as additional protection against reactivity excursions caused by water ingress.
- In the event of a steam generator leak into the primary coolant, the main coolant loop is shutdown and the main steam line is isolated. This acts to isolate the steam generator and trip the main helium circulator to limit water ingress into the core and other vulnerable components on the Vessel, Reactor, and Main Heat Transport Systems.

TABLE 8.14-1 REACTOR PROTECTION SYSTEM BOUNDARIES AND INTERFACES

REACTOR PROTECTION SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Reactor Protection System (RPS)	TBD	1) Reactor System at NCA and pellet hopper connections 2) Power Conversion System at isolation valve connections 3) Plant Electrical System at power input connection for this system 4) Site & Civil Works at the building / component support interface 5) NHS Control Room Operator Interface System at the distribution panels for the control room 6) Main Heat Transport System at main circulator motor controls 7) Vessel System at relief valve	1) Connection with structural concrete embeds and building steel (SCW) The interfaces are at the physical electrical connection at the device.	<u>Electrical & control</u> 1) Power connection for system equipment (PES) 2) Connection to control room (CROIS) 3) Boronated graphite pellet hoppers (RS) 4) Neutron control assemblies (RS) 5) Secondary loop steam isolation valves (PCS) 6) Connections to the circulator and sensors for monitoring and shutdown during a loss of primary coolant (MHTS)

8.15 NHS INVESTMENT PROTECTION SYSTEM

The NHS Investment Protection System (IPS) is designed to limit damage to plant equipment during upsets and events. There is likely one IPS for each reactor module. Like the RPS, the IPS is designed to operate automatically but can be initiated by an operator. See Table 8.15-1 for boundaries and interfaces. The types of functions this system will perform are:

- Steam generator isolation and steam/water dump which limits the quantity of water that can leak into the core and the resulting chemical attack on reactor components.
- Primary coolant pump down, which limits the release of primary coolant and the thermal cycling of reactor components.
- Shutdown Cooling System initiation, which starts the Shutdown Cooling System upon loss of primary coolant , thus reducing thermal cycling of large components.
- Startup control rod insertion at reactor shutdown event.

The IPS may also provide the following investment related plant monitoring functions:

- The Vessel System pressure relief valve closure interlock
- Safety related equipment status and RPS channel readout information displays
- Investment protection equipment status and channel readout information displays
- Post accident monitoring information and displays
- Monitoring to facilitate post transient plant restart
- Helium leak monitoring
- A continuous, dedicated display of a minimum set of plant parameters or derived variables that may be used by the operator during all plant conditions to access plant safety status.

TABLE 8.15-1 NHS INVESTMENT PROTECTION SYSTEM BOUNDARIES AND INTERFACES

NHS INVESTMENT PROTECTION SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
NHS Investment Protection System (IPS)	TBD	General note: Boundary of this system is at electrical connection of each device. 1) Reactor System at NCA controls for rod drop at shutdown 2) Vessel System at the pressure relief valve block connections 3) Main Heat Transport System at connections to circulator controls 4) Shutdown Cooling System at connections to circulator controls 5) NHS Control Room Operator Interface System at the distribution panels for the control room 6) Power Conversion System at steam isolation valve 7) Plant Electrical System at power connection for system 8) Site & Civil Works at the building / component support interface. 9) Plant Electrical System at power input connection for this system 10) Steam/Water Dump System at connection to dump valve actuator controls	All electrical interfaces are at the device connection point 1) Connection with structural concrete embeds and building steel (SCW)	<u>Electrical & control</u> 1) Power connection for system equipment (PES) 2) Steam isolation valves for steam dump and isolation (PCS) 3) Vessel System relief valve for coolant pump down (VS) 4) Primary coolant circulator to shut down and close valve (MHTS) 5) Start SCS circulator to cool the reactor core during shutdown (SCS) 6) NCA rod insertion at reactor shutdown (RS) 7) Connection to control room (CROIS) 8) Connection to dump valve actuator control(SWDS)

8.16 NHS CONTROL AND MONITORING SYSTEM

The NHS Control and Monitoring System (NCMS) provides direct interface to all plant actuators and sensors to perform plant control functions within the Nuclear Island (NI) and the Power Conversion System (PCS). Plant level load allocation is performed by the NCMS. Each reactor module can be controlled independently. See Table 8.16-1 for boundaries and interfaces.

