APPENDIX A: SYSTEM FUNCTIONS

APPENDIX A

SYSTEM FUNCTIONS

An essential part of the evaluation of plant systems, structures, and components (SSC) is the identification of SSCs functions and the risks associated with those functions. This appendix summarizes the system and component functions for the pilot systems as well as the safety categorization and Risk category associated with the system components.

Tables A-1, A-2 and A-3 provide a listing of components that make up the pilot systems at Quad Cities. The definition of codes listed in these tables are summarized below:

Safety Classification	P	Safety-related for Reactor Coolant Pressure Boundary
	S	Safety-related for Principal Safety
	A	Safety-related for Auxiliary Safety
	I	Safety-related for Integrity of system
	#	Non-safety related with special requirements
	R	Non-safety related but Regulatory related
	N	Non-safety related
ASME Qualify Classification	A	ASME Section IX Class 1 ISI
10CFR50.55a	B	ASME Section IX Class 2 ISI
	C	ASME Section IX Class 3 ISI
	N	All other components
Electrical Classification	E	Class 1E
10CFR50.55a	N	Non-Class 1E
Seismic Classification	I	Category I
10CFR100	Q	Category I (SQUG)
	S	Seismically supported or mounted
	N	Non-seismic
Environmental Qualification	1	Category I
10CFR50.49	2	Category II
	3	Category III
	4	Excluded from EQ
	N	Not Applicable
Operational Mode	A	Active Component
	P	Passive Component
	D	Display or Information
	N	Non-safety related function
Regulatory Guide 1.97	1	Category 1
	2	Category 2
	3	Category 3
	N	Not subject to RG 1.97 Requirements

A.1 CORE SPRAY SYSTEM FUNCTIONS

The Core Spray system provides an independent source of low pressure makeup to the reactor vessel in the event that high pressure makeup systems are unavailable.

The primary function of the Core Spray system is to prevent fuel damage during a Loss of Coolant Accident (LOCA). This is accomplished by spraying water directly onto the core. Core Spray is used in conjunction with the Automatic Depressurization System (ADS) and the High Pressure Coolant Injection (HPCI) system to protect the reactor core in all postulated liquid or steam pipe breaks. This includes breaks ranging in size from those in which the core is adequately cooled by the HPCI system alone up to and including the design basis accident LOCA.

A secondary function of the Core Spray system is to provide long term cooling of fuel bundles after steam cooling is no longer effective. This function applies when cores with a top peaked power strategy are being utilized.

Because these functions prevent a release that could potentially exceed the 10CFR100 release limits and they assure the capability to maintain a safe shutdown condition, they are classified as safety functions.

Core Spray System Description

The Core Spray system consists of two independent coolant injection loops per unit which are normally in a standby configuration while the reactor is at power. Key components of each subsystem include a pump, various manual and motor-operated valves, and actuation logic circuits.

Each loop contains a motor-driven centrifugal pump capable of providing 100% of the coolant flow required to cool the core during any postulated accident. Suction for the pump in each loop comes from an independent connection to the Emergency Core Cooling Systems (ECCS) torus suction ring header or from a manually aligned connection to the Contaminated Condensate Storage Tanks (CCSTs). Each pump's discharge line has two branch lines, each of which contains a motor-operated valve. The first connection is a small minimum-flow line used to prevent the pump from overheating while running at shutoff head. The second branch is used for full-flow testing; its

associated motor-operated valve is normally closed. A normally closed motor-operated valve also provides isolation between the Core Spray system and the reactor vessel during the system standby configuration.

When a Core Spray initiation signal is received, the pumps start and run, with flow through the minimum flow bypass line. When reactor pressure drops below 325 psig, the isolation valve opens and allows water to be sprayed onto the core and the minimum flow bypass line is isolated. Each Core Spray subsystem is designed to act as a completely independent system.

The Core Spray system break detection instrumentation detect a break in the Core Spray piping located between the reactor pressure vessel wall and the outside of the shroud.

The Core Spray discharge headers are maintained full by the ECCS Fill system to prevent pipe damage due to water hammer when the pumps start.

Core Spray Component Descriptions

Core Spray Sparger

The Core Spray sparger and rated Core Spray system flow rate combine to distribute a specific amount of flow to each fuel bundle. The water is injected into the reactor vessel through two independent sparger rings, each of which is connected to a single Core Spray loop. Each sparger ring consists of two 180-degree sections and is capable of providing a spray pattern covering the entire core. Because the spray distribution is essential for the long term cooling function, the spargers are classified as safety-related.

Suppression Pool Suction Strainer

Normal suction for the Core Spray pumps is from the suppression pool via the ECCS suction header. There are four suction lines from the suppression pool to the 24-inch ECCS torus suction ring header. Suction strainer screens are provided on each line from the suppression pool to the ECCS suction header. The screens are located above the bottom of the suppression pool to minimize plugging. The flow area of the four suction lines is sized for the combined, full-flow requirements

of HPCI, RHR, Reactor Core Isolation Cooling (RCIC) and Core Spray systems with one suction screen assumed completely plugged. Because the suction strainer is essential in achieving the safety functions, it is classified as safety-related.

