Attachment 1

Instructions for Updating the Technical Specifications

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Attachment 2

Revised Technical Specification Pages

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3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.2 High Pressure Injection (HPI)

LCO 3.5.2 The HPI System shall be OPERABLE with:

a. Two HPI trains OPERABLE;

b. An additional HPI pump OPERABLE;

c. Two LPI-HPI flow paths OPERABLE;

d. Two HPI discharge crossover valves OPERABLE;

e. HPI suction headers cross-connected; and

f. HPI discharge headers separated.

APPLICABILITY: MODES 1 and 2,
MODE 3 with Reactor Coolant System (RCS) temperature > 350°F.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One HPI pump inoperable. OR One or more HPI discharge crossover valve(s) inoperable.	A.1 Restore HPI pump to OPERABLE status. AND A.2 Restore HPI discharge crossover valve(s) to OPERABLE status.	72 hours 72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time of Condition A not met.	B.1 Reduce THERMAL POWER to ≤ 75% RTP.	12 hours
	AND	
	B.2 Verify by administrative means that the ADV flow path for each steam generator is OPERABLE.	12 hours
	AND	
	B.3 Restore HPI pump to OPERABLE status.	30 days from initial entry into Condition A
	AND	
	B.4 Restore HPI discharge crossover valve(s) to OPERABLE status.	30 days from initial entry into Condition A

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One HPI train inoperable.	C.1 ---------NOTE--------- Only required when inoperable HPI train is incapable of automatic actuation and incapable of actuation through remote manual alignment. ----------------------	
	Reduce THERMAL POWER to ≤ 75% RTP.	3 hours
	AND	
	C.2 ---------NOTE--------- Only required when THERMAL POWER ≤ 75% RTP. ----------------------	
	Verify by administrative means that the ADV flow path for each steam generator is OPERABLE.	3 hours
	AND	
	C.3 Restore HPI train to OPERABLE status.	72 hours
D. HPI suction headers not cross-connected.	D.1 Cross-connect HPI suction headers.	72 hours
E. HPI discharge headers cross-connected.	E.1 Hydraulically separate HPI discharge headers.	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. One LPI-HPI flow path inoperable.	F.1 Restore LPI-HPI flow path to OPERABLE status.	72 hours
G. Required Action and associated Completion Time of Condition B, C, D, E, or F not met.	G.1 Be in MODE 3. AND G.2 Reduce RCS temperature to ≤ 350°F.	12 hours 60 hours
H. Two HPI trains inoperable. OR Two LPI-HPI flow paths inoperable.	H.1 Enter LCO 3.0.3.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.2.1	Verify each HPI manual and non-automatic power operated valve in the flow path, that is not locked, sealed, or otherwise secured in position, is in the correct position.	31 days
SR 3.5.2.2	-------------------NOTE-------------------- Not applicable to operating HPI pump(s). -- Vent each HPI pump casing.	 31 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.5.2.3	Verify each HPI pump's developed head at the test flow point is greater than or equal to the required developed head.	In accordance with the Inservice Testing Program
SR 3.5.2.4	Verify each HPI automatic valve in the flow path that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal.	18 months
SR 3.5.2.5	Verify each HPI pump starts automatically on an actual or simulated actuation signal.	18 months
SR 3.5.2.6	Verify, by visual inspection, each HPI train reactor building sump suction inlet is not restricted by debris and suction inlet trash racks and screens show no evidence of structural distress or abnormal corrosion.	18 months
SR 3.5.2.7	Cycle each HPI discharge crossover valve and LPI-HPI flow path discharge valve.	18 months

3.7 PLANT SYSTEMS

3.7.4 Atmospheric Dump Valve (ADV) Flow Paths

LCO 3.7.4 The ADV flow path for each steam generator shall be OPERABLE.

APPLICABILITY: When required by Required Actions B.2 and C.2 of LCO 3.5.2, "High Pressure Injection (HPI)"

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or both required ADV flow path(s) inoperable.	A.1 Be in MODE 3. <u>AND</u> A.2 Reduce RCS temperature to ≤ 350°F.	12 hours 60 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.7.4.1 Cycle the valves which comprise the ADV flow paths.	18 months

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(continued)

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.2 High Pressure Injection (HPI)

BASES

BACKGROUND

The function of the ECCS is to provide core cooling to ensure that the reactor core is protected after any of the following accidents:

a. Loss of coolant accident (LOCA);

b. Rod ejection accident (REA);

c. Steam generator tube rupture (SGTR); and

d. Main steam line break (MSLB).

There are two phases of ECCS operation: injection and recirculation. In the injection phase, all injection is initially added to the Reactor Coolant System (RCS) via the cold legs or Core Flood Tank (CFT) lines to the reactor vessel. After the borated water storage tank (BWST) has been depleted, the recirculation phase is entered as the suction is transferred to the reactor building sump.

The HPI System consists of two independent trains, each of which splits to discharge into two RCS cold legs, so that there are a total of four HPI injection lines. Each train takes suction from the BWST, and has an automatic suction valve and discharge valve which open upon receipt of an Engineered Safeguards Protective System (ESPS) signal. The two HPI trains are designed and aligned such that they are not both susceptible to any single active failure including the failure of any power operating component to operate or any single failure of electrical equipment. The HPI System is not required to withstand passive failures.

There are three ESPS actuated HPI pumps; the discharge flow paths for two of the pumps are normally aligned to automatically support HPI train "A" and the discharge flow path for the third pump is normally aligned to automatically support HPI train "B." The discharge flow paths can be manually aligned such that each of the HPI pumps can provide

(continued)

BASES

BACKGROUND (continued)

flow to either train. At least one pump is normally running to provide RCS makeup and seal injection to the reactor coolant pumps. Suction header cross-connect valves are normally open; cross-connecting the HPI suction headers during normal operation was approved by the NRC in Reference 6. The discharge crossover valves (HP-409 and HP-410) are normally closed; these valves can be used to bypass the normal discharge valves and assure the ability to feed either train's injection lines via HPI pump "B." For each discharge valve and discharge crossover valve, a safety grade flow indicator is provided to enable the operator to throttle flow during an accident to assure that runout limits are not exceeded.

A suction header supplies water from the BWST or the reactor building sump (via the LPI-HPI flow path) to the HPI pumps. HPI discharges into each of the four RCS cold legs between the reactor coolant pump and the reactor vessel. There is one flow limiting orifice in each of the four injection headers that connect to the RCS cold legs. If a pipe break were to occur in an HPI line between the last check valve and the RCS, the orifice in the broken line would limit the HPI flow lost through the break and maximize the flow supplied to the reactor vessel via the other line supplied by the HPI header.

The HPI pumps are capable of discharging to the RCS at an RCS pressure above the opening setpoint of the pressurizer safety valves. The HPI pumps cannot take suction directly from the sump. If the BWST is emptied and HPI is still needed, a cross-connect from the discharge side of the LPI pump to the suction of the HPI pumps would be opened. This is known as "piggy backing" HPI to LPI and enables continued HPI to the RCS.

The HPI System also functions to supply borated water to the reactor core following increased heat removal events, such as MSLBs.

The HPI and LPI (LCO 3.5.3, "Low Pressure Injection (LPI)") components, along with the passive CFTs and the BWST covered in LCO 3.5.1, "Core Flood Tanks (CFTs)," and LCO 3.5.4, "Borated Water Storage Tank (BWST)," provide the cooling water necessary to meet 10 CFR 50.46 (Ref. 1).

(continued)

BASES (continued)

APPLICABLE SAFETY ANALYSES

The LCO helps to ensure that the following acceptance criteria for the ECCS, established by 10 CFR 50.46 (Ref. 1), will be met following a LOCA;

a. Maximum fuel element cladding temperature is ≤ 2200°F;

b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;

c. Maximum hydrogen generation from a zirconium water reaction is ≤ 0.01 times the hypothetical amount generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react;

d. Core is maintained in a coolable geometry; and

e. Adequate long term cooling capability is maintained.

The HPI System is credited in the small break LOCA analysis (Ref. 2). This analysis establishes the minimum required flow and discharge head requirements at the design point for the HPI pumps, as well as the minimum required response time for their actuation. The SGTR and MSLB analyses also credit the HPI pumps, but these events are bounded by the small break LOCA analyses with respect to the performance requirements for the HPI System. The HPI System is not credited for mitigation of a large break LOCA.

During a small break LOCA, the HPI System supplies makeup water to the reactor vessel via the RCS cold legs. The HPI System is actuated upon receipt of an ESPS signal. If offsite power is available, the safeguard loads start immediately. If offsite power is not available, the Engineered Safeguards (ES) buses are connected to the Keowee Hydro Units. The time delay associated with Keowee Hydro Unit startup, HPI valve opening, and pump starting determines the time required before pumped flow is available to the core following a LOCA.

One HPI train provides sufficient flow to mitigate most small break LOCAs. However, for cold leg breaks located on the discharge of the reactor coolant pumps, some HPI injection will be lost out the break; for this case, two HPI trains are required. Thus, three HPI pumps must be OPERABLE to ensure adequate cooling in response to the design basis

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

RCP discharge small break LOCA. Additionally, in the event one HPI train fails to automatically actuate due to a single failure (e.g., failure of HPI pump "C" or HP-26), operator actions from the Control Room are required to cross-connect the HPI discharge headers within 10 minutes in order to provide HPI flow through a second HPI train (Ref. 6).

Hydraulic separation of the HPI discharge headers is required during normal operation to maintain defense-in-depth (i.e., independence of the HPI discharge headers). Additionally, hydraulic separation of the HPI discharge headers ensures that a complete loss of HPI would not occur in the event an accident were to occur with only two of the three HPI pumps OPERABLE coincident with the HPI discharge headers cross-connected. A single active failure of an HPI pump would leave only one HPI pump to mitigate the accident. The remaining HPI pump could experience runout conditions and could fail prior to operator action to throttle flow or start another pump.

Hydraulic separation on the suction side of the HPI pumps could cause a loss of redundancy. With any one of the normally open suction header cross-connect valves closed, a failure of an automatic suction valve to open during an accident could cause two pumps to lose suction. Thus, the suction header cross-connect valves must remain open.

The safety analyses show that the HPI pump(s) will deliver sufficient water for a small break LOCA and provide sufficient boron to maintain the core subcritical.

The HPI System satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

In MODES 1 and 2, and MODE 3 with RCS temperature > 350°F, the HPI System is required to be OPERABLE with:

a. Two HPI trains OPERABLE;

b. An additional HPI pump OPERABLE;

c. Two LPI-HPI flow paths OPERABLE;

d. Two HPI discharge crossover valves OPERABLE;

(continued)

BASES

LCO (continued)

e. HPI suction headers cross-connected; and

f. HPI discharge headers separated.

The LCO establishes the minimum conditions required to ensure that the HPI System delivers sufficient water to mitigate a small break LOCA. Additionally, individual components within the HPI trains may be called upon to mitigate the consequences of other transients and accidents.

Each HPI train includes the piping, instruments, pump, valves, and controls to ensure an OPERABLE flow path capable of taking suction from the BWST and injecting into the RCS cold legs upon an ESPS signal. For an HPI train to be OPERABLE, the associated HPI pump must be capable of taking suction from the BWST through the suction header valve associated with that train upon an ESPS signal. For example:

1) if HPI pump "B" is being credited as part of HPI train "A," then it must be capable of taking suction through HP-24 upon an ESPS signal; or

2) if HPI pump "B" is being credited as part of HPI train "B," then it must be capable of taking suction through HP-25 upon an ESPS signal.

The safety grade flow indicator associated with the normal discharge valve is required to be OPERABLE to support the associated HPI train's OPERABILITY.

To support HPI pump OPERABILITY, the piping, valves and controls which ensure the HPI pump can take suction from the BWST upon an ESPS signal are required to be OPERABLE.

To support HPI discharge crossover valve OPERABILITY, the safety grade flow indicator associated with the HPI discharge crossover valve is required to be OPERABLE.

Each LPI-HPI flow path includes the piping, instruments, valves and controls to ensure the capability to manually transfer suction to the reactor building sump (LPI-HPI flow path). The OPERABILITY requirements regarding the LPI System are addressed in LCO 3.5.3, "Low Pressure Injection (LPI)."

(continued)

BASES

LCO (continued)

During an event requiring HPI actuation, a flow path is provided to ensure an abundant supply of water from the BWST to the RCS via the HPI pumps and their respective discharge flow paths to each of the four cold leg injection nozzles and the reactor vessel. In the recirculation phase, this flow path is manually transferred to take its supply from the reactor building sump and to supply borated water to the RCS via the LPI-HPI flow path (piggy-back mode).