TABLE 8.16-1 NCMS BOUNDARIES AND INTERFACES

NCMS BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
NHS Control and monitoring System (NCMS)	TBD	1) The boundary of this system is at electrical connection of each device 2) Spent Fuel Storage and Cooling System at device connection 3) NIHVAC system at device connection 4) Helium Service System at device connection 5) Reactor Cavity Cooling System at device connection 6) Shutdown Cooling System at device connection 7) Site & Civil Works at the building / component support interface 8) Reactor System at connection to NCAs that enable removal and installation of the NCA 9) Vessel System at pressure relief valve 10) NHS Control and Monitoring System at circulator motor control and fault monitoring (over-amp, vibration, etc.) 11) Plant Electrical System at power input connection for this system 12) Steam/Water Dump System at sensor for leak detection	1) Connection with structural concrete embeds and building steel (SCW)	Electrical & control 1) The NHS Control and Monitoring System interfaces to all plant actuators and sensors. The interface point is considered the connection point nearest the device. (RS, VS, MHTS, SCS, RCCS, SFSS, HSS, NIHVAC, PES, CROIS, SWDS)

8.17 CONTROL ROOM AND OPERATOR INTERFACE SYSTEM

The purpose of the Control Room and Operator Interface System (CROIS) is to provide a means for the operator to monitor and control the plant. This system provides the operator with information from the NCMS, IPS, and RPS systems. Similarly, the CROIS allows the operator to transmit instructions to NCMS, IPS, and RPS controllers or directly to individual actuators.

TABLE 8.17-1 CROIS BOUNDARIES AND INTERFACES

CROIS BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Control room and operator interface system (CROIS)	TBD	1) The boundary of this system is at the distribution panels for the control room. All physical connections with other systems are made here. 2) Site & Civil Works at the building / component support interface	1) Connection with structural concrete embeds and building steel (SCW)	Electrical & control 1) Power connection for system equipment The control room and operator interface system interfaces with the NCMS, IPS, and RPS systems to provide the operator full control and monitoring of NHS equipment. The interface point for connection to these systems is the distribution panel.

8.18 RADIOACTIVE WASTE AND DECONTAMINATION SYSTEM

The Radioactive Waste and Decontamination System provides a means of managing and where possible, decontamination of all radioactive waste generated within the plant. See Table 8.18-1 for boundaries and interfaces.

All potentially radioactive gas generated in the reactor plant is collected. Gases with low levels of radioactivity may be stored allowing for activity decay to allowable levels prior to release; otherwise, the gasses are processed by the system.

All potentially radioactive liquids are captured and treated based upon the liquid type and the expected level of contamination. Liquids may be treated and prepared for disposal, treated and recycled for use in the plant, or treated and released to the environment.

All potentially radioactive solid waste generated within the reactor plant are captured and treated in this facility except used fuel elements. Compactable items are compacted and made ready for shipment. Liquefied waste are treated and solidified where necessary.

The decontamination services provides the facility and tools required for general decontamination of equipment and components used within the reactor plant.

TABLE 8.18-1 RWDS BOUNDARIES AND INTERFACES

RWDS BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Radioactive Waste and Decontamination System (RWDS)	TBD	1) The boundaries of this system are at the collection point of the source and the physical boundaries of the processing facility. 2) Site & Civil Works at the building / component support interface 3) Spent Fuel Storage and Cooling System (liquid) at the storage well drain to sump 4) Reactor Cavity Cooling System (liquid) at cavity drain to sump	1) Connection with structural concrete embeds and building steel (SCW) 2) Component Handling System equipment to assure capacity to lift and manipulate RWDS equipment (CHS) 3) Spent Fuel Storage and Cooling System (liquid) at the storage well drain to sump (SFSS) 4) Reactor Cavity Cooling System (liquid) at cavity drain to sump (RS)	Radiological Monitoring of system as deemed necessary by health physics Electrical & control 1) Power connection for system equipment (PES)

8.19 STEAM/WATER DUMP SYSTEM

The STEAM/WATER Dump System is capable of emptying the steam generator's steam/water inventory in the event of a leak which results in moisture ingress to the primary coolant. It can also be used to drain the steam generator to perform maintenance. The system consists of a redundant valve train connected to the main feedwater line between the SG and the feedwater line isolation valve, see Figure 8.19-1. The boundary of this system is the pipe connection of the first dump valve off of the feedwater line. See Table 8.19-1 for boundaries and interfaces.