Pumps

The Core Spray pumps are single-stage double-suction centrifugal pumps that produce a total dynamic head of 585 feet. Each pump is designed to deliver 4500 gpm at a reactor vessel pressure of 90 psig. The pumps are powered by electric motors, which are rated at 800 hp. The pumps are located at the lowest level of the reactor building to ensure that water from the suppression pool maintains the net positive suction head requirements of the system. Because the pumps are essential in achieving the safety functions, they are classified as safety-related

ECCS Fill System

The ECCS Fill pump maintains the RHR and Core Spray system discharge headers full and thus prevents water hammer during system initiation. The Unit 1 pump takes suction from the Loop B Core Spray suction pipe (Unit 2 takes suction from the Loop A Core Spray suction pipe) and discharges into the various ECCS pump discharge lines. Motive and control power to the pump is provided through Motor Control Center (MCC) 18-1A (28-1). The Contaminated Condensate Transfer system acts as a manual backup to the ECCS fill pump. The ECCS Fill System is non-safety-related because its operation is not essential for achieving the system safety function.

HVAC

Cooling to the Core Spray pump rooms is provided by the Reactor Building Ventilation system. 480VAC Buses 18(28) and 19(29) power the supply and exhaust fans. Emergency Air Handling Units (AHU), cooled by the Diesel Generator Cooling Water system, are also located in each pump room. These coolers are powered by 480VAC Motor Control Centers 18(28)-1A and 19(29)-1. Because the room coolers are considered to be essential for operation of the system, the cooling water is classified as safety-related.

Valves

The pump suction valves MO-1402-3A and B are AC-motor-operated valves that are normally open. They may be closed from the control room in the event of a piping failure which would cause flooding from the Torus. Because these valves are essential in achieving the safety functions, they are classified as safety-related.

The AC-motor-operated test valves MO-1402-4A and B are provided to allow for full-flow testing of the spray loops. Flow is returned to the suppression pool via the Low Pressure Coolant Injection (LPCI) test line, which discharges into the vapor space in the torus. The test valves automatically close (if open) upon receipt of a Core Spray initiation signal. Because closure of these valves (if open) is essential in achieving the safety functions, the closure function is classified as safety-related.

The AC-motor-operated valves MO-1402-38A and B in the bypass line are normally closed valves that close when pump discharge flow exceeds 700 gpm as the reactor vessel isolation valves open and reopen as flow decreases to less than 500 gpm. The minimum-flow bypass line that diverts sufficient flow to protect the pumps from overheating while the Core Spray isolation valves are awaiting the low pressure permissive signal to open. Because these valves are essential in preventing system failure, they are classified as safety-related.

Failure of the test line valve to close (if it were open) would divert sufficient flow to prevent successful operation of that Core Spray loop. Failure of the minimum flow line valve to close on increasing pump flow would not significantly impact Core Spray delivery to the reactor vessel due to the relatively small size of the minimum-flow line (one and one-half inches) and its restricting orifice.

Two AC-motor-operated isolation valves and a check valve provide isolation from the high pressure primary coolant system for each loop. This combination of valves allows the motor-operated valves to be cycled for testing while maintaining two-valve isolation between the high-pressure reactor pipe and the low-pressure Core Spray pipe. The inboard motor-operated valve and the check valve provide the containment isolation safety function.

The inboard isolation valves MO-1402-25A and B are normally closed and automatically open on receipt of a Core Spray initiation signal in conjunction with a reactor-vessel low-pressure permissive signal (325 psig). These valves cannot be opened from the main control room unless reactor pressure is less than 325 psig, or the outboard isolation valves are shut. The outboard isolation valves MO-1402-24A and B are normally open and will automatically open (if closed) upon receipt of an initiation signal in conjunction with a reactor-vessel pressure less than 325 psig. Each injection line also contains a relief valve set at 475 psig to protect the low pressure piping. Because these valves are essential in preventing a release that could result in an offsite exposure exceeding 10CFR100 guidelines, they are classified as safety-related.

All Core Spray valves, with the exception of the isolation check valve, are located outside of the primary containment. Within the drywell, each Core Spray line contains the isolation check valve and a locked-open manual isolation valve. The locked-open manual isolation valve located in the drywell is used for maintenance purposes only.