The OPERABILITY of the HPI System must be maintained to ensure that no single active failure can disable both HPI trains. Additionally, while the HPI System was not designed to cope with passive failures, the HPI trains must be maintained independent to the extent possible during normal operation. The NRC approved exception to this principle is cross-connecting the HPI suction headers during normal operation (Ref. 6).

APPLICABILITY

In MODES 1 and 2, and MODE 3 with RCS temperature > 350°F, the HPI System OPERABILITY requirements for the small break LOCA are based on analysis performed at 100% RTP. The HPI pump performance is based on the small break LOCA, which establishes the pump performance curve. Mode 2 and MODE 3 with RCS temperature > 350°F requirements are bounded by the MODE 1 analysis.

In MODE 3 with RCS temperature ≤ 350°F and in MODE 4, the probability of an event requiring HPI actuation is significantly lessened. In this operating condition, the low probability of an event requiring HPI actuation and the LCO 3.5.3 requirements for the LPI System provide reasonable assurance that the safety injection function is preserved.

In MODES 5 and 6, unit conditions are such that the probability of an event requiring HPI injection is extremely low. Core cooling requirements in MODE 5 are addressed by LCO 3.4.7, "RCS Loops—MODE 5, Loops Filled," and LCO 3.4.8, "RCS Loops—MODE 5, Loops Not Filled." MODE 6 core cooling requirements are addressed by LCO 3.9.4, "Decay Heat Removal (DHR) and Coolant Circulation—High Water Level," and LCO 3.9.5, "Decay Heat Removal (DHR) and Coolant Circulation—Low Water Level."

(continued)

BASES (continued)

ACTIONS

A.1 and A.2

With one HPI pump inoperable, or one or more HPI discharge crossover valve(s) (i.e., HP-409 and HP-410) inoperable, the HPI pump and discharge crossover valve(s) must be restored to OPERABLE status within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is based on NRC recommendations (Ref. 4) that are based on a risk evaluation and is a reasonable time for many repairs.

In the event HPI pump "C" becomes inoperable, Condition C must be entered as well as Condition A. Until actions are taken to align an HPI pump to HPI train "B," HPI train "B" is inoperable due to the inability to automatically provide injection in response to an ESPS signal. Additionally, in order to utilize another HPI pump to supply HPI train "B," HP-116 must be opened. This action results in cross-connecting the HPI discharge headers; thus, Condition E must be entered. The HPI discharge headers cannot be separated in this situation, because it would require HPI pumps "A" and "B" to operate with flows less than the minimum requirements.

This Condition permits multiple components of the HPI System to be inoperable concurrently. When this occurs, other Conditions may also apply. For example, if HPI pump "C" and HP-409 are inoperable coincidentally, HPI train "B" is incapable of being automatically actuated or manually aligned from the Control Room. Thus, Required Action C.1 would apply.

B.1, B.2, B.3, and B.4

If the Required Action and associated Completion Time of Condition A is not met, THERMAL POWER of the unit must be reduced to ≤ 75% RTP within 12 hours. The 12 hour Completion Time is reasonable, based on operating experience, to reach the required unit condition from full power conditions in an orderly manner and without challenging unit systems. This time is less restrictive than the Completion Time for Required Action C.1, because the HPI System remains capable of performing its function, barring a single failure.

(continued)

BASES

ACTIONS

B.1, B.2, B.3, and B.4 (continued)

Two HPI trains are required to mitigate specific small break LOCAs, if no credit for enhanced steam generator cooling is assumed in the accident analysis. However, if equipment not qualified as QA-1 (i.e., an atmospheric dump valve (ADV) flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if reactor power is ≤ 75% RTP.

Required Actions B.2, B.3, and B.4 modify the HPI pump and discharge crossover valve OPERABILITY requirements to permit reduced requirements at power levels ≤ 75% RTP for an extended period of time. Required Action B.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is OPERABLE within 12 hours. This compensatory measure provides additional assurance regarding the ability of the plant to mitigate an accident. Compliance with this requirement can be established by ensuring that the ADV flow path for each steam generator is OPERABLE in accordance with LCO 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths."

Required Actions B.3 and B.4 require that the HPI pump and discharge crossover valve(s) be restored to OPERABLE status within 30 days from initial entry into Condition A. The 30-day time period limits the time that the plant can operate while relying on non QA-1 ADVs to provide enhanced steam generator cooling to mitigate small break LOCAs. The 30-day time period is acceptable, because:

1. Without crediting an ADV flow path, the HPI System remains capable of performing the safety function, barring a single failure;
2. If credit is taken for an ADV flow path for a steam generator, the safety analysis has demonstrated that only one HPI train is required to mitigate the consequences of a small break LOCA when THERMAL POWER is ≤ 75% RTP. Thus, for this case, the HPI System would be capable of performing its safety function even with an additional single failure;

(continued)

BASES

ACTIONS

B.1, B.2, B.3, and B.4 (continued)

3. OPERABILITY of the ADV flow path for each steam generator is required to be confirmed by Required Action B.2 within 12 hours. Additional defense-in-depth is provided, because the ADV flow path for only one steam generator is required to mitigate the small break LOCA; and

4. A risk-informed assessment (Ref. 7) concluded that operating the plant in accordance with these Required Actions is acceptable.

C.1, C.2, and C.3

If the plant is operating with THERMAL POWER > 75% RTP, two HPI pumps capable of providing flow through two HPI trains are required. One HPI train is required to provide flow automatically upon receipt of an ESPS signal, while flow through the other HPI train must be capable of being established from the Control Room within 10 minutes. Thus, if the plant is operating at > 75% RTP, and one HPI train is inoperable and incapable of being automatically actuated or manually aligned from the Control Room to provide flow post-accident, the HPI System would be incapable of performing its safety function. For this Condition, Required Action C.1 requires the power to be reduced to ≤ 75% RTP within 3 hours. Required Action C.1 is modified by a Note which limits its applicability to the condition defined above. The 3 hour Completion Time is considered reasonable to reduce the unit from full power conditions to ≤ 75% RTP in an orderly manner and without challenging unit systems. The time frame is more restrictive than the Completion Time provided in Required Action B.1 for the same action, because the condition involves a loss of safety function.

If the plant is operating with THERMAL POWER > 75% RTP and the inoperable HPI train can be automatically actuated or manually aligned to provide flow post-accident, Required Action C.3 permits 72 hours to restore the HPI train to an OPERABLE status.

If enhanced steam generator cooling is not credited in the accident analysis, two HPI trains are required to mitigate specific small break LOCAs with THERMAL POWER ≤ 75% RTP. However, if equipment not qualified as QA-1 (i.e., an ADV

(continued)

BASES

ACTIONS

C.1, C.2, and C.3 (continued)

flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if THERMAL POWER is ≤ 75% RTP. In order to permit an HPI train to be inoperable regardless of the reason when THERMAL POWER is ≤ 75% RTP, Required Action C.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is OPERABLE within 3 hours. This Required Action is modified by a Note which states that it is only required if THERMAL POWER is ≤ 75% RTP. This compensatory measure provides assurance regarding the ability of the plant to mitigate an accident while in the Condition and THERMAL POWER ≤ 75% RTP. Compliance with this requirement can be established by ensuring that the ADV flow path for each steam generator is OPERABLE in accordance with LCO 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths."

With one HPI train inoperable, the inoperable HPI train must be restored to OPERABLE status within 72 hours. This action is appropriate because:

1. With THERMAL POWER ≤ 75% RTP, the safety analysis demonstrates that only one HPI train is required to mitigate the consequences of a small break LOCA assuming credit is taken for the ADV flow path for one steam generator. The OPERABILITY of the ADV flow path for each steam generator is confirmed by Required Action C.2 within 3 hours. This provides additional defense-in-depth. Additionally, a risk-informed assessment (Ref. 7) concluded that operating the plant in accordance with this Required Action is acceptable.

2. With THERMAL POWER > 75% RTP, the remaining OPERABLE HPI train is capable of automatic actuation, and the inoperable train can be manually aligned by operator action to cross-connect the discharge headers of the HPI trains. This manual action was approved by the NRC in Reference 6.

(continued)

BASES

ACTIONS (continued)

D.1

With the HPI suction headers not cross-connected, the HPI suction headers must be cross-connected within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is based on NRC recommendations (Ref. 4) that are based on a risk evaluation and is a reasonable time for many repairs.

An argument similar to that utilized for Required Actions B.2, B.3, and B.4 could have been made for operating the HPI System with the suction headers not cross-connected for an extended period of time. However, this action was not considered prudent, due to the potential of damaging two HPI pumps in the event HP-24 or HP-25 failed to open in response to an ESPS signal while the HPI suction headers were not cross-connected.

E.1

With the HPI discharge headers cross-connected, the independence of the HPI trains is not being maintained to the extent practical (i.e., defense-in-depth principle is not met). Thus, the HPI discharge headers must be hydraulically separated within 72 hours. This action limits the time period that the HPI discharge headers may be cross-connected. The 72-hour allowed outage time is acceptable, because cross-connecting the HPI discharge headers in conjunction with:

1. the rest of the HPI System being OPERABLE would not result in the inability of the HPI System to perform its safety function even assuming a single active failure; and

2. an HPI pump being inoperable would not result in the inability of the HPI System to perform its safety function, barring a single failure. However, in this condition, a single active failure of one of the two remaining OPERABLE HPI pumps could result in the remaining HPI pump failing due to runout.

(continued)

BASES

ACTIONS (continued)

F.1

With one LPI-HPI flow path inoperable, the inoperable LPI-HPI flow path must be restored to OPERABLE status within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is justified because there is a limited range of break sizes, and therefore a lower probability for a small break LOCA which would require piggy back operation.

G.1 and G.2

If a Required Action and associated Completion Time of Condition B, C, D, E, or F are not met, the unit must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit must be brought to at least MODE 3 within 12 hours and the RCS temperature reduced to ≤ 350°F within 60 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

H.1

If two HPI trains are inoperable or two LPI-HPI flow paths are inoperable, the HPI System is incapable of performing its safety function and in a condition not explicitly addressed in the Actions for ITS 3.5.2. Thus, immediate plant shutdown in accordance with LCO 3.0.3 is required.

SURVEILLANCE REQUIREMENTS

SR 3.5.2.1

Verifying the correct alignment for manual and non-automatic power operated valves in the HPI flow paths provides assurance that the proper flow paths will exist for HPI operation. This SR does apply to the HPI suction header cross-connect valves, the HPI discharge cross-connect valves, the HPI discharge crossover valves, and the LPI-HPI flow path discharge valves (LP-15 and LP-16). This SR does not apply to valves that are locked, sealed, or otherwise secured in position, since these valves were verified to be in the correct position prior to locking, sealing, or securing. Similarly, this SR does not apply to automatic valves since automatic valves actuate to their required

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.2.1 (continued)

position upon an accident signal. This Surveillance does not require any testing or valve manipulation; rather, it involves verification that those valves capable of being mispositioned are in the correct position. The 31 day Frequency is appropriate because the valves are operated under administrative control. This Frequency has been shown to be acceptable through operating experience.

SR 3.5.2.2

With the exception of the HPI pump operating to provide normal makeup, the other two HPI pumps are normally in a standby, non-operating mode. As such, the emergency injection flow path piping has the potential to develop voids and pockets of entrained gases. Venting the HPI pump casings periodically reduces the potential that such voids and pockets of entrained gases can adversely affect operation of the HPI System. This will also reduce the potential for water hammer, pump cavitation, and pumping of noncondensible gas (e.g., air, nitrogen, or hydrogen) into the reactor vessel following an ESPS signal. This Surveillance is modified by a Note that indicates it is not applicable to operating HPI pump(s) providing normal makeup. The 31 day Frequency takes into consideration the gradual nature of gas accumulation in the HPI piping and the existence of procedural controls governing system operation.

SR 3.5.2.3

Periodic surveillance testing of HPI pumps to detect gross degradation caused by impeller structural damage or other hydraulic component problems is required by Section XI of the ASME Code (Ref. 5). SRs are specified in the Inservice Testing Program, which encompasses Section XI of the ASME Code.

SR 3.5.2.4 and SR 3.5.2.5

These SRs demonstrate that each automatic HPI valve actuates to the required position on an actual or simulated ESPS signal and that each HPI pump starts on receipt of an actual or simulated ESPS signal. This SR is not required for valves that are locked, sealed, or otherwise secured in position under administrative controls. The test will be

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.2.4 and SR 3.5.2.5 (continued)

considered satisfactory if control board indication verifies that all components have responded to the ESPS actuation signal properly (all appropriate ESPS actuated pump breakers have opened or closed and all ESPS actuated valves have completed their travel). The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a unit outage and the potential for an unplanned transient if the Surveillance were performed with the reactor at power. The 18 month Frequency is also acceptable based on consideration of the design reliability (and confirming operating experience) of the equipment. The actuation logic is tested as part of the ESPS testing, and equipment performance is monitored as part of the Inservice Testing Program.