Figure 8.19-1 STEAM/WATER DUMP SYSTEM

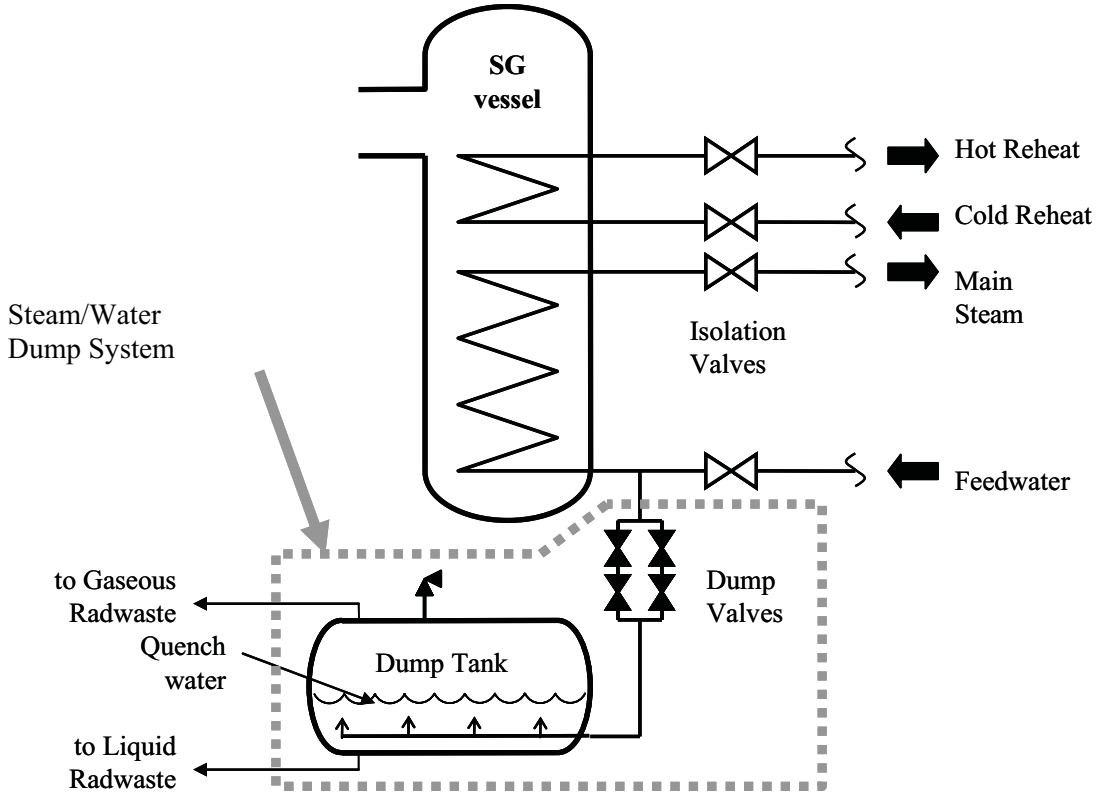


TABLE 8.19-1 STEAM/WATER DUMP SYSTEM BOUNDARIES AND INTERFACES

STEAM/WATER DUMP SYSTEM BOUNDARIES AND INTERFACES				
System	**Included components**	**Boundaries**	**Physical interfaces**	**Other interfaces**
Steam/Water Dump System (SWDS)	Dump valve	1) Power Conversion System at the pipe connections of the first dump valves. 2) Site & Civil Works at the building / component support interface 3) Radioactive Waste and Decontamination System at the pipe connection to the dump tank 4) NI Investment Protection System at valve controls 5) Plant Electrical System at valve actuator 6) NHS Plant Control and Monitoring at sensor for dump valve leak detection	1) Power Conversion System at the pipe connections of the first dump valves. (PCS) 2) Site & Civil Works at the building / component support interface (SCW) 3) Radioactive Waste and Decontamination System at the exhaust/vent pipe connection to the dump tank (RWDS)	<u>Radiological</u> Monitoring of system at the dump tank, dump tank relief, and as deemed necessary by health physics <u>Electrical & control</u> 1) Power connection for dump valves (PES) 2) IPS for valve actuation 3) Sensor for dump valve leak detection (NCMS)