Table A-1
CORE SPRAY SYSTEM COMPONENTS

Component	EID Number	Component Description	Funct.	Safety class	ASME Class	Electrical	Seismic	E	Q	Oper Mode	RG 1.97
				P,S,A,I,R,#,N	A,B,C,N	E,N	I,Q,S,N	1,2,3,4,N	A,P,D,N	1,2,3,N	
Press Indicator	1402 0040 A,B PI	Pump Suction Ind.	8	#	N	N	S	N	P	N	
Angle Valve	1402 0040 A,B V18	Pump Suction Ind.	8	#	N	N	S	N	P	N	
Press Switch	1402 0042 A,B PS	Injection Vlv permissive	1,7	#	N	N	S	N	P	N	
Angle Valve	1402 0042 A,B V18	Injection Vlv permissive	1,7	#	N	N	S	N	P	N	
Gate Valve	1402 0002 A,B V73	Fill Line Isolation	6	I	B	N	I	N	P	N	
Panel	1402 0003 A,B P05	Suction Isolation	1, 4,7	I	N	E	I	4	P	N	
Control Station	1402 0004 A,B HK	Full Flow Test	8	I	N	E	I	3	P	N	
Globe Valve	1402 0005 A,B V74	Test Return Valve	1,7	I	B	N	I	N	P	N	
Globe Valve	1402 0017 A,B V74	Test valve		I	B	N	I	N	P	N	
Control Station	1402 0024 A,B HK	NO Injection & Isolation	1,7	I	N	E	I	4	P	N	
Control Station	1402 0025 A,B HK	NC Injection & Isolation	1, 5,7	I	N	E	I	4	P	N	
Relief Valve	1402 0028 A,B V26	Discharge Line Relief	1,7	I	B	N	I	N	P	N	
Control Station	1402 0038 A,B HK	Minimum Flow Valve	1,7	I	N	E	I	3	P	N	
Motor Heater	1402 A,B H13	Pump	1,7	N	N	N	S	N	N	N	
Gate Valve	1402 0001 V73	Fill Line Isolation	6	N	N	N	S	N	N	N	
Limit Switch	1402 0006 A,B ZS	Maintenance Isolation	8	N	N	N	S	N	N	N	
Globe Valve	1402 0011 A,B V74	Test valve	8	N	N	N	S	N	N	N	
Globe Valve	1402 0012 A,B V74	Drain Valve	8	N	N	N	S	N	N	N	
Globe Valve	1402 0015 A,B V74	Drain Valve	8	N	N	N	S	N	N	N	
Globe Valve	1402 0016 A,B V74	Drain Valve	8	N	N	N	S	N	N	N	
Globe Valve	1402 0017 A,B V74	Test valve	8	N	N	N	S	N	N	N	
Globe Valve	1402 0018 A,B V74	Test valve	8	N	N	N	S	N	N	N	

Globe Valve	1402 0022 A,B V74	Drain Valve	8	N	N	N	S	N	N	N
Globe Valve	1402 0032 A,B V74	Test valve	8	N	N	N	S	N	N	N
Globe Valve	1402 0036 V74	Min flow	1,7	N	N	N	S	N	N	N
Globe Valve	1402 0039 A,B V74	Drain Valve	8	N	N	N	S	N	N	N

Table A-1

CORE SPRAY SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Funct.	Safety class	ASME Class	Electrical	Seismic	EQ	Oper Mode	RG 1.97
				P,S,A,I,R,#,N	A,B,C,N	E,N	I,Q,S,N	1,2,3,4,N	A,P,D,N	1,2,3,N
Gate Valve	1402 0006 A,B V73	Maintenance Isolation	1,7,8	P	A	N	I	N	P	N
AO Check	1402 0009 A,B V25	Injection & Isolation	1, 5,7	P	A	N	I	N	A	N
MO Gate Valve	1402 0025 A,B V74	NC Injection & Isolation	1, 5,7	P	A	N	I	N	A	N
Globe Valve	1402 0026 A,B V74	Test valve	8	P	A	N	I	N	P	N
Globe Valve	1402 0027 A,B V74	Instrument Valve	8	P	A	N	I	N	P	N
Globe Valve	1402 0029 A,B V74	Test valve	8	P	A	N	I	N	P	N
Excess Flow Valve	1402 0031 A,B V74	Instrument Valve	8	P	A	N	I	N	P	N
Globe Valve	1402 0033 A,B V74	Test valve	8	P	A	N	I	N	P	N
Globe Valve	1402 0035 A,B V74	Drain Valve	8	P	A	N	I	N	P	N
Pump Motor	1401 A,B M10	Pump	1,7	S	N	E	I	1	A	N
Pump	1401 A,B P30	Pump	1,7	S	B	N	I	N	A	N
Actuator	1402 0003 A,B L05	Suction Isolation	1, 4,7	S	N	E	I	4	A	N
MO Gate Valve	1402 0003 A,B V73	Suction Isolation	1, 4,7	S	B	N	I	N	A	N
Actuator	1402 0004 A,B L05	Full Flow Test	1,7,8	S	N	E	I	1	A	N
MO Gate Valve	1402 0004 A,B V74	Full Flow Test	1,7,8	S	B	N	I	N	A	N
Stop Check	1402 0008 A,B V18	Pump Discharge	1,7	S	B	N	I	N	A	N
Stop Check	1402 0013 A,B V18	Minimum Flow Check	1,7	S	B	N	I	N	A	N
Globe Valve	1402 0021 A,B V74	Vent Valve	8	S	B	N	I	N	P	N
Actuator	1402 0024 A,B L05	NO Injection &	1,7	S	N	E	I	1	A	N

MO Gate Valve	1402 0024 A,B V74	Isolation NO Injection & Isolation	1,7	S	B	N	I	N	A	N
Actuator	1402 0025 A,B L05	NC Injection & Isolation	1, 5,7	S	N	E	I	1	A	N
Bfly Valve	1402 0034 A,B V71	LO Pump Suction	1,7	S	B	N	I	N	P	N
Actuator	1402 0038 A,B L05	Minimum Flow Valve	1,7	S	N	E	I	1	A	N
MO Gate Valve	1402 0038 A,B V74	Minimum Flow Valve	1,7	S	B	N	I	N	A	N
Orifice	1402 0041 A,B MO1	Minimum Flow line	8	S	B	N	I	N	P	N

Table A-1
CORE SPRAY SYSTEM COMPONENTS (CONTINUED)