SR 3.5.2.6

Periodic inspections of the reactor building sump suction inlet (for LPI-HPI flow path) ensure that it is unrestricted and stays in proper operating condition. The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a unit outage, on the need to preserve access to the location, and on the potential for an unplanned transient if the Surveillance were performed with the reactor at power. This Frequency has been found to be sufficient to detect abnormal degradation and has been confirmed by operating experience.

SR 3.5.2.7

Periodic stroke testing of the HPI discharge crossover valves (HP-409 and HP-410) and LPI-HPI flow path discharge valves (LP-15 and LP-16) is required to ensure that the valves can be manually cycled. The HPI discharge crossover valves must be capable of being stroked from the Control Room. The LPI-HPI flow path discharge valves must be capable of being stroked locally. This test is performed on an 18-month Frequency. Operating experience has shown that these components usually pass the surveillance when performed at this Frequency. Therefore, the Frequency is acceptable from a reliability standpoint.

(continued)

BASES (continued)

REFERENCES

1. 10 CFR 50.46.

2. UFSAR, Section 15.14.3.3.6.

3. 10 CFR 50.36.

4. NRC Memorandum to V. Stello, Jr., from R.L. Baer, "Recommended Interim Revisions to LCOs for ECCS Components," December 1, 1975.

5. ASME, Boiler and Pressure Vessel Code, Section XI, Inservice Inspection, Article IWV-3400.

6. Letter from R. W. Reid (NRC) to W. O. Parker, Jr. (Duke) transmitting Safety Evaluation for Oconee Nuclear Station, Units Nos. 1, 2, and 3, Modifications to the High Pressure Injection System, dated December 13, 1978.

7. Letter from W. R. McCollum (Duke) to the U. S. NRC, "Proposed Amendment to the Facility Operating License Regarding the High Pressure Injection System Requirements," dated December 16, 1998.

B 3.7 PLANT SYSTEMS

B 3.7.4 Atmospheric Dump Valve (ADV) Flow Paths

BASES

BACKGROUND

The ADV flow path for each steam generator is credited as a compensatory measure in Actions B and C of LCO 3.5.2, "High Pressure Injection (HPI)," to permit operation to continue with THERMAL POWER ≤ 75% RTP: a) for 30 days with an HPI pump or HPI discharge crossover valve(s) inoperable; and b) for 72 hours with an HPI train inoperable.

During these periods of time, the ADV flow path for one steam generator is credited to depressurize the steam generator and enhance primary-to-secondary heat transfer during certain small break loss of coolant accidents (LOCAs). This is done in conjunction with the secondary cooling water from the Emergency Feedwater (EFW) System. The preferred heat sink via the Turbine Bypass System to the condenser may not be available following a small break LOCA.

For each steam generator, the ADV flow path is comprised of the atmospheric dump block valve bypass (1″ bypass), the atmospheric vent valve (a 12″ block valve), the atmospheric dump control valve (i.e., throttle valve), and the atmospheric vent block valve (i.e., isolation valve). The throttle valve and the isolation valve are in parallel and are located downstream of the atmospheric vent valve.

The atmospheric vent valve should be opened prior to opening the throttle valve or isolation valve. This is accomplished by first opening the atmospheric dump block valve bypass. This equalizes the differential pressure across the atmospheric vent valve. Once the atmospheric vent valve is opened, the cool down rate is controlled using the throttle valve. If additional relief capacity is needed, the isolation valve can be opened. The capacity of the throttle or isolation valve exceeds decay heat loads and is sufficient to cool down the plant.

(continued)

BASES (continued)

APPLICABLE SAFETY ANALYSES

If enhanced steam generator cooling is not credited in the small break LOCA analysis, two HPI trains are required to mitigate specific small break LOCAs. However, if equipment not qualified as QA-1 (i.e., an ADV flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if THERMAL POWER is ≤ 75% RTP.

The analysis for Action C of LCO 3.5.2, "High Pressure Injection (HPI)," credits an ADV flow path for one steam generator as a compensatory measure in the event an HPI train is inoperable and THERMAL POWER is ≤ 75% RTP. During this situation, the ADV flow path for one steam generator is credited during certain small break LOCAs to depressurize the steam generator and enhance primary-to-secondary heat transfer. This is done in conjunction with the EFW System providing cooling water to the steam generator. The ADV flow path is comprised of manual valves. Operator action is credited within 25 minutes of an Engineered Safeguards Protective System (ESPS) signal to open them.

Additionally, the ADV flow path for each steam generator is credited as a compensatory measure in the analysis for Action B of LCO 3.5.2, "High Pressure Injection (HPI)," to permit an HPI pump or HPI discharge crossover valve(s) to be inoperable for 30 days with the THERMAL POWER ≤ 75% RTP. Typically, single failures are not considered once the plant has entered a condition defined in the Technical Specifications. However, the Completion Time permitted by Required Actions B.3 and B.4 of LCO 3.5.2, "High Pressure Injection (HPI)," is an extended period of time (i.e., 30 days). In the event an accident occurred during this 30-day Completion Time and a single failure were to occur in the degraded HPI System, the ability of a plant to mitigate the consequences of specific small break LOCAs continues to be assured by the ADV flow path for one steam generator.

The ADV flow path satisfies Criterion 3 of 10 CFR 50.36 (Ref.1).

(continued)

BASES (continued)

LCO

The ADV flow path for each steam generator is required to be OPERABLE. Failure to meet the LCO can result in the inability to depressurize a steam generator following a small break LOCA. This function is required to support operation with a degraded HPI System when THERMAL POWER is ≤ 75% RTP.

An ADV flow path is considered OPERABLE when it is capable of providing a controlled relief of the main steam flow, and each valve which comprises the ADV flow path is capable of opening and closing.

APPLICABILITY

When required by Required Actions B.2 and C.2 of LCO 3.5.2, "High Pressure Injection (HPI)," the ADV flow path for each steam generator is required to be OPERABLE.

For all other conditions, an ADV flow path is not credited for mitigating a small break LOCA to satisfy the conditions of 10 CFR 50.46.

ACTIONS

A.1 and A.2

With one or both of the required ADV flow path(s) inoperable, the unit must be placed in a condition in which the LCO does not apply. The ADV flow path for each steam generator is required to support operation with a degraded HPI System. Thus, the unit must be placed in a condition outside the Applicability of LCO 3.5.2, "High Pressure Injection (HPI)." To achieve this status, the unit must be placed in at least MODE 3 within 12 hours, and RCS temperature reduced to ≤ 350°F within 60 hours. The Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems. They are consistent with the Completion Times provided in Required Actions G.1 and G.2 of LCO 3.5.2, "High Pressure Injection (HPI)."

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.7.4.1

To perform a controlled cool down of the RCS, the valves which comprise the ADV flow path for each steam generator must be able to perform the following functions:

a) the atmospheric dump block valve bypass and the atmospheric vent valve must be capable of being opened and closed; and

b) the atmospheric dump control valve and atmospheric vent block valve must be capable of being opened and throttled through their full range.

This SR ensures that the valves which comprise the ADV flow path for each steam generator are tested through a full control cycle at least once per 18 months. Performance of inservice testing or use of an ADV flow path during a unit cool down may satisfy this requirement. Operating experience has shown that these components usually pass the Surveillance when performed at the 18 month Frequency. Therefore, the Frequency is acceptable from a reliability standpoint.

REFERENCES

1. 10 CFR 50.36.

Attachment 3

Markup of Improved Technical Specifications

TABLE OF CONTENTS

(continued)

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.2 High Pressure Injection (HPI)

LCO 3.5.2 Two HPI trains and two LPI-HPI flow paths shall be OPERABLE.

INSERT A

---NOTE---
When THERMAL POWER is > 60% RTP, three HPI pumps and the HPI discharge crossover valves shall be OPERABLE and the suction header shall be cross-connected.

APPLICABILITY: MODES 1 and 2,
MODE 3 with Reactor Coolant System (RCS) temperature > 350°F.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One HPI pump inoperable with THERMAL POWER > 60% RTP. <u>OR</u> One or more HPI discharge crossover valve(s) inoperable with THERMAL POWER > 60% RTP. <u>OR</u>	A.1 Restore HPI pump to OPERABLE status. <u>AND</u>	72 hours
	A.2 Restore HPI discharge crossover valve(s) to OPERABLE status. <u>AND</u>	72 hours
D. HPI suction header not cross-connected with THERMAL POWER > 60% RTP.	A.3 D.1 Cross-connect HPI suction header(s).	72 hours

(continued)

Insert A

The HPI System shall be OPERABLE with:

a. Two HPI trains OPERABLE;

b. An additional HPI pump OPERABLE;

c. Two LPI-HPI flow paths OPERABLE;

d. Two HPI discharge crossover valves OPERABLE;

e. HPI suction headers cross-connected; and

f. HPI discharge headers separated.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time of Condition A not met.	B.1 Reduce THERMAL POWER to ≤ 60% RTP.	12 hours
C. One LPI-HPI flow path inoperable.	C.1 Restore LPI-HPI flow path to OPERABLE status.	72 hours
D. One HPI train incapable of being automatically actuated but capable of being manually actuated with THERMAL POWER > 60% RTP. OR One HPI train inoperable with THERMAL POWER ≤ 60% RTP.	D.1 Restore capability to automatically actuate train. AND D.2 Restore train to OPERABLE status.	24 hours 24 hours
E. Required Action and associated Completion Time of Condition C or D not met.	E.1 Be in MODE 3. AND E.2 Reduce RCS temperature to ≤ 350°F.	12 hours 60 hours

Insert B

CONDITION	REQUIRED ACTION	COMPLETION TIME
	...	
	AND	
	B.2 Verify by administrative means that the ADV flow path for each steam generator is OPERABLE.	12 hours
	AND	
	B.3 Restore HPI pump to OPERABLE status.	30 days from initial entry into Condition A
	AND	
	B.4 Restore HPI discharge crossover valve(s) to OPERABLE status.	30 days from initial entry into Condition A

Insert C

CONDITION	REQUIRED ACTION	COMPLETION TIME
	C.1 ---------NOTE---------- Only required when inoperable HPI train is incapable of automatic actuation and incapable of actuation through remote manual alignment. -----------------------	
	Reduce THERMAL POWER to ≤ 75% RTP.	3 hours
	AND	
	C.2 ----------NOTE--------- Only required when THERMAL POWER ≤ 75% RTP. -----------------------	
	Verify by administrative means that the ADV flow path for each steam generator is OPERABLE.	3 hours
	AND	
	...	

Insert D

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. HPI discharge headers cross-connected.	E.1 Hydraulically separate HPI discharge headers.	72 hours

Insert E

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. Two HPI trains inoperable. OR Two LPI-HPI flowpaths inoperable.	H.1 Enter LCO 3.0.3.	Immediately

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.5.2.1	Verify each HPI manual and non-automatic power operated valve in the flow path, that is not locked, sealed, or otherwise secured in position, is in the correct position.	31 days
SR 3.5.2.2	-------------------NOTE-------------------- Not applicable to operating HPI pump(s). -- Vent each HPI pump casing.	31 days
SR 3.5.2.3	Verify each HPI pump's developed head at the test flow point is greater than or equal to the required developed head.	In accordance with the Inservice Testing Program
SR 3.5.2.4	Verify each HPI automatic valve in the flow path that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal.	18 months
SR 3.5.2.5	Verify each HPI pump starts automatically on an actual or simulated actuation signal.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.5.2.6	Verify, by visual inspection, each HPI train reactor building sump suction inlet is not restricted by debris and suction inlet trash racks and screens show no evidence of structural distress or abnormal corrosion.	18 months
SR 3.5.2.7	Cycle each LPI discharge valve to the LPI-HPI flow path open manually.	18 months

3.7 PLANT SYSTEMS

3.7.4 Not used

INSERT ITS 3.7.4, "Atmospheric Dump Valve (ADV) Flow PATHS"

TABLE OF CONTENTS

(continued)

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.2 High Pressure Injection (HPI)

BASES

BACKGROUND

The function of the ECCS is to provide core cooling to ensure that the reactor core is protected after any of the following accidents:

a. Loss of coolant accident (LOCA);

b. Rod ejection accident (REA);

c. Steam generator tube rupture (SGTR); and

d. Main steam line break (MSLB).