9.0 REFERENCES

1. AREVA document 51-9103803-000, NGNP Conceptual Design Baseline Document for Conventional Steam Cycle for Process Heat and Cogeneration

APPENDIX A: NHS SYSTEM BOUNDARY MATRIX

Sect. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	SCW	PCS
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES *	NI CWS **	CHS	RPS	IPS *	NCMS *	CROIS	RWDS	SWDS		
RS		■	■	■		■							■	■	■	■				■	
VS	■		■	■		■			■		■				■	■				■	■
MHTS	■	■				■			■			■		■	■	■					■
SCS	■	■							■			■			■	■				■	
RCCS											■					■		■		■	
FHS	■	■	■				■				■		■							■	
SFSS						■		■			■					■		■		■	
NFHS							■				■									■	
HSS		■	■	■							■	■				■				■	
NIHVAC											■	■				■				■	
PES *					■	■	■	■	■	■			■	■	■	■				■	
NICWS **		■	■						■	■										■	
CHS	■					■					■		■							■	
RPS	■	■	■								■						■			■	■
IPS *	■	■	■	■							■						■		■	■	■
NCMS *	■	■		■	■		■		■	■	■					■	■		■	■	
CROIS														■	■	■				■	
RWDS					■		■												■	■	
SWDS											■				■	■		■		■	■

NOTES: READ TABLE FROM LEFT TO RIGHT. PICK SYSTEM IN LEFT COLUMN AND READ WHICH SYSTEMS IT INTERFACES IN THAT ROW.

* A general boundary exists for all systems using electrical power & controls where the boundary is at the physical connection at the device.

** A general boundary exists at the point where mobile equipment can access the intended load.

*** The boundaries of this system are at the collection point of the source and the physical boundaries of the processing facility.

RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Control and Monitoring System
VS	Vessel System	SFSS	Spent Fuel Storage and	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and	CHS	Component handling sys.	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection system		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	Investment protection sys.	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				

APPENDIX B: NHS SYSTEM PHYSICAL INTERFACE MATRIX

Sect. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	S	P
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES	NI CWS	CHS	RPS	IPS	NCMS	CROIS	RWDS	SWDS	C W	C S
RS		■	■	■		■	■	■					■								
VS	■		■	■		■														■	■
MHTS	■	■							■			■	■								
SCS	■	■							■			■	■							■	
RCCS																				■	
FHS	■	■					■						■							■	
SFSS	■					■		■					■					■		■	
NFHS	■						■						■							■	
HSS		■	■	■								■								■	
NIHVAC												■								■	
PES																				■	
NICWS			■	■					■	■										■	
CHS	■	■	■	■		■	■	■										■		■	
RPS																				■	
IPS																				■	
NCMS																				■	
CROIS																				■	
RWDS	■						■						■						■	■	
SWDS																		■		■	■

NOTE: READ TABLE FROM LEFT TO RIGHT. PICK SYSTEM IN LEFT COLUMN AND READ WHICH SYSTEMS IT INTERFACES IN THAT ROW.

PLANT SYSTEM ABBREVIATION TABLE							
RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Control and Monitoring System
VS	Vessel System	SFSS	Spent Fuel Storage and Cooling System	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface System
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and Storage System	CHS	Component Handling System	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection system		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	NHS Investment Protection System	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				

APPENDIX C: NHS SYSTEM ELECTRICAL INTERFACE MATRIX

Sect. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	SCW	PCS
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES	NI CWS	CHS	RPS	IPS	NCMS	CROIS	RWDS	SWDS		
RS														■	■	■					
VS															■	■					
MHTS														■	■	■					
SCS															■	■					
RCCS											■					■					
FHS											■										
SFSS											■					■					
NFHS											■										
HSS											■					■					
NIHVAC											■					■					
PES					■	■	■	■	■	■			■	■	■	■			■		
NICWS											■										
CHS											■										
RPS	■		■								■						■				■
IPS	■	■	■	■							■						■		■		■
NCMS	■	■	■	■	■		■		■	■	■						■		■		
CROIS														■	■	■					
RWDS											■										
SWDS											■				■	■					

NOTE: READ TABLE FROM LEFT TO RIGHT. PICK SYSTEM IN LEFT COLUMN AND READ WHICH SYSTEMS IT INTERFACES IN THAT ROW.