Core Spray System Functions	Safety Classification	Safety Significance	Potential Function RISC Category
1. RPV Injection	Safety-related	LSS	RISC-3
2. Spray Distribution (sparger)	Safety-related	LSS	RISC-3
3. Debris Retention	non-safety-related	LSS	RISC-4
4. Flood Prevention	non-safety-related	LSS	RISC-4
5. Containment (Pressure) Isolation including all safety class = P	Safety-related	HSS	RISC-1
6. Keep Fill	non-safety-related	LSS	RISC-4
7 Containment Flooding	non Safety related	LSS	RISC 4
8. Maintenance/test	non-safety related	Not in PRA but evaluated as LSS	RISC-4

A.2 FEEDWATER FUNCTION

The Feedwater and Condensate (FWC) system is an integral part of the power conversion process. The system includes those components from the main condenser hotwell to the feedwater sparger the reactor vessel (inclusive). Condensers, heat exchangers, demineralizers, pumps, valves, instruments, controls, and associated piping are the basic mechanical hardware that allow the FWC system to accomplish its function.

The primary function of the FWC system is to supply the reactor vessel with demineralized feedwater during normal operation at a rate sufficient to maintain reactor water level at 100% reactor power. To accomplish this function, the condensate supply from the main condenser hotwell is pumped through condensate demineralizers and feedwater heaters to the suction of the feedwater pumps. The feedwater pumps deliver the condensate to the reactor vessel after additional feedwater heating. The feedwater must be regulated (controlled) to match the reactor steam generation rate and maintain sufficient water level in the reactor.

When the reactor is not generating steam for power operations, the FWC system may be used to provide makeup to the reactor vessel for the removal of decay heat. The feedwater heating and cleanup functions are not essential to cooling the reactor during off-normal conditions.

During normal power operations the FWC system operates in automatic control maintaining feedwater flow approximately equal to reactor steam generation rate, thereby maintaining reactor water level. During non-power or reactor trip operations, the same controls are adjusted to provide feedwater flow control to maintain reactor water level.

Feedwater System Description

The main condenser removes the latent heat of vaporization from the main turbine exhaust steam. The condensate, condensate booster, and feedwater pumps increase pressure so that the primary water can be returned to the reactor vessel. Other components, such as the steam-jet air ejectors,

gland sealing condenser, off-gas condensers, condensate demineralizers, and feedwater heaters facilitate and increase the efficiency of the power conversion process by creating a vacuum in the condenser, heating the feedwater and maintaining appropriate water quality.

Feedwater Component Descriptions

Main Condenser Hotwell

The main condenser hotwell is the reservoir underneath the main condenser that collects the condensate from the turbine steam exhaust or main steam bypass. The condenser hotwell makeup pumps supply makeup water for level control from the contaminated condensate storage tanks (CCSTs) through valves LCV-3301 or LCV-3302. Water is returned from the main condenser hotwell to the CCSTs via valves LCV-3303 or LCV-3304 downstream of the condensate booster pumps.

Condensate Pumps

The main condenser hotwell volume provides net positive suction head for four parallel horizontal, one-stage, centrifugal condensate pumps. The motor for each condensate pump [1-3302A (2-3302-A) through -3302D] also drive the condensate booster pumps. Under pre-uprate operation, the condensate pumps are designed such that only three are required for 100% power operation . The fourth condensate pump acts as a standby and will start when the feed pump suction pressure drops below 160 psig or a running condensate/condensate booster pump trips. Four pumps are required to operate at uprated power.

Steam-Jet Air Ejector (SJAE) Condensers

There are two steam-jet air ejector (SJAE) condensers, each of which is capable of passing 50% of the rated main condensate flow from the condensate pumps and 100% of the air ejector steam flow. Both condensers are normally operated to allow for 100% condensate flow. A 50% capacity main condensate flow bypass line is provided [MOV-3304] in the event that an SJAE condenser

requires maintenance. The bypass line has an orifice to simulate the main condensate flow pressure drop through one condenser. Condensate formed in the SJAE condenser is gravity drained to the main condenser hotwell via loop seals.

Gland Steam Condensers

After flowing through the SJAE condensers, the full main condensate flow is directed through the tube side of one of two gland seal steam condensers, either of which provides condensation of the gland sealing steam. Condensate formed in the gland seal steam condenser is vacuum drained back to the main condenser hotwell via level control valves.

Off-gas Condensers

After passing through the gland seal steam condensers, main condensate is directed to the tube sides of two off-gas condensers. The off-gas condensers are each sized to pass 100% of the rated condensate flow. A manual bypass valve is provided [-3399-131], but is not normally utilized. Condensate formed in the off-gas condenser is also gravity-drained to the main condenser hotwell through level control valves.

Condensate Demineralizers

After the condensate has left the off-gas condensers, it passes through condensate demineralizers. There are seven demineralizers, of which six are required for 100% flow. The demineralizers remove impurities which can foul heat transfer surfaces and become activated in the reactor. A “Master Flow Controller” divides the flow between all seven demineralizers such that the dirtiest demineralizer will always have the greatest differential pressure drop and concurrent maintenance is avoided. A bypass valve [MOV-3303] able to pass 100% flow is provided, but is not normally utilized.

Just downstream of the demineralizers, a flow path is provided to return condensate to the condensate storage tanks. Lines are also provided downstream of the demineralizers to fill the condensate reheat seal troughs and cool the turbine hood region.