There are two phases of ECCS operation: injection and recirculation. In the injection phase, all injection is initially added to the Reactor Coolant System (RCS) via the cold legs or Core Flood Tank (CFT) lines to the reactor vessel. After the borated water storage tank (BWST) has been depleted, the recirculation phase is entered as the suction is transferred to the reactor building sump.

The HPI System consists of two ~~redundant~~ independent trains, each of which splits to discharge into two RCS cold legs, so that there are a total of four HPI injection lines. Each train takes suction from the BWST, and has an automatic suction valve and discharge valve which open upon receipt of an Engineered Safeguards Protective System (ESPS) signal. The two HPI trains are designed and aligned such that they are not both susceptible to any single active failure including the failure on of any power operating component to operate or any single failure of electrical equipment. The HPI System is not required to withstand passive failures. INSERT A There are three ESPS actuated HPI pumps; ~~each of which can provide flow to either train.~~ At least one pump is normally running ~~providing~~ to provide RCS makeup and seal injection to the reactor coolant pumps. Suction header cross-connect valves are normally open; Cross-connecting the HPI Suction headers during normal operation was approved by the NRC in Reference 6. The ~~and~~ discharge ~~header~~ cross-~~connect~~ over valves (HP-409 and HP-410) are normally closed; ~~Additional discharge valves (HPI discharge crossover valves)~~ these valves can be used to bypass the normal discharge valves and assure the ability to feed either train's injection lines ~~from the pump(s) on the other train.~~ via HPI pump "B". For each discharge valve and discharge crossover valve, A safety grade flow indicator is provided to enable the operator ~~for the flow path associated with each of these four discharge valves. These~~

(continued)

INSERT A

the discharge flow paths for two of the pumps are normally aligned to automatically support HPI train "A" and the discharge flow path for the third pump is normally aligned to automatically support HPI train "B." The discharge flow paths can be manually aligned such that each of the HPI pumps can provide flow to either train.

BASES

BACKGROUND (continued)

~~indicators are required to be OPERABLE to support HPI OPERABILITY and are needed~~ to throttle ~~HPI~~ flow during an accident to assure that runout limits are not exceeded.

~~To fulfill HPI ECCS heat removal requirements during a small break LOCA with the reactor above 350°F, one HPI pump is assumed to inject immediately through one HPI train upon ESPS actuation. If THERMAL POWER is above 60% RTP, there are additional HPI System heat removal requirements to mitigate the consequences of certain small break LOCAs. Three HPI pumps must be OPERABLE to ensure adequate cooling in response to the design basis RCP discharge small break LOCA. If one HPI train fails to actuate, and the break location is such that full flow from only one of the two injection lines of the other HPI train actually reaches the reactor, at least one HPI pump is assumed to provide flow through the automatically actuating train and injection through the other HPI train must occur within 10 minutes.~~

A suction header supplies water from the BWST or the reactor building sump (via the LPI-HPI flow path) to the HPI pumps. HPI discharges into each of the four RCS cold legs between the reactor coolant pump and the reactor vessel. There is one flow limiting orifice in each of the four injection headers that connect to the RCS cold legs. If a pipe break were to occur in an HPI line between the last check valve and the RCS, the orifice in the broken line would limit the HPI flow lost through the break and ~~increase~~ maximize the flow supplied to the reactor vessel via the other line supplied by the HPI header.

The HPI pumps are capable of discharging to the RCS at an RCS pressure above the opening setpoint of the pressurizer safety valves. The HPI pumps cannot take suction directly from the sump. If the BWST is emptied and HPI is still needed, a cross-connect from the discharge side of the LPI pump to the suction of the HPI pumps would be opened. This is known as "piggy backing" HPI to LPI and enables continued HPI to the RCS.

(continued)

BASES

BACKGROUND (continued)

The HPI System also functions to supply borated water to the reactor core following increased heat removal events, such as MSLBs.

MOVE TO ASA →

During a small break LOCA, the HPI System supplies makeup water to the reactor vessel via the RCS cold legs. The HPI System is actuated upon receipt of an ESPS signal. If offsite power is available, the safeguard loads start immediately. If offsite power is not available, the Engineered Safeguards (ES) buses are connected to the Keowee Hydro Units. The time delay associated with Keowee Hydro Unit startup, HPI valve opening, and pump starting determines the time required before pumped flow is available to the core following a LOCA.

The HPI and LPI (LCO 3.5.3, "Low Pressure Injection (LPI)") components, along with the passive CFTs and the BWST covered in LCO 3.5.1, "Core Flood Tanks (CFTs)," and LCO 3.5.4, "Borated Water Storage Tank (BWST)," provide the cooling water necessary to meet 10 CFR 50.46 (Ref. 1).

APPLICABLE SAFETY ANALYSES

The LCO helps to ensure that the following acceptance criteria for the ECCS, established by 10 CFR 50.46 (Ref. 1), will be met following a LOCA:

a. Maximum fuel element cladding temperature is ≤ 2200°F;

b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;

c. Maximum hydrogen generation from a zirconium water reaction is ≤ 0.01 times the hypothetical amount generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react; ~~and~~

d. Core is maintained in a coolable geometry~~.~~ ; and

e. Adequate longterm cooling capability is maintained.

The HPI System is credited in the small break LOCA analysis (Ref. 2). This analysis establishes the minimum required flow and discharge head requirements at the design point for

(continued)

, but these events are bounded by the small break LOCA analyses with respect to the performance requirements of the HPI System.

The HPI System is not credited for mitigation of a large break LOCA.

BASES

APPLICABLE SAFETY ANALYSES (continued)

the HPI pumps, as well as the minimum required response time for their actuation. The SGTR and MSLB analyses also credit the HPI pumps ~~but are not limiting in their design~~.

INSERT from BACKGROUND

One HPI ~~pump injecting down one~~ train provides sufficient flow to mitigate most small break LOCAs. However, for cold leg breaks located on the discharge of the reactor coolant pumps, some HPI injection will be lost out the break. ~~For this reason, operator actions are credited to cross-connect the HPI trains when flow in one train is insufficient. The safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if THERMAL POWER is ≤ 60% RTP. For THERMAL POWER levels > 60 RTP%, the additional HPI flow obtained by cross-connecting the HPI trains and the second HPI pump is necessary to mitigate the reactor coolant pump discharge break small break LOCA.~~

INSERT B

INSERT C

Hydraulic separation on the suction side of the HPI pumps could cause a loss of redundancy. With any one of the normally open suction header cross-connect valves closed, a failure of an automatic suction valve to open during an accident could cause two pumps to lose suction. ~~For HPI OPERABILITY above 60% RTP, the suction header cross-connect valves must remain open. However, with THERMAL POWER ≤ 60% RTP, cross-connection is not required since the accident analysis requirements are met with one HPI pump injecting through a single train.~~

Thus, the suction header cross-connect valves must remain open.

The safety analyses show that the HPI pump(s) will deliver sufficient water for a small break LOCA and provide sufficient boron to maintain the core subcritical.

~~In the small break LOCA analyses, only one HPI train is credited after actuation of the ESPS signal. For a large break LOCA, HPI is not credited at all.~~

The HPI ~~trains satisfy~~ System satisfies Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

In MODES 1 and 2, and MODE 3 with RCS temperature > 350°F, ~~two independent HPI trains and two independent LPI-HPI flow paths are required to ensure that at least one HPI train is available, assuming a single failure in the other train.~~

INSERT D

Additionally, individual components within the HPI trains

(continued)

INSERT B

; for this case, two HPI trains are required. Thus, three HPI pumps must be OPERABLE to ensure adequate cooling in response to the design basis RCP discharge small break LOCA. Additionally, in the event one HPI train fails to automatically actuate due to a single failure (e.g., failure of HPI pump "C" or HP-26), operator actions from the Control Room are required to cross-connect the HPI discharge headers within 10 minutes in order to provide HPI flow through a second HPI train (Ref. 6).

INSERT C

Hydraulic separation of the HPI discharge headers is required during normal operation to maintain defense-in-depth (i.e., independence of the HPI discharge headers). Additionally, hydraulic separation of the HPI discharge headers ensures that a complete loss of HPI would not occur in the event an accident were to occur with only two of the three HPI pumps OPERABLE coincident with the HPI discharge headers cross-connected. A single active failure of an HPI pump would leave only one HPI pump to mitigate the accident. The remaining HPI pump could experience runout conditions and could fail prior to operator action to throttle flow or start another pump.

INSERT D

The HPI System is required to be OPERABLE with:

a. Two HPI trains OPERABLE;

b. An additional HPI pump OPERABLE;

c. Two LPI-HPI flow paths OPERABLE;

d. Two HPI discharge crossover valves OPERABLE;

e. HPI suction headers cross-connected; and

f. HPI discharge headers separated.

The LCO establishes the minimum conditions required to ensure that the HPI System delivers sufficient water to mitigate a small break LOCA.

BASES

LCO (continued)

may be called upon to mitigate the consequences of other transients and accidents. ¶ Each HPI train includes the piping, instruments, pumps, valves, and controls to ensure an OPERABLE flow path capable of taking suction from the BWST [and injecting into the RCS cold legs] upon an ESPS signal. [INSERT N] The safety grade flow indicator associated with the normal discharge valve is required to be OPERABLE to support the associated HPI train's OPERABILITY. [INSERT E] ¶ Each LPI-HPI flow path includes the piping, instruments, ~~pumps,~~ valves and controls to ensure the capability to manually transfer suction to the reactor building sump (LPI-HPI flow path). [The OPERABILITY requirements regarding the LPI System are addressed in LCO 3.5.3, "Low Pressure Injection (LPI)."]

During an event requiring HPI actuation, a flow path is provided to ensure an abundant supply of water from the BWST to the RCS via the HPI pumps and their respective discharge flow paths to each of the four cold leg injection nozzles and the reactor vessel. In the ~~long term,~~ [recirculation phase] this flow path ~~may be~~ [is] manually transferred to take its supply from the reactor building sump and to supply borated water to the RCS via the LPI-HPI flow path (piggy-back mode).

[INSERT F]

~~The flow path for each HPI train must maintain its designed independence to ensure that no single active failure can disable both HPI trains.~~

~~The LCO is modified by a Note that requires three HPI pumps and the HPI discharge crossover valves (HP-409 and HP-410) to be OPERABLE and the suction header to be cross-connected when THERMAL POWER is > 60% RTP. The safety grade flow indicator associated with a HPI discharge crossover valve is required to be OPERABLE to support HPI discharge crossover valve OPERABILITY. The Note modifies the pump and valve OPERABILITY and valve alignment requirements to provide additional requirements assumed by the safety analyses at power levels > 60% RTP.~~

APPLICABILITY

In MODES 1 and 2, and MODE 3 with RCS temperature > 350°F, the HPI ~~train~~ [System] OPERABILITY requirements for the small break LOCA are based [on analysis performed at 100% RTP.] ~~on full power operation. Although reduced power would not require the same level of performance, the accident analysis does not provide for reduced cooling requirements in the lower MODES.~~ The HPI pump performance is based on the small break LOCA, which establishes the pump

(continued)

INSERT N

For an HPI train to be OPERABLE, the associated HPI pump must be capable of taking suction from the BWST through the suction header valve associated with that train upon an ESPS signal. For example:

1) if HPI pump "B" is being credited as part of HPI train "A," then it must be capable of taking suction through HP-24 upon an ESPS signal; or

2) if HPI pump "B" is being credited as part of HPI train "B," then it must be capable of taking suction through HP-25 upon an ESPS signal.

INSERT E

To support HPI pump OPERABILITY, the piping, valves and controls which ensure the HPI pump can take suction from the BWST upon an ESPS signal are required to be OPERABLE.

To support HPI discharge crossover valve OPERABILITY, the safety grade flow indicator associated with the HPI discharge crossover valve is required to be OPERABLE.

INSERT F

The OPERABILITY of the HPI System must be maintained to ensure that no single active failure can disable both HPI trains. Additionally, while the HPI System was not designed to cope with passive failures, the HPI trains must be maintained independent to the extent possible during normal operation. The NRC approved exception to this principle is cross-connecting the HPI suction headers during normal operation (Ref. 6).

BASES

APPLICABILITY (continued)

performance curve. MODE 2 and MODE 3 with RCS temperature > 350°F requirements are bounded by the MODE 1 analysis.

In MODE 3 with RCS temperature ≤ 350°F and in MODE 4, the probability of an event requiring HPI actuation is significantly lessened. In this operating condition, the low probability of an event requiring HPI actuation and the ~~availability of~~ (LCO 3.5.3 requirements for) the LPI System provide reasonable assurance that the safety injection function is preserved.