PLANT SYSTEM ABBREVIATION TABLE							
RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Plant Control & Monitoring Sys.
VS	Vessel System	SFSS	Spent Fuel Storage and Cooling System	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface System
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and Storage System	CHS	Component Handling System	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection system		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	NHS Investment Protection System	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				

APPENDIX D: NHS SYSTEM RADIOLOGICAL CONCERNS MATRIX

Sect #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	SCW	PCS
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES	NI CWS	CHS	RPS	IPS	NCMS	CROIS	RWDS	SWDS		
	■	■	■	■	■	■	■	■	■	■		■						■	■		

NOTE: THE RADIOLOGICAL CONCERNS DO NOT INTERFACE WITH OTHER SYSTEMS. LISTED ABOVE ARE THE SYSTEMS THAT HAVE RADIOLOGICAL CONCERNS ATTRIBUTED TO THEM.

PLANT SYSTEM ABBREVIATION TABLE							
RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Control and Monitoring System
VS	Vessel System	SFSS	Spent Fuel Storage and Cooling System	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface Sys.
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and Storage System	CHS	Component Handling System	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection system		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	NHS Investment Protection System	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				

APPENDIX E: NHS SYSTEM THERMAL HYDRAULIC INTERFACE MATRIX

Sect. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	SCW	PCS
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES	NI CWS	CHS	RPS	IPS	NCMS	CROIS	RWDS	SWDS		
RS			■	■																	■
VS			■	■	■					■											
MHTS	■	■																			■
SCS	■	■	■																		
RCCS		■																			
FHS																					
SFSS										■		■									
NFHS																					
HSS			■									■									
NI HVAC		■					■														
PES																					
N ICWS			■	■			■		■	■											
CHS																					
RPS																					
IPS																					
NCMS																					
CROIS																					
RWDS																					
SWDS																					

NOTE: READ TABLE FROM LEFT TO RIGHT. PICK SYSTEM IN LEFT COLUMN AND READ WHICH SYSTEMS IT INTERFACES IN THAT ROW.

PLANT SYSTEM ABBREVIATION TABLE							
RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Control and Monitoring System
VS	Vessel System	SFSS	Spent Fuel Storage and Cooling System	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface System
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and Storage System	CHS	Component Handling System	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection sys.		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	NHS Investment Protection System	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				

APPENDIX F: NHS SYSTEM HEAT TRANSFER INTERFACE MATRIX

Sect. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	S	P
	RS	VS	MHTS	SCS	RCCS	FHS	SFSS	NFHS	HSS	NI HVAC	PES	NI CWS	CHS	RPS	IPS	NCMS	CROIS	RWDS	SWDS	C W	C S
RS		■	■																		
VS	■	■																		■	
MHTS		■																			■
SCS			■																		
RCCS		■																			
FHS																					
SFSS																					
NFHS																					
HSS		■																			
NIHVAC																					
PES																					
NICWS																					
CHS																					
RPS																					
IPS																					
NCMS																					
CROIS																					
RWDS																					
SWDS																					

NOTE: READ TABLE FROM LEFT TO RIGHT. PICK SYSTEM IN LEFT COLUMN AND READ WHICH SYSTEMS IT INTERFACES IN THAT ROW.

PLANT SYSTEM ABBREVIATION TABLE							
RS	Reactor System	FHS	Fuel Handling System	PES	Plant Electrical System	NCMS	NHS Control and Monitoring System
VS	Vessel System	SFSS	Spent Fuel Storage and Cooling System	NICWS	NI Cooling Water System	CROIS	NHS Control Room Operator Interface Sys.
MHTS	Main Heat Transport System	NFHS	New Fuel Handling and Storage System	CHS	Component Handling System	RWDS	Radioactive Waste and Decontamination System
SCS	Shutdown Cooling System	HSS	Helium Service System	RPS	Reactor protection system		
RCCS	Reactor Cavity Cooling System	NIHVAC	NI Heating Ventilation and Air Conditioning	IPS	NHS Investment Protection System	SWDS	Steam/Water Dump System
SCW	Site & Civil Works	PCS	Power Conversion System				