Condensate Booster Pumps

Four condensate booster pumps [3401A through 3401D] increase the pressure of the condensate to provide net positive suction head for the reactor feed pumps. The condensate booster pumps are driven by the same four motors which drive the condensate pumps. At the discharge of the booster pumps, lines are provided for recirculating condensate to the main condenser (through normally open FCV-3401), supplying reactor feed pump seal water, and cooling the moisture separator drains. The main flow of condensate is directed toward the low-pressure feedwater heaters.

Low-Pressure Feedwater Heaters

The condensate enters the tube sides of three parallel strings of low-pressure feedwater heaters. Each string is comprised of a drain cooler and three heaters, yielding a total of three drain coolers [A1-3102 through A3-3102] and nine low-pressure feedwater heaters [A1-3101 through A3-3101, B1-3103 through B3-3103, and C1-3104 through C3-3104]. The primary purpose of the feedwater heaters is to improve overall plant efficiency by pre-heating the condensate to improve the overall thermal efficiency of the steam cycle.

A bypass line [MOV-3403] is provided to bypass a string of low-pressure heaters in the event of failure of a heater string. Each heater string has a set of MOVs (inlet and outlet) to permit isolation in case of heater failure. The bypass line has an orifice to simulate the pressure drop through one heater string.

Reactor Feed Pumps

Three two-stage, centrifugal, horizontal reactor feed pumps (RFPs) take their suction from the outlets of the low-pressure feedwater heaters. Each RFP has an outlet check valve and motor-operated gate valve. Selection of a standby RFP automatically opens the associated discharge valve. A recirculation line to the main condenser hotwell taps off between each reactor feed pump and its associated outlet check valve. The recirculation path assures that the minimum flow requirement for each RFP is satisfied. Two ventilation fans are also provided. At least one of two ventilation fans

must be running to start the reactor feed pumps.

Feedwater Regulating Valves

The discharge of the RFPs flows through a common discharge header that goes to three parallel feedwater regulating valves (FRVs). The -0642A&B valves are equipped with electro-hydraulic actuators. This type of actuator uses hydraulic oil, supplied by its own hydraulic power unit, to position the valve. Upon failure of the hydraulic operating unit, or loss of control signal, the valve will fail in its current position.

The third path through which the feedwater may flow includes the low-flow feedwater regulating valve [AO-0643]. The low-flow valve can pass approximately 20% of rated feedwater flow when fully open. The valve is an air-to-close and spring-to-open design. On loss of 100 psi instrument air, the spring-loaded air-lock valve will lock in its current position. The regulating valve will not move until sufficient air pressure is available to open the air-lock valve.

High-Pressure Feedwater Heaters

After passing through the FRVs, the feedwater flows through three high-pressure feedwater heaters. The heaters are arranged in parallel and serve the same purposes as the low-pressure feedwater heaters. A bypass line [MOV -3203] is provided in the event any of the high-pressure feedwater heaters need to be bypassed. Each heater has two isolation MOVs (inlet and outlet).

The common discharge from the high-pressure feedwater heaters splits into two lines before penetrating the primary containment. Each line has an isolation valve [MOV -3205A/B]. One of the lines contains a tap-in from the Reactor Water Cleanup system return line and the High Pressure Coolant Injection line. Once inside the primary containment, each line splits again before penetrating the vessel to supply four separate feedwater spargers.

Series check valves inboard and outboard of the primary containment provide a containment isolation function and are classified as safety-related. Other components of the Feedwater and

Condensate systems are not safety-related since they are not credited in any safety analysis and are not power by on-site power sources.

Table A-2
FEEDWATER SYSTEM COMPONENTS

Component	EID Number	Component Function Description	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	Q Oper Mode 1,2,3,4,N	RG 1.97 A,P,D,N	Mode 1,2,3,N
Globe Valve	220-0060 B V15	Instrument	9	I	B	N	I	N	P	N
Globe Valve	3299-0126 V15	Drain	9	I	B	N	I	N	P	N
Hydraulic Operated Valve	0642 A&B	Feedwater Control Vlv	1,7	N	N	N	N	N	N	N
AO Valve	0643	Low Flow Control	1,7	N	N	N	N	N	N	N
Swing Check Valve	220-0059A V25	Upstream RCIC inj	1,3	N	N	N	S	N	N	N
Globe Valve	220-0060A V15	Instrument	9	N	N	N	S	N	N	N
Globe Valve	220-0061 A&B V15	Instrument	9	N	N	N	S	N	N	N
Globe Valve	220-0087 A&B V15	Instrument	9	N	N	N	S	N	N	N
Heater	3105 D1, D2, D3	HP Fdwtr Htr	1,5	N	N	N	N	N	N	N
MO Valve	3201 A,B&C	RFP Disch Isolation	1	N	N	N	N	N	N	N
Reactor Feed Pump	3201 A,B&C	Reactor Feed Pump	1	N	N	N	N	N	N	N
MO Valve	3202 A,B&C	HP Fdwtr Inlet Isolation	1,5	N	N	N	N	N	N	N
MO Valve	3203	Heater Bypass	5	N	N	N	N	N	N	N
MO Valve	3204 A,B&C	HP Heater Disch Isolation	1,5	N	N	N	N	N	N	N
MO Valve	3205 A&B	Feed Header Isolations	1	N	N	N	N	N	N	N
MO Valve	3206 A&B	FCV Isolations	1,7	N	N	N	N	N	N	N
MO Valve	3207 A&B	AO 1-0643 Isolations	1,7	N	N	N	N	N	N	N
Check Valve	3208 A,B&C	RFP Discharge	1	N	N	N	N	N	N	N
Globe Valve	3299-0127 V15	Drain	9	N	N	N	S	N	N	N