In MODES 5 and 6, unit conditions are such that the probability of an event requiring HPI injection is extremely low. Core cooling requirements in MODE 5 are addressed by LCO 3.4.7, "RCS Loops – MODE 5, Loops Filled," and LCO 3.4.8, "RCS Loops – MODE 5, Loops Not Filled." MODE 6 core cooling requirements are addressed by LCO 3.9.4, "Decay Heat Removal (DHR) and Coolant Circulation – High Water Level," and LCO 3.9.5, "Decay Heat Removal (DHR) and Coolant Circulation – Low Water Level."

ACTIONS

A.1~~,~~ (and) A.2 ~~and A.3~~

With one ~~required~~ HPI pump inoperable, (or) one or more HPI discharge crossover valve(s) (i.e., HP-409 and HP-410) inoperable, ~~or the HPI suction header not cross-connected when required with THERMAL POWER > 60% RTP~~, the HPI pump and discharge crossover valve(s) must be restored to OPERABLE status ~~and the HPI suction header must be cross-connected~~ within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is based on NRC recommendations (Ref. 4) that are based on a risk evaluation and is a reasonable time for many repairs.

(INSERT G)

B.1 (,) ~~and~~ B.2 (, B.3 and B.4)

If the Required Action and associated Completion Time of Condition A is not met, ~~the unit must be brought to a MODE or condition in which the LCO does not apply. To achieve this status,~~ THERMAL POWER of the unit must be reduced to ≤ ~~60%~~ (75%) RTP within 12 hours. The 12 hour Completion Time is reasonable, based on operating experience, to reach the required unit condition from full power conditions in an orderly manner and without challenging unit systems. (This time is less restrictive than the Completion Time for Required Action C.1, because the HPI System remains capable of performing its function, barring a single failure.)

(continued)

INSERT G

In the event HPI pump "C" becomes inoperable, Condition C must be entered as well as Condition A. Until actions are taken to align an HPI pump to HPI train "B," HPI train "B" is inoperable due to the inability to automatically provide injection in response to an ESPS signal. Additionally, in order to utilize another HPI pump to supply HPI train "B," HP-116 must be opened. This action results in cross-connecting the HPI discharge headers; thus, Condition E must be entered. The HPI discharge headers cannot be separated in this situation, because it would require HPI pumps "A" and "B" to operate with flows less than the minimum flow requirements.

This Condition permits multiple components of the HPI System to be inoperable concurrently. When this occurs, other Conditions may also apply. For example, if HPI pump "C" and HP-409 are inoperable, HPI train "B" is incapable of being automatically actuated or manually aligned from the Control Room. Thus, Required Action C.1 would apply.

BASES (INSERT H)

ACTIONS (continued)

~~C.1~~ F.1

With one LPI-HPI flow path inoperable, the inoperable LPI-HPI flow path must be restored to OPERABLE status within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is justified because there is a limited range of break sizes, and therefore a lower probability for a small break LOCA which would require~~d~~ piggy back operation.

INSERT I

~~D.1 and D.2~~

~~With one HPI train incapable of being automatically actuated but capable of being manually actuated with THERMAL POWER > 60% RTP, the automatic capability must be restored within 24 hours. With one HPI train inoperable with THERMAL POWER ≤ 60% RTP, the inoperable HPI train must be restored to OPERABLE status within 24 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 24 hour Completion Time is appropriate based on engineering judgment, taking into consideration the time required to complete the required action.~~

~~E.1~~ G.1 and G.2

If ~~the~~ a Required Action~~s~~ ~~and~~ ~~the~~ associated Completion Time~~s~~ of Condition ~~C or D~~ B, C, D, E or F are not met, the unit must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit must be brought to at least MODE 3 within 12 hours and the RCS temperature reduced to 350°F within 60 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

INSERT K

SURVEILLANCE REQUIREMENTS

SR 3.5.2.1

Verifying the correct alignment for manual and non-automatic power operated valves in the HPI flow paths provides assurance that the proper flow paths will exist for HPI operation. This SR does apply to the HPI suction header cross-connect valves, the HPI discharge cross-connect valves, the HPI discharge crossover valves, and the LPI-HPI flow path discharge valves (LP-15 and LP-16). This SR does not apply to valves that are

(continued)

INSERT H

Two HPI trains are required to mitigate specific small break LOCAs, if no credit for enhanced steam generator cooling is assumed in the accident analysis. However, if equipment not qualified as QA-1 (i.e., an atmospheric dump valve (ADV) flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if reactor power is ≤ 75% RTP.

Required Actions B.2, B.3, and B.4 modify the HPI pump and discharge crossover valve OPERABILITY requirements to permit reduced requirements at power levels ≤ 75% RTP for an extended period of time. Required Action B.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is OPERABLE within 12 hours. This compensatory measure provides additional assurance regarding the ability of the plant to mitigate an accident. Compliance with this requirement can be established by ensuring that the ADV flow path for each steam generator is OPERABLE in accordance with LCO 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths."

Required Actions B.3 and B.4 require that the HPI pump and discharge crossover valve(s) be restored to OPERABLE status within 30 days from initial entry into Condition A. The 30-day time period limits the time that the plant can operate while relying on non QA-1 ADVs to provide enhanced steam generator cooling to mitigate small break LOCAs. The 30-day time period is acceptable, because:

1. Without crediting an ADV flow path, the HPI System remains capable of performing the safety function, barring a single failure;

2. If credit is taken for an ADV flow path for a steam generator, the safety analysis has demonstrated that only one HPI train is required to mitigate the consequences of a small break LOCA when THERMAL POWER is ≤ 75% RTP. Thus, for this case, the HPI System would be capable of performing its safety function even with an additional single failure;

3. OPERABILITY of the ADV flow path for each steam generator is required to be confirmed by Required Action B.2 within 12 hours. Additional defense-in-depth is provided, because the ADV flow path for only one steam generator is required to mitigate the small break LOCA; and

4. A risk-informed assessment (Ref. 7) concluded that operating the plant in accordance with these Required Actions is acceptable.

INSERT I

C.1, C.2, and C.3

If the plant is operating with THERMAL POWER > 75% RTP, two HPI pumps capable of providing flow through two HPI trains are required. One HPI train is required to provide flow automatically upon receipt of an ESPS signal, while flow through the other HPI train must be capable of being established from the Control Room within 10 minutes. Thus, if the plant is operating at > 75% RTP, and one HPI train is inoperable and incapable of being automatically actuated or manually aligned from the Control Room to provide flow post-accident, the HPI System would be incapable of performing its safety function. For this Condition, Required Action C.1 requires the power to be reduced to ≤ 75% RTP within 3 hours. Required Action C.1 is modified by a Note which limits its applicability to the condition defined above. The 3 hour Completion Time is considered reasonable to reduce the unit from full power conditions to ≤ 75% RTP in an orderly manner and without challenging unit systems. The time frame is more restrictive than the Completion Time provided in Required Action B.1 for the same action, because the condition involves a loss of safety function.

If the plant is operating with THERMAL POWER > 75% RTP and the inoperable HPI train can be automatically actuated or manually aligned to provide flow post-accident, Required Action C.3 permits 72 hours to restore the HPI train to an OPERABLE status.

If enhanced steam generator cooling is not credited in the accident analysis, two HPI trains are required to mitigate specific small break LOCAs with THERMAL POWER ≤ 75% RTP. However, if equipment not qualified as QA-1 (i.e., an ADV flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if THERMAL POWER is ≤ 75% RTP. In order to permit an HPI train to be inoperable regardless of the reason when THERMAL POWER is ≤ 75% RTP, Required Action C.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is OPERABLE within 3 hours. This Required Action is modified by a Note which states that it is only required if THERMAL POWER is ≤ 75% RTP. This compensatory measure provides assurance regarding the ability of the plant to mitigate an accident while in the Condition and THERMAL POWER ≤ 75% RTP. Compliance with this requirement can be established by ensuring that the ADV flow path for each steam generator is OPERABLE in accordance with LCO 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths."

With one HPI train inoperable, the inoperable HPI train must be restored to OPERABLE status within 72 hours. This action is appropriate because:

INSERT I CONTINUED

1. With THERMAL POWER ≤ 75% RTP, the safety analysis demonstrates that only one HPI train is required to mitigate the consequences of a small break LOCA assuming credit is taken for the ADV flow path for one steam generator. The OPERABILITY of the ADV flow path for each steam generator is confirmed by Required Action C.2 within 3 hours. This provides additional defense-in-depth. Additionally, a risk-informed assessment (Ref. 7) concluded that operating the plant in accordance with this Required Action is acceptable.

2. With THERMAL POWER > 75% RTP, the remaining OPERABLE HPI train is capable of automatic actuation, and the inoperable train can be manually aligned by operator action to cross-connect the discharge headers of the HPI trains. This manual action was approved by the NRC in Reference 6.

D.1

With the HPI suction headers not cross-connected, the HPI suction headers must be cross-connected within 72 hours. The HPI System continues to be capable of mitigating an accident, barring a single failure. The 72 hour Completion Time is based on NRC recommendations (Ref. 4) that are based on a risk evaluation and is a reasonable time for many repairs.

An argument similar to that utilized for Required Actions B.2, B.3, and B.4 could have been made for operating the HPI System with the suction headers not cross-connected for an extended period of time. However, this action was not considered prudent, due to the potential of damaging two HPI pumps in the event HP-24 or HP-25 failed to open in response to an ESPS signal while the HPI suction headers were not cross-connected.

E.1

With the HPI discharge headers cross-connected, the independence of the HPI trains is not being maintained to the extent practical (i.e., defense-in-depth principle is not met). Thus, the HPI discharge headers must be hydraulically separated within 72 hours. This action limits the time period that the HPI discharge headers may be cross-connected. The 72-hour allowed outage time is acceptable, because cross-connecting the HPI discharge headers in conjunction with:

1. the rest of the HPI System being OPERABLE would not result in the inability of the HPI System to perform its safety function even assuming a single active failure; and

2. an HPI pump being inoperable would not result in the inability of the HPI System to perform its safety function, barring a single failure. However, in this condition, a single active failure of one of the two remaining OPERABLE HPI pumps could result in the remaining HPI pump failing due to runout.

INSERT K

H.1

If two HPI trains are inoperable or two LPI-HPI flow paths are inoperable, the HPI System is incapable of performing its safety function and in a condition not explicitly addressed in the Actions for ITS 3.5.2. Thus, immediate plant shutdown in accordance with LCO 3.0.3 is required.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.2.1 (continued)

locked, sealed, or otherwise secured in position, since these valves were verified to be in the correct position prior to locking, sealing, or securing. Similarly, this SR does not apply to automatic valves since automatic valves actuate to their required position upon an accident signal. This Surveillance does not require any testing or valve manipulation; rather, it involves verification that those valves capable of being mispositioned are in the correct position. The 31 day Frequency is appropriate because the valves are operated under administrative control. This Frequency has been shown to be acceptable through operating experience.

SR 3.5.2.2

With the exception of the HPI pump operating to provide normal makeup, the other two HPI pumps are normally in a standby, nonoperating mode. As such, the emergency injection flow path piping has the potential to develop voids and pockets of entrained gases. Venting the HPI pump casings periodically reduces the potential that such voids and pockets of entrained gases can adversely affect operation of the HPI System. This will also ~~minimize~~ reduce the potential for water hammer, pump cavitation, and pumping of noncondensible gas (e.g., air, nitrogen, or hydrogen) into the reactor vessel following an ESPS signal. This Surveillance is modified by a Note that indicates it is not applicable to operating HPI pump(s) providing normal makeup. The 31 day Frequency takes into consideration the gradual nature of gas accumulation in the HPI piping and the existence of procedural controls governing system operation.

SR 3.5.2.3

Periodic surveillance testing of HPI pumps to detect gross degradation caused by impeller structural damage or other hydraulic component problems is required by Section XI of the ASME Code (Ref. 5). SRs are specified in the Inservice Testing Program, which encompasses Section XI of the ASME Code.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.5.2.4 and SR 3.5.2.5

These SRs demonstrate that each automatic HPI valve actuates to the required position on an actual or simulated ESPS signal and that each HPI pump starts on receipt of an actual or simulated ESPS signal. This SR is not required for valves that are locked, sealed, or otherwise secured in position under administrative controls. The test will be considered satisfactory if control board indication verifies that all components have responded to the ESPS actuation signal properly (all appropriate ESPS actuated pump breakers have opened or closed and all ESPS actuated valves have completed their travel). The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a unit outage and the potential for an unplanned transient if the Surveillance were performed with the reactor at power. The 18 month Frequency is also acceptable based on consideration of the design reliability (and confirming operating experience) of the equipment. The actuation logic is tested as part of the ESPS testing, and equipment performance is monitored as part of the Inservice Testing Program.