Globe Valve	3299-0132 V15	Drain	9	N	N	N	S	N	N	N
Globe Valve	3299-0133 V15	Drain	9	N	N	N	S	N	N	N
MO Valve	3401A,B,C	RFP Disch	1	N	N	N	N	N	N	N

Table A-2
FEEDWATER SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4,N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
MO Valve	3402A,B,C	HP Htr Inlet Isolation	1,5	N	N	N	N	N	N	N
MO Valve	3403	Bypass	5	N	N	N	N	N	N	N
Manual Valve	3299-15	Drain	9	N	N	N	N	N	N	N
Manual Valve	3299-16	Drain	9	N	N	N	N	N	N	N
Manual Valve	3299-17	Drain	9	N	N	N	N	N	N	N
Manual Valve	3213A	Min Flow A	9	N	N	N	N	N	N	N
Manual Valve	3213B	Min Flow B	9	N	N	N	N	N	N	N
Manual Valve	3213C	Min Flow C	9	N	N	N	N	N	N	N
LP Feedwater Heater	A1,2,3-3101	LP Feedwater Heater	6	N	N	N	N	N	N	N
Drain Cooler	A1,2,3-3102	Drain Cooler	6	N	N	N	N	N	N	N
LP Feedwater Heater	B1,2,3-3103	LP Feedwater Heater	6	N	N	N	N	N	N	N
LP Feedwater Heater	C1,2,3-3104	LP Feedwater Heater	6	N	N	N	N	N	N	N
Gate Valve	220-0057A&B V15	Maintenance Valve	1,3,4	P	A	N	I	N	P	N
Swing Check Valve	220-0058A&B V25	Inbd Containment	1,2,3,4	P	A	N	I	N	P	N
Swing Check Valve	220-0062A&B V25	Outbd Containment	1,2,3,4	P	A	N	I	N	A	N
Globe Valve	220-0086A&B V15	Instrument	9	P	A	N	I	N	P	N
Globe Valve	220-0115A&B V15	Drain	9	P	A	N	I	N	P	N
Globe Valve	220-0116A&B V15	Drain	9	P	A	N	I	N	P	N
Globe Valve	3299-0122 V15	Vent	9	P	A	N	I	N	P	N
Globe Valve	3299-0123 V15	Vent	9	P	A	N	I	N	P	N
Globe Valve	3299-0124 V15	Drain	9	P	A	N	I	N	P	N
Globe Valve	3299-0125 V15	Drain	9	P	A	N	I	N	P	N

Table A-2
FEEDWATER SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4,N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
Globe Valve	3299-0128 V15	Vent	9	P	A	N	I	N	P	N
Globe Valve	3299-0129 V15	Vent	9	P	A	N	I	N	P	N
Globe Valve	3299-0130 V15	Drain	9	P	A	N	I	N	P	N
Globe Valve	3299-0131 V15	Drain	9	P	A	N	I	N	P	N
Swing Check Valve	220-0059 B V25	Upstream HPCI inj	1,3,4	S	B	N	I	N	A	N

Feedwater System Functions	Safety Classification	Safety Significance	Potential Function RISC Category
1. RPV Makeup	Non-Safety	HSS	RISC-2
2. Containment Isolation including all safety class = P	Safety	HSS	RISC-1
3. Provide HPCI, RCIC, RWCU flow path to reactor	Non-Safety	HSS	RISC-2
4. Provide flow path for Zinc/Hydrogen Injection	Non-Safety	LSS	RISC-4
5. High Pressure Feedwater Heating	Non-Safety	LSS	RISC-4
6. Low Presssure Feedwater Heating	Non-Safety	LSS	RISC-4
7. Feedwater Flow Regulation	Non-Safety	HSS	RISC-2
8. Flood Prevention[1]	Non-Safety	LSS	RISC-4
9. Maintenance/Test	Non-Safety	Not in PRA but evaluated as LSS	RISC-4

A.3 STANDBY GAS TREATMENT SYSTEM FUNCTIONS

The functions of the Standby Gas Treatment System (SBGT) are to remove gaseous and particulate radioactive material from the containment atmosphere, in a controlled manner, and to establish secondary containment by maintaining the Reactor Building at a negative pressure of 0.25 inches of water. Although maintaining secondary containment is classified as a safety-related function, other BWROG activities are justifying that such categorization is not necessary.

In addition, SBGT is interconnected, via the containment purge and vent systems, with the primary containment and the primary containment isolation system. In the event of a containment isolation signal the associated primary containment isolation valves close to maintain the primary containment boundary. The containment isolation function is classified as safety-related.

Selected components of the SBGT systems are explicitly included in the Quad Cities PSA. These components are valves used for the purpose of system isolation (e.g., Primary Containment Isolation, isolation from Augmented Primary Containment Vent system during Post-Accident Venting). The secondary containment pressure maintenance function is implicitly modeled in the PSA in the turbine trip initiating event frequency. The filtration function of SBGT is not explicitly or implicitly credited in the PSA.

SBGT System Description

SBGT is provided with two redundant filter trains. One train is continuously maintained in the primary (selected) mode. This train will start automatically on receipt of an initiating signal. The second train is maintained in a standby mode and acts as a backup to the primary train. Each train consists of a demister, an electric heater, rough and high efficiency prefilters, an activated carbon iodine adsorber, a high efficiency afterfilter and a fan, as well as controls and instrumentation. Dampers are provided to align the exhaust gas flow path through the SBGT system.

The SBGT system is common to both units at Quad Cities. Gases enter the SBGT system from the torus/drywell or the reactor building of either Unit 1 or 2. Venting air from the reactor building does not interfere with primary containment pressure control using the Torus/Drywell Vent. In this

way the secondary containment is not compromised.

The gases from the reactor building pass through the normally open SBGT isolation dampers, MO1-7503 and MO2-7503. Upon automatic system initiation, the damper for the unit not requiring the SBGT system closes. The gases from the reactor building or torus/drywell then pass through one of the two SBGT filter trains. The inlet dampers to the SBGT filter trains, MO1/2-7505A(B), are normally closed. Automatic or manual system initiation causes one of the dampers to open, admitting air to the primary train. The outside air (turbine building) supply dampers, MO1/2-7504A(B), are normally open and receive a signal to close on either manual or automatic start of the associated SBGT train. The gas flow rate through the SBGT system is regulated by the flow control dampers, AO1/2-7510A(B), which are controlled using a signal from a flow element located on the suction piping, upstream of the train inlet damper. The damper is normally open and fails open on a loss of instrument air. The fan discharge dampers, MO1/2-7507A(B), are normally closed but open automatically upon system initiation.

Emergency operating procedures allow the primary containment pressure and post-accident hydrogen accumulation to be controlled by using certain SBGT valves to vent the containment. Operators are directed to limit the total amount of the radioactive release by controlling and maintaining pressure or hydrogen concentration below their applicable limits rather than maintaining a continuous vent path.

SBGT Component Descriptions

Demister

The first component in the SBGT filter train is the demister. The demister reduces the moisture content of the incoming gases. Moisture is removed from the gases to prevent condensation on the filters, which would lower filter efficiency. The demister consists of a two-inch layer of teflon yarn that is held together by a stainless steel mesh. Water that is removed by the demister is collected and drained to the Reactor Building Equipment Drain Tank (RBEDT) through a loop seal arrangement.

Electric Heater

Upon leaving the demister, the exhaust gases pass through an electric heater. The electric heater, 1/2-A(B)-7503, raises the air temperature sufficiently to lower the relative humidity to less than 70%. The relative humidity is reduced to allow more efficient operation of the charcoal adsorbers. The heater is thermostatically controlled, and energizes automatically as the train starts operating.

Prefilters

The rough prefilter, 1/2-A-7510 or 1/2-B-7510, consists of two inches of fiberglass which removes dust and lint from the gases. The high efficiency prefilter, 1/2-A(B)-7502, then removes 99.7% of the particles larger than 0.3 micron. It is composed of two-inch thick waterproof fire retardant fiberglass pads within a cadmium plated steel frame.

Charcoal Bed Adsorber

Upon exiting the high efficiency prefilter, the exhaust gases pass though the charcoal bed adsorber, 1/2-A(B)-7509. The adsorber consists of non-regenerative, activated charcoal treated with potassium iodide (KI3) to increase its methyl iodide retention.

High Efficiency Afterfilter

The next component in the filter train is the high efficiency afterfilter, 1/2-A(B)-7504, which removes particulates and carbon dust which may be carried from the charcoal bed. The afterfilter is identical to the high efficiency prefilter.

Fans

The final component of the filter train is the fan. The fan provides the motive force for the system. It is located downstream of the process filters to minimize contamination.

Table A-3
SBGT SYSTEM COMPONENTS

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4, N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
Ball Valve	7599 0021 A,B	Afterfilter DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0022 A,B	Afterfilter DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0023 A,B	Adsorber DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0024 A,B	Adsorber DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0025 A,B	Prefilter DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0026 A,B	Prefilter DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0027 A,B	Roughing Filter DP Isolation	4	#	N	N	S	N	P	N
Ball Valve	7599 0028 A,B	Roughing Filter DP Isolation	4	#	N	N	S	N	P	N
Ball Valve	7599 0029 A,B	Dimister DP Isol	4	#	N	N	S	N	P	N
Ball Valve	7599 0030 A,B	Dimister DP Isol	4	#	N	N	S	N	P	N
Indicating Light	7504 A,B GIL	Train Inlet fm TB	5	I	N	E	I	N	D	2
Indicating Light	7504 A,B RIL	Train Inlet fm TB	5	I	N	E	I	N	D	2
Indicating Light	7505 A,B GIL	Train Inlet Isolation	1,2,3	I	N	E	I	N	D	2
Indicating Light	7505 A,B RIL	Train Inlet Isolation	1,2,3	I	N	E	I	N	D	2
Indicating Light	7507 A,B GIL	Train Outlet Isolation	1,2,3	I	N	E	I	N	D	2
Indicating Light	7507 A,B RIL	Train Outlet	1,2,3	I	N	E	I	N	D	2
Plug Valve	7599 0001	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0002	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0003	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0004	Filter Train Drain	4	I	N	N	I	N	P	N