SR 3.5.2.6

Periodic inspections of the reactor building sump suction inlet (for LPI-HPI flow path) ensure that it is unrestricted and stays in proper operating condition. The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a unit outage, on the need to preserve access to the location, and on the potential for an unplanned transient if the Surveillance were performed with the reactor at power. This Frequency has been found to be sufficient to detect abnormal degradation and has been confirmed by operating experience.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

INSERT L

SR 3.5.2.7

The function of the LPI discharge valve (LP-15, LP-16) to the LPI-HPI flow path is to open and allow a cross-connection from the discharge side of an LPI pump to the suction of the HPI pumps. Manually cycling each valve open demonstrates the ability to fulfill this function. This test is performed on an 18-month Frequency. Operating experience has shown that these components usually pass the Surveillance when performed at ~~the~~ this Frequency. Therefore, the Frequency is acceptable from a reliability standpoint.

REFERENCES

1. 10 CFR 50.46.
2. UFSAR, Section 15.14.3.3.6.
3. 10 CFR 50.36.
4. NRC Memorandum to V. Stello, Jr., from R.L. Baer, "Recommended Interim Revisions to LCOs for ECCS Components," December 1, 1975.
5. ASME, Boiler and Pressure Vessel Code, Section XI, Inservice Inspection, Article IWV-3400.

INSERT M

INSERT L

Periodic stroke testing of the HPI discharge crossover valves (HP-409 and HP-410) and LPI-HPI flow path discharge valves (LP-15 and LP-16) is required to ensure that the valves can be manually cycled. The HPI discharge crossover valves must be capable of being stroked from the Control Room. The LPI-HPI flow path discharge valves must be capable of being stroked locally.

INSERT M

6. Letter from R. W. Reid (NRC) to W. O. Parker, Jr. (Duke) transmitting Safety Evaluation for Oconee Nuclear Station, Units Nos. 1, 2, and 3, Modifications to the High Pressure Injection System, dated December 13, 1978.

7. Letter from W. R. McCollum (Duke) to the U. S. NRC, "Proposed Amendment to the Facility Operating License Regarding the High Pressure Injection System Requirements," dated December 16, 1998.

B 3.7 PLANT SYSTEMS

B 3.7.4 Not used

INSERT BASES FOR

ITS 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths"

Attachment 4

Discussion of Proposed Changes

Background

Current Technical Specification (CTS) 3.3.1.a provides requirements for the High Pressure Injection (HPI) System when there is fuel in the core, reactor coolant system temperature > 350°F, and reactor power < 60% full power. These requirements were based on the analysis of a Small Break Loss of Coolant Accident (SBLOCA) which assumed a break on the discharge side of the reactor coolant pumps. The analysis concluded that one HPI train had sufficient capacity to mitigate SBLOCAs when reactor power was < 60% full power. As reported in Licensee Event Report (LER) 269/90-15, Duke discovered that the analysis was non-conservative. It assumed:

1) an even flow split between the injection line connected to the broken cold leg and the injection line connected to the intact cold leg. The even flow split resulted from the assumption that the back pressure on each line was equal to RCS pressure; and

2) HPI flow from the injection line connected to the broken leg is injected into the reactor coolant pump discharge volume. A computer model then determined how much of the injection flow is lost out the break.

In the LER, Duke reported that one HPI train was inadequate to mitigate a break of an HPI injection line when reactor power was < 60% full power. In this case, the appropriate back pressure assumption would be containment pressure for the broken injection line, and RCS pressure for the intact injection lines. Additionally, none of the HPI flow through the broken injection line would reach the RCS. The resulting flow split from this asymmetric pressure boundary condition would cause less injection flow to reach the reactor. As a result, Duke imposed additional requirements upon the operation of Oconee Nuclear Station Units 1, 2, and 3 with reactor power < 60% full power. These additional requirements were equivalent to the requirements for operation with reactor power > 60% full

power (i.e., a third HPI pump and HPI discharge crossover valves were required to be operable, and the HPI suction headers were required to be cross-connected).

To resolve this deficiency, as well as other known deficiencies with the HPI Technical Specifications, Duke submitted a proposed license amendment on March 31, 1997. Duke supplemented this request with additional information on February 9, 1998, and June 17, 1998. The staff of the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) on July 16, 1998. To resolve the questions raised by the NRC, a substantial revision to the proposed license amendment was required. Also, in verbal discussions, the NRC staff highly recommended that the revised license amendment request include a risk-informed justification in accordance with Regulatory Guides 1.174 and 1.177. Due to the significance of the changes required, Duke concluded that it would be appropriate to withdraw the original request, and submit another proposed license amendment which would stand alone. Thus, on November 4, 1998, Duke withdrew the license amendment request submitted on March 31, 1997.

This submittal provides a proposed license amendment to resolve the issue identified in LER 269/90-15 and other deficiencies with the HPI Technical Specifications. Additionally, the proposed license amendment is provided in terms of the Improved Technical Specifications (ITS); this was necessary because the proposed license amendment regarding the ITS will be approved and implemented prior to the NRC approval of this license amendment request.

Discussion of the Proposed Changes to the ITS

Attachment 3 provides a mark-up of the applicable ITS pages. On October 1, 1998, Duke submitted Supplement 3 to the proposed license amendment regarding ITS for Oconee Nuclear Station. This supplement provided a revision to the ITS regarding the HPI System and the ADVs; it essentially provided a conversion of the CTS requirements regarding the HPI System and the ADVs. The proposed changes to the ITS

for Oconee Nuclear Station are described and justified below.

ITS LCO 3.5.2

Description of Proposed Changes

ITS Limiting Condition for Operation (LCO) 3.5.2 requires two HPI trains and two LPI-HPI flow paths to be operable when in Mode 1, Mode 2, and Mode 3 with Reactor Coolant System (RCS) temperature > 350°F. It also requires, when Thermal Power is > 60% Rated Thermal Power (RTP), three HPI pumps and the HPI discharge crossover valves to be operable and the suction header to be cross-connected. Duke proposes to revise ITS LCO 3.5.2 by:

a) expanding the applicability for the requirements regarding the third HPI pump, the discharge crossover valves, and the HPI suction headers. The revised LCO would require the third HPI pump and the HPI discharge crossover valves to be operable and the suction header to be cross-connected whenever ITS LCO 3.5.2 is applicable; and

b) specifically requiring the HPI discharge headers to be separated whenever ITS LCO 3.5.2 is applicable.

Justification for Proposed Changes

a) One HPI train provides sufficient flow to mitigate most SBLOCAs. However, for cold leg breaks located on the discharge of the reactor coolant pumps, some HPI injection will be lost out the break; for this case, two HPI trains are required. Thus, three HPI pumps must be operable to ensure adequate cooling in response to the design basis RCP discharge SBLOCA. Additionally, in the event one HPI train fails to automatically actuate due to a single failure (e.g., failure of HPI pump 'C' or HP-26), operator actions from the Control Room are required to cross-connect the HPI discharge headers within 10 minutes in order to provide HPI flow through a second HPI train. These operator actions were approved by the NRC in a Safety Evaluation Report

dated December 13, 1978, for operation with reactor power > 60% full power.

This proposed change establishes the minimum conditions required to ensure that the HPI System delivers sufficient water to mitigate a SBLOCA. The safety analysis requires one HPI train to be automatically capable of responding to an accident, and the other HPI train to be capable of being manually aligned from the Control Room within 10 minutes in the event of a SBLOCA. A discussion of the SBLOCA analysis is provided in Enclosure 1 to this attachment.

b) Hydraulic separation of the HPI discharge headers is required during normal operation to maintain defense-in-depth (i.e., independence of the HPI discharge headers). Additionally, hydraulic separation of the HPI discharge headers ensures that a complete loss of HPI would not occur in the event an accident were to occur with only two of the three HPI pumps operable coincident with the HPI discharge headers cross-connected. In this case, a single active failure of an HPI pump would leave only one HPI pump to mitigate the accident. The remaining HPI pump could experience runout conditions and could fail prior to operator action to throttle flow or start another pump.

The proposed change to specifically address cross-connecting the HPI discharge headers clarifies the requirement to maintain the HPI discharge headers hydraulically separated to the extent possible. This requirement is consistent with Duke's current practice.

Condition A of ITS LCO 3.5.2

Description of Proposed Changes

Condition A of ITS LCO 3.5.2 addresses one HPI pump inoperable, one or more HPI discharge crossover valve(s) inoperable, or the HPI suction header not cross-connected with Thermal Power > 60% RTP. Duke proposes to:

a) expand the applicability of this Condition by deleting the phrase "with THERMAL POWER > 60% RTP;" and

b) address failure to cross-connect the HPI suction headers as an independent condition. This condition will be named Condition D.

Justification for Proposed Changes

a) The proposed change to apply Condition A regardless of Thermal Power level supports a proposed change to ITS LCO 3.5.2. The revised LCO requires the third HPI pump to be operable, the discharge crossover valves to be operable, and the HPI suction headers cross-connected whenever the LCO is applicable. The SBLOCA analysis requires two HPI trains to mitigate the accident (one operating automatically, and the other manually aligned from the Control Room within 10 minutes). The proposed requirements are more restrictive than the ITS.

b) The proposed change to address cross-connecting the HPI suction headers as an independent condition does not result in any technical changes to the requirements regarding the HPI suction headers. The Required Action continues to limit the period of time that the HPI suction headers can be hydraulically separated to 72 hours. This proposed change is an administrative change based on operator preference.

Condition B of ITS LCO 3.5.2

Description of Proposed Changes

In the event a Required Action or Completion Time of Condition A of ITS LCO 3.5.2 is not met, Condition B of ITS LCO 3.5.2 would apply. Required Action B.1 of ITS LCO 3.5.2 requires Thermal Power to be reduced to ≤ 60% RTP. Duke proposes to revise this condition by:

a) revising Required Action B.1 to only require Thermal Power to be reduced to ≤ 75% RTP; and

b) adding Required Actions B.2, B.3, and B.4. These required actions limit the amount of time that a plant may be operated with Thermal Power ≤ 75% RTP in the event a HPI pump is inoperable, or one or more HPI discharge crossover valves are inoperable. Required Action B.2 requires the verification by administrative means that the Atmospheric Dump Valve (ADV) flow path for each steam generator is operable within 12 hours. Required Action B.3 requires restoration of the HPI pump to an operable status within 30 days. Required Action B.4 requires restoration of the HPI discharge crossover valve(s) to an operable status within 30 days.

Justification for Proposed Changes

If enhanced steam generator cooling is not credited in the SBLOCA analysis, two HPI trains are required to mitigate specific SBLOCAs. However, if equipment not qualified as QA-1 (i.e., an ADV flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a SBLOCA on the discharge of the reactor coolant pumps if Thermal Power is ≤ 75% RTP. A discussion of the SBLOCA analysis is provided in Enclosure 1 of this attachment.

a) Required Action B.1 was revised to only require Thermal Power to be reduced to ≤ 75% RTP. At this power level, the SBLOCA analysis demonstrates that only one HPI train is required to mitigate SBLOCAs if credit is taken for an ADV flow path for one steam generator.

b) The ADV flow paths are not fully qualified as QA-1. Thus, Required Actions B.2, B.3, and B.4 were added to limit the period of time that the plant would rely upon the ADV flow path for one steam generator for accident mitigation.

Proposed Required Action B.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is operable within 12 hours. This compensatory measure provides additional

assurance regarding the ability of the plant to mitigate an accident.

Proposed Required Actions B.3 and B.4 require that the HPI pump and discharge crossover valve(s) be restored to operable status within 30 days from initial entry into Condition A. The 30-day time period limits the time that the plant can operate while relying on the non QA-1 ADVs to provide enhanced steam generator cooling to mitigate SBLOCAs. The 30-day time period is acceptable, because:

1. Without crediting an ADV flow path, the HPI System remains capable of performing the safety function, barring a single failure.

2. If credit is taken for an ADV flow path for a steam generator, the safety analysis has demonstrated that only one HPI train is required to mitigate the consequences of a SBLOCA when Thermal Power is ≤ 75% RTP. Thus, for this case, the HPI System would be capable of performing its safety function even with an additional single failure.

3. Operability of the ADV flow path for each steam generator is required to be confirmed by Required Action B.2 within 12 hours. Additional defense-in-depth is provided, because only the ADV flow path for one steam generator is required to mitigate the small break LOCA; and

4. A risk-informed assessment (Attachment 7) concluded that operating the plant in accordance with these Required Actions is acceptable.