Table A-3
SBGT SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4, N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
Plug Valve	7599 0005	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0006	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0007	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0008	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0009	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0010	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0011	Filter Train Drain	4	I	N	N	I	N	P	N
Plug Valve	7599 0012	Filter Train Drain	4	I	N	N	I	N	P	N
Globe Valve	7599 0031 A,B	Train Cross-tie	4	I	N	N	I	N	P	N
Motor	7509 LOF	Train Cross-tie	4	N	N	N	S	N	N	N
Check Valve	7599 0032 A,B	7510 A.B Instrument Air Check Valve	4	N	N	N	S	N	N	N
Check Valve	7599 0033 A,B	7510 A.B Instrument Air Check Valve	4	N	N	N	S	N	N	N
AO Valve	7599 0034 A,B	7510 A,B Air Operator PCV	4	N	N	N	S	N	N	N
Ball Valve	7599 0035 A,B	7510 A,B Air Operator Pneumatic Supply	4	N	N	N	S	N	N	N
Ball Valve	7599 0036 B	7510 B Air Operator Pneumatic Isol	4	N	N	N	S	N	N	N
Ball Valve	7599 0037 A,B	Air Accumulator Tank Drain	4	N	N	N	S	N	N	N

Table A-3
SBGT SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4, N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
Ball Valve	7599 0040 A,B	7510 A,B Air Operator Test Line	4	N	N	N	S	N	N	N
Demister	7501 A,B F10	Train Demister	1,2,3	S	N	N	I	N	P	N
Filter	7502 A,B F10	Train High Eff. Filter	1,2,3	S	N	N	I	N	P	N
Heater	7503 A,B H10	Train Heater	1,2,3	S	N	N	I	3	N	N
Actuator	7503 L05 Q1,Q2	RB Suction	1,2,3	S	N	E	I	4	A	N
MO BFLY Valve	7503 V71 Q1,Q2	RB Suction	1,2,3	S	N	N	I	N	A	N
Filter	7504 A,B F10	Train Inlet fm TB	5	S	N	N	I	N	P	N
Valve Motor	7504 A,B L05	Train Inlet fm TB	5	S	N	E	I	1	A	N
MO BFLY Valve	7504 A,B V71	Train Inlet fm TB	5	S	N	N	I	N	A	N
Valve Motor	7505 A,B L05	Train Inlet Isolation	1,2,3	S	N	E	I	1	A	N
MO BFLY Valve	7505 A,B V71	Train Inlet Isolation	1,2,3	S	N	N	I	N	A	N
Fan	7506 A,B F05	Train Fan	1,2,3	S	N	N	I	N	A	N
Motor	7506 A,B M10	Train Fan	1,2,3	S	N	E	I	1	A	N
Valve Motor	7507 A,B L05	Train Outlet	1,2,3	S	N	E	I	1	A	N
MO BFLY Valve	7507 A,B V71	Train Outlet	1,2,3	S	N	N	I	N	A	N
Adsorber	7509 A,B A05	Train Adsorber	1,2,3	S	N	N	I	N	P	N
MO BFLY Valve	7509 V71	Train Cross-tie	4	S	N	N	I	N	P	N
Air Operator	7510 A.B A12	Train Outlet Isolation	1,2,3	S	N	N	I	N	A	N
Filter	7510 A.B F10	Train Rough Filter	1,2,3	S	N	N	I	N	P	N
AO BFLY Valve	7510 A.B V71	Train Outlet Isolation	1,2,3	S	N	N	I	N	A	N

Table A-3
SBGT SYSTEM COMPONENTS (CONTINUED)

Component	EID Number	Component Description	Function	Safety class P,S,A,I,R,#,N	ASME Class A,B,C,N	Electrical E,N	Seismic I,Q,S,N	EQ 1,2,3,4, N	Oper Mode A,P,D,N	RG 1.97 1,2,3,N
Globe Valve	7599 0013	Demister B Loop Seal Isolation	4	S	N	N	I	N	P	N
Globe Valve	7599 0014	Demister B Loop Seal Isolation	4	S	N	N	I	N	P	N
Ball Valve	7599 0017 A,B	FE Instrument Tap Isolation	4	S	N	N	I	N	P	N
Ball Valve	7599 0018 A,B	FE Instrument Tap Isolation	4	S	N	N	I	N	P	N
Ball Valve	7599 0019 A,B	FE Instrument Tap Test Connection	4	S	N	N	I	N	P	N
Ball Valve	7599 0020 A,B	FE Instrument Tap Test Connection	4	S	N	N	I	N	P	N

SBGTS System Functions	Safety Classification	Safety Significance	Potential Function RISC Category
1. Filter effluent during release to environs	Safety Related	LSS	RISC-3
2. Maintain negative pressure in Secondary Containment	Safety Related	LSS	RISC-3
3. Containment Venting	Non-Safety Related	LSS	RISC-4
4. Maintenance/Test	Non-Safety Related	Not in PRA but evaluated as LSS	RISC-4
5. Turbine Building Vent	Non-Safety Related	Not in PRA but evaluated as LSS	RISC-4

[0] Flood prevention is a passive feature and therefore is not identified in table A-2.