Additional Consideration Regarding Reactor Coolant Pump Seal Injection

Proposed Conditions B and C of ITS 3.5.2 were not developed to ensure that the HPI System remained capable of supplying RCP seal injection assuming an additional single failure while operating in the condition. The rationale for this decision is provided below:

1) Typically, an additional single failure is not addressed while a plant is operating in a Condition permitted by the Technical Specifications.

2) The risk-informed analysis (Attachment 7) determined that the impact of proposed Conditions B and C of ITS 3.5.2 on the core damage frequency associated with an RCP seal LOCA was low;

3) While the component cooling system would be isolated following an ESPS signal, the current Emergency Operating Procedure requires the component cooling system to be unisolated.

4) Duke has committed to control maintenance of the component cooling system while the HPI System is degraded in accordance with the maintenance rule configuration management program.

5) Procedural guidance is in place to establish standby shutdown facility reactor coolant makeup flow to the RCP seals in the event the component cooling system and HPI System are lost.

Condition C of ITS LCO 3.5.2

Description of Proposed Changes

Condition C of ITS LCO 3.5.2 has been renamed Condition F.

Justification for Proposed Changes

The proposed change is an administrative change. Reordering the conditions is a matter of preference. This change does not affect the technical content or requirements in the condition.

Condition D of ITS LCO 3.5.2

Description of Proposed Changes

Condition D of ITS LCO 3.5.2 addresses one HPI train being incapable of being automatically actuated but capable of being manually actuated with Thermal Power > 60% RTP or one HPI train being inoperable with Thermal Power ≤ 60% RTP. If either of these condition exists, Required Action D.1 requires the restoration of the capability to automatically actuate the HPI train be restored within 24 hours, and Required Action D.2 requires the HPI train to be restored to an operable status within 24 hours. Duke proposes to change this condition by:

a) renaming the condition as Condition C;

b) simplifying the condition to address one HPI train being inoperable regardless of the power level that the plant is being operated, or the reason for the inoperability;

c) deleting the explicit requirement to restore the capability to automatically actuate the train within 24 hours;

d) adding a Required Action to reduce Thermal Power to ≤ 75% RTP within three hours in the event an HPI train cannot be actuated via automatic or manual means;

e) adding a Required Action to verify by administrative means that the ADV flow path for each steam generator is operable within 3 hours; and

f) expanding the Completion Time for restoring an inoperable HPI train to 72 hours.

Justification for Proposed Changes

a) Condition D has been renamed Condition C. Reordering the conditions is a matter of preference. This change alone does not affect the technical content or requirements in the condition.

b-f) Proposed Condition C has been written to reflect the new SBLOCA analysis. If enhanced steam generator cooling is not credited in the SBLOCA analysis, two HPI trains are required to mitigate specific SBLOCAs. One HPI train is required to provide flow automatically upon receipt of an ESPS signal, while flow through the other HPI train must be capable of being established from the Control Room within 10 minutes. However, if equipment not qualified as QA-1 (i.e., an ADV flow path for a steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate SBLOCAs if Thermal Power is ≤ 75% RTP. A discussion of the SBLOCA is provided in Enclosure 1 of this attachment.

If the plant is operating at > 75% RTP, and one HPI train is inoperable and incapable of being automatically actuated or manually aligned from the Control Room to provide post-accident flow, the HPI System would be incapable of performing its safety function. To address this situation, Duke proposes to add Required Action C.1; it requires the power to be reduced to ≤ 75% RTP within 3 hours in the event an HPI train is incapable of being automatically actuated and incapable of being manually aligned. This requirement is consistent with the ITS, which would require the unit to enter LCO 3.0.3. The 3-hour Completion Time is considered reasonable to reduce the unit from full power conditions to ≤ 75% RTP in an orderly manner and without challenging unit systems. The time frame is more restrictive than the Completion Time provided in Required Action B.1 for the same action, because the condition involves a loss of safety function.

In order to permit an HPI train to be inoperable regardless of the reason when Thermal Power is ≤ 75% RTP, Required Action C.2 provides a compensatory measure to verify by administrative means that the ADV flow path for each steam generator is operable within 3 hours. This Required Action is modified by a Note which states that it is only required if Thermal Power is ≤75% RTP. This compensatory measure provides assurance regarding the ability of the plant to mitigate an accident while in the Condition with Thermal Power ≤ 75% RTP.

With one HPI train inoperable, the inoperable HPI train must be restored to operable status within 72 hours. This action is appropriate, because:

1. With Thermal Power ≤ 75% RTP, the safety analysis demonstrates that only one HPI train is required to mitigate the consequences of a SBLOCA assuming credit is taken for an ADV flow path for one steam generator. The operability of the ADV flow path for each steam generator is confirmed by Required Action C.2 within 3 hours. This provides additional defense-in-depth. A risk-informed assessment (Attachment 7) concluded that operating the plant in accordance with this Required Action was acceptable.

2. With Thermal Power > 75% RTP, the remaining operable HPI train is capable of automatic actuation, and the inoperable train can be manually aligned by operator action to cross-connect the discharge headers of the HPI trains. This manual action was approved by the NRC in a Safety Evaluation dated December 13, 1978.

Additional Considerations Regarding Reactor Coolant Pump Seal Injection

Proposed Condition C of ITS 3.5.2 was not developed to ensure that the HPI System would remain capable of supplying RCP seal injection assuming an additional single failure while operating in the condition. The rationale for this decision is provided in the justification for the changes to Condition B of ITS LCO 3.5.2.

Condition E of ITS LCO 3.5.2

Description of Proposed Changes

Condition E of ITS LCO 3.5.2 addresses the condition of failing to meet a Required Action and associated Completion Time of Condition C or D. Duke proposes to change this condition by:

a) renaming the condition as Condition G; and

b) expanding the applicability of this condition to address failure to meet a Required Action and associated Completion Time of Condition B, C, D, E, or F.

Justification for Proposed Changes

a) Reordering the conditions is a matter of preference. This change does not affect the technical content or requirements in the condition. The proposed change is an administrative change.

b) In the event a Required Action or associated Completion Time for Condition B, C, D, E, or F of LCO 3.5.2 is not met, action should be required to place the unit in a mode or condition in which the LCO does not apply. The proposed Condition G achieves this by requiring the plant to be brought to Mode 3 within 12 hours and the RCS temperature to be reduced to ≤ 350°F within 60 hours. These requirements are consistent with current shutdown requirements contained in the Oconee ITS.

New Conditions

Description of Proposed Changes

a) Currently, Duke would enter Condition C of ITS 3.5.2 when the HPI discharge headers are cross-connected. It requires the inoperable HPI train to be restored within 24 hours. Condition E is added to specifically address cross-connecting the HPI discharge headers. It

requires the HPI discharge headers to be hydraulically separated within 72 hours.

b) Condition H is added to direct the user to enter LCO 3.0.3 immediately in the event two HPI trains or two LPI-HPI flow paths are inoperable.

Justification for Proposed Changes

a) Adding a condition to specifically address cross-connecting the HPI discharge headers provides clarity, and ensures that the appropriate action is taken with respect to the condition. With the HPI discharge headers cross-connected, the independence of the HPI trains is not being maintained to the extent practical (i.e., defense-in-depth principle is not met). This action assures that cross-connecting the discharge headers of the HPI System is limited to 72 hours. The 72-hour allowed outage time is acceptable, because cross-connecting the HPI discharge headers in conjunction with:

   1. the rest of the HPI System being operable would not result in the inability of the HPI System to perform its safety function even assuming a single active failure; and

   2. an HPI pump being inoperable would not result in the inability of the HPI System to perform its safety function, barring a single failure.

b) Adding a condition which directs the user of the technical specifications to enter ITS LCO 3.0.3 in the event two HPI trains or two LPI-HPI flow paths clarifies the technical specification requirements. It is consistent with the requirements of the ITS. Providing a condition which directs entry into ITS 3.0.3 is a matter of preference. It is appropriate in this case because of the complexity of ITS 3.5.2.

ITS SR 3.5.2.7

Description of Proposed Changes

ITS Surveillance Requirement (SR) 3.5.2.7 requires each discharge valve to the LPI-HPI flow path to be manually cycled open every 18 months. Duke proposes to revise this SR to require the HPI discharge crossover valves to be cycled every 18 months. This proposed change is more restrictive.

Justification for Proposed Changes

Currently, the ITS does not contain an SR which demonstrates operability of the HPI discharge crossover valves. These valves are required to be manually aligned from the Control Room post-accident to provide coolant flow from the second HPI train within 10 minutes. Periodic stroke testing of the HPI discharge crossover valves (HP-409 and HP-410) ensures that the valves can be manually cycled from the Control Room. This test is performed on an 18-month Frequency. Operating experience has shown that this type of component usually pass the surveillance when performed at this Frequency. Therefore, the Frequency is acceptable from a reliability standpoint.

ITS 3.7.4

Description of Proposed Changes

ITS 3.7.4 has been added to provide requirements regarding the ADV flow paths.

Justification for Proposed Changes

Required Actions B.2 and C.2 of LCO 3.5.2 require confirmation that the ADV flow path for each steam generator is operable. These actions are compensatory measures which permit a plant to be operated for a limited period of time with specific components of the HPI System inoperable and Thermal Power ≤ 75% RTP. ITS 3.7.4 has been included to provide requirements regarding the ADV flow paths. The

requirements provide assurance that the ADV flow paths will be operable when required.

Discussion of Proposed Changes to the ITS Bases

The majority of the changes to the Bases were made to reflect the proposed changes to the Technical Specifications. These changes are not described in detail, because the justifications are identical to those provided for the proposed changes to the Technical Specifications. Proposed changes to the Bases that are not related to the proposed changes to the Technical Specifications are addressed individually. Additionally, no specific justification is provided for obvious minor editorial corrections.

Background Section of Bases for ITS 3.5.2

Description of Proposed Changes

a) Currently, the Bases state: "The two HPI trains are designed and aligned such that they are not both susceptible to any single active failure including the failure on any power operating component to operator or any single failure of electrical equipment."

Duke proposes to add a statement to clarify that the HPI System is not required to withstand passive failures.

b) Currently, the Bases state: "There are three ESPS actuated HPI pumps, each of which can provide flow to either train. At least one pump is normally running providing RCS makeup and seal injection to the reactor coolant pumps. Suction header cross-connect valves are normally open, and discharge header cross-connect valves are normally closed. Additional discharge valves (HPI discharge crossover valves) can be used to bypass the normal discharge valves and assure the ability to feed either trains' injection lines from the pump(s) on the other train. A safety grade flow indicator is provided for the flow path associated with

each of these four discharge valves. These indicators are required to be OPERABLE to support HPI OPERABILITY and are needed to throttle HPI flow during an accident to assure that runout limits are not exceeded."

Duke proposes to replace this paragraph with the following paragraph: "There are three ESPS actuated HPI pumps; the discharge flow paths for two of the pumps are normally aligned to automatically support HPI train "A" and the discharge flow path for the third pump is normally aligned to automatically support HPI train "B." The discharge flow paths can be manually aligned such that each of the HPI pumps can provide flow to either train. At least one pump is normally running to provide RCS makeup and seal injection to the reactor coolant pumps. Suction header cross-connect valves are normally open; cross-connecting the HPI suction headers during normal operation was approved by the NRC in Reference 6. The discharge crossover valves (HP-409 and HP-410) are normally closed; these valves can be used to bypass the normal discharge valves and assure the ability to feed either train's injection linesvia HPI pump "B." For each discharge valve and discharge crossover valve, a safety grade flow indicator is provided to enable the operator to throttle flow during an accident to assure that runout limits are not exceeded."

c) Duke proposes to eliminate the paragraph regarding the operability requirements and the accident analysis from the Background Section of the Bases.

d) The Bases state: "...the orifice in the broken line would limit the HPI flow lost through the break and <u>increase</u> [emphasis added] the flow supplied to the reactor vessel..."

Duke proposes to revise this statement by replacing the word "increase" with the word "maximize."

e) Currently, the Background Section contains a paragraph describing how the HPI System is actuated and how it is supplied electrical power.

Duke proposes to relocate this information to the Applicable Safety Analysis Section of the Bases.

f) Currently, the Bases states: "The HPI System consists of two redundant trains...". Duke proposes to change this statement to: "The HPI System consists of two independent trains...".

Justification for Proposed Changes

a) The HPI System is not designed to cope with passive failures. This is not a change to the design basis. As stated in Supplement 1 to the AEC's Safety Evaluation for Oconee Unit 1 dated March 24, 1972, the HPI System is designed to withstand a single failure of an active component without a loss of function. This statement is incorporated by reference into the AEC's Safety Evaluation for Oconee Units 2 and 3 dated July 6, 1973. Further information regarding the long term cooling requirements for the HPI System are provided in Enclosure 4 of this Attachment.

b) The revision to the description of the normal alignment of the HPI System is an editorial enhancement.

A reference to the NRC Safety Evaluation which permitted the HPI suction headers to be cross-connected during normal operation was added to provide a basis for the independence exception.

The operability requirements regarding the flow indicators for the discharge valves was removed from the Background Section of the Bases. This type of information belongs in the "LCO" section of the Bases. Thus, a similar statement was added to the Bases discussion in the "LCO" section.

c) The Background Section contains a paragraph which discusses the SBLOCA analysis and the operability requirements pertaining to the HPI System. This discussion is redundant to discussions provided in the

"Applicable Safety Analyses" and "LCO" sections of the Bases. Thus, the paragraph has been eliminated.

d) The orifice limits the amount of HPI flow lost through the broken leg, as a result the HPI flow to the reactor vessel can be maximized. It does not actively increase the amount of flow supplied to the reactor vessel. The proposed change to replace the word "increase" with the word "maximize" is appropriate, because it more accurately describes the condition.

e) Relocation of a paragraph to another section of the Bases is an administrative change. The paragraph was relocated intact. This proposed change does not involve any technical changes to the relocated paragraph.

f) The small break LOCA analysis conducted at a Thermal Power of 100% RTP requires one HPI train to be capable of automatically injecting upon an ESPS signal, and tbe second HPI train to be capable of being manually aligned from the Control Room within 10 minutes. Thus, both trains of the HPI System are required to mitigate a small break LOCA when operating at 100% RTP. The HPI trains are not redundant, but are required to be independent so as to be able to withstand a single active failure. The NRC approved the use of operator actions to align the second train of HPI within 10 minutes on December 13, 1978.

Applicable Safety Analyses Section of Bases for ITS 3.5.2

<u>Description of Proposed Changes</u>

a) Duke proposes to revise the Applicable Safety Analyses Section to reflect the new SBLOCA analysis.

b) Duke proposes to include a paragraph regarding the requirements to maintain separation of the HPI discharge headers to the extent possible.

c) Currently, the Bases state: "For a large break LOCA, HPI is not credited at all."

Duke proposes to change this statement to: "The HPI System is not credited for mitigation of a large break LOCA;" and to relocate it to earlier in the section.

d) Duke proposes to add a statement denoting that the LCO helps ensure that adequate long term cooling capability is maintained.

e) Currently, the Bases state: "The SGTR and MSLB analyses also credit the HPI pumps but are not limiting in their design."

Duke proposes to modify this statement as follows: "The SGTR and MSLB analyes also credit the HPI pumps, but these events are bounded by the small break LOCA with respect to the performance requirements of the HPI System."

Justification for Proposed Changes

a) These proposed changes were made to reflect the new SBLOCA analysis. Enclosure 1 of this Attachment provides a description of the SBLOCA analysis.

b) A paragraph regarding separation of the HPI discharge headers was added to clarify the HPI independence requirements. It ensures that the user of the technical specifications understands the requirement to maintain the HPI trains independent to the extent possible.

c) The proposed change relocates information from one paragraph to another. While the sentence was rewritten, the technical content remains unchanged.

d) Principally, the long-term cooling requirements of 10 CFR 50.46(b)(5) are met by the LPI System which is comprised of two independent trains. However, if an accident occurs and the RCS pressure remains above the shutoff head of the LPI pumps as the Borated Water Storage Tank (BWST) approaches depletion, the HPI

System would deliver water to the RCS using the LPI discharge piping as its suction source (i.e., HPI piggyback mode of operation). There are two independent flow paths which allow the HPI System to take suction from the discharge of the LPI System by manual operator action. The HPI piggyback mode of operation mission is limited to establishing conditions which permit the use of the LPI System. The EOP has guidance to terminate HPI flow when sufficient LPI flow has been established.

Adding a statement to the Bases of the LCO which denotes that the requirements ensure that adequate long term cooling capability is maintained is appropriate. Additional information regarding the Oconee long term cooling requirements is provided in Enclosure 4 of this attachment.

Additionally, extending the operability requirements of the HPI System to temperatures below 350°F would introduce a conflict between mitigating LOCAs initiating from lower temperatures and pressures, and preventing the limiting LTOP transient initiating event (mass addition resulting from HPI actuation). The Oconee LTOP analyses restrict HPI flow to normal makeup type of flowrates in order to obtain acceptable analysis results. Acceptable LTOP analysis results cannot be obtained with ECCS type of HPI flowrates. In addition, HPI actuation at lower temperatures and pressures for LOCA mitigation would also rely on manual operator action since the actuation circuitry must be bypassed.

Should a LOCA occur at lower temperatures and pressures, the RCS will depressurize to the saturation pressure for all except the very small break sizes. For a temperature of 350°F, this corresponds to a pressure of 135 psia. This is well below the LPI deadhead pressure of approximately 190 psig. Therefore, it is likely that direct LPI injection will be available for core cooling, and HPI injection will not be necessary. With the LPI System aligned for decay heat removal operation, the operator would need to realign the operating LPI pump for the ECCS mode, or

align a second LPI pump (Oconee has three LPI pumps) for the ECCS mode. Also, a LOCA is less probable at reduced pressure, and it may be more appropriate to design for LTOP events at low pressure.

The Oconee technical specifications also require that the Emergency Feedwater System be operable above 250°F. With the EFW System operable down to 250°F, there is additional capability to depressurize the RCS to conditions where the LPI System can provide core cooling for SBLOCA events with HPI unavailable.

Based on the above arguments, no additional requirements regarding HPI operability below 350°F were added.

e) The proposed revision to the Bases statement regarding the steam generator tube rupture (SGTR) and main steam line break (MSLB) analyses and their impact on the HPI System performance requirements clarifies the intent of the statement. The small break LOCA analyses bound the SGTR and MSLB with respect to the performance requirements of the HPI System.

LCO Section of Bases for ITS 3.5.2

Description of Proposed Changes

a) Duke proposes to revise the LCO Section of the Bases for ITS 3.5.2 to reflect the proposed changes to ITS LCO 3.5.2. The proposed changes to ITS 3.5.2 were justified in a previous section of this attachment.

b) Duke proposes to add the following information regarding HPI train operability: "For an HPI train to be OPERABLE, the associated HPI pump must be capable of taking suction from the BWST through the suction header valve associated with that train upon an ESPS signal. For example:

1) if HPI pump "B" is being credited as part of HPI train "A," then it must be capable of taking suction through HP-24 upon an ESPS signal; or

2) if HPI pump "B" is being credited as part of HPI train "B," then it must be capable of taking suction through HP-25 upon an ESPS signal."

c) Duke proposes to revise the requirements regarding the LPI-HPI flow path by excluding the LPI pumps, and adding a reference to LCO 3.5.3, "Low Pressure Injection (LPI)."

d) Duke proposes to add the following statement regarding HPI pump operability: "To support HPI pump OPERABILITY, the piping, valves and controls which ensure the HPI pump can take suction from the BWST upon an ESPS signal are required to be OPERABLE."

e) Duke proposes to add the following information regarding HPI discharge crossover valve operability: "To support HPI discharge crossover valve OPERABILITY, the safety grade flow indicator associated with the HPI discharge crossover valve is required to be OPERABLE."

f) The Bases state: "The flow path for each HPI train must maintain its designed independence to ensure that no single active failure can disable both HPI trains."

Duke proposes to replace this with the following statement: "The OPERABILITY of the HPI System must be maintained to ensure that no single active failure can disable both HPI trains. Additionally, while the HPI System was not designed to cope with passive failures, the HPI trains must be maintained independent to the extent possible during normal operation. The NRC approved exception to this principle is cross-connecting the HPI suction headers during normal operation (Ref. 6)."

g) The Bases state: "In the long term, this flow path may be manually transferred to take its supply from the reactor building sump...".

Duke proposes to modify this statement as follows: "In the recirculation phase, this flow path is manually transferred to take its supply from the reactor building sump...".

Justification for Proposed Changes

a) The Bases for the Actions have been rewritten to match the proposed changes to the Actions of ITS 3.5.2. The proposed changes to the Actions of ITS 3.5.2 were justified in a previous section of this attachment.

b) Additional information was added to assist the user in determinations regarding HPI train operability. For an HPI train to be operable, the associated HPI pump must be capable of taking suction from the BWST through the suction header valve associated with that train upon an ESPS signal. This information ensures that the HPI trains will not be vulnerable to a single failure.

c) Excluding the LPI pumps from the operability requirements regarding the LPI-HPI is appropriate, because the operability requirements for the LPI pumps are addressed in LCO 3.5.3.

d) Additional information was added to assist the user in determinations regarding HPI pump operability. For an HPI pump to be operable, the HPI pump must be capable of taking suction from the BWST upon an ESPS signal. This information ensures that the HPI pumps are capable of performing their function post-accident.

e) Additional information was added to assist the user in determinations regarding HPI discharge crossover valve operability. For an HPI discharge crossover valve to be operable, the associated safety grade flow indicator must be operable. This information was originally provided in the Background section of the Bases. It

has been removed from that section, and incorporated into the "LCO" section of the Bases.

f) The discussion regarding the requirement for the HPI System to be able to cope with a single active failure has been editorially enhanced, and expanded to include a discussion regarding passive failure considerations, and independence.

The discussion regarding the passive failure considerations reflects the current design basis as reflected in Supplement 1 to the AEC's Safety Evaluation for Oconee Unit 1 dated March 24, 1972, and incorporated by reference into the AEC's Safety Evaluation for Oconee Units 2 and 3 dated July 6, 1973.

The HPI requirements regarding independence are complicated; thus, a discussion regarding the separation requirements was added to ensure the user understood the need to maintain independence to the extent possible. Also, a reference to the NRC Safety Evaluation which permitted operation of the HPI suction headers to be cross-connected was added.

g) The recirculation phase begins when the suction for the LPI pumps is transferred from the BWST to the reactor building sump. Thus, replacing the term "long term" with "recirculation phase" is appropriate, because the term "recirculation phase" is more descriptive of the applicable plant condition.

Applicability Section of Bases for ITS 3.5.2

<u>Description of Proposed Changes</u>

a) Duke proposes to modify the Applicability section to reflect the new SBLOCA analysis.

b) The Bases state: "...and the availability of the LPI System..."

Duke proposes to replace the phrase "availability of" with the phrase "LCO 3.5.3 requirements of."

Justification for Proposed Changes

a) This proposed change was made to reflect the new SBLOCA analysis. Enclosure 1 of this Attachment provides a description of the SBLOCA analysis.

b) LCO 3.5.3 provides requirements regarding the LPI System. These requirements are applicable in Modes 1, 2, 3, and 4. Currently, the paragraph which discusses operation in Mode 3 with RCS temperature ≤ 350°F and in Mode 4 only implies that the LPI system would be available during these condition. In fact, two LPI trains are required to be operable during these Modes. Thus, the paragraph was revised to reference LCO 3.5.3.

Actions Section of Bases for ITS 3.5.2

Description of Proposed Changes

a) Duke proposes to revise the Actions section of the Bases to reflect the proposed changes to the Actions of ITS 3.5.2.

b) Duke proposes to provide the following guidance to the Bases for Required Actions A.1 and A.2:

"In the event HPI pump "C" becomes inoperable, Condition C must be entered as well as Condition A. Until actions are taken to align an HPI pump to HPI train "B," HPI train "B" is inoperable due to the inability to automatically provide injection in response to an ESPS signal. Additionally, in order to utilize another HPI pump to supply HPI train "B," HP-116 must be opened. This action results in cross-connecting the HPI discharge headers; thus, Condition E must be entered. The HPI discharge headers cannot be separated in this situation, because it would require HPI pumps "A" and "B" to operate with flows less than the minimum flow requirements.

This Condition permits multiple components of the HPI System to be inoperable concurrently. When this

occurs, other Conditions may also apply. For example, if HPI pump "C" and HP-409 are inoperable coincidentally, HPI train "B" is incapable of being automatically actuated or manually aligned from the Control Room. Thus, Required Action C.1 would apply."

Justification for Proposed Changes

a) The proposed changes to the Actions section of the Bases which reflect the proposed changes to the Actions of ITS 3.5.2 were justified in a previous section of this attachment.

b) Due to the complexity of the HPI System and the various configurations that could occur, additional information was added to the Bases of Required Actions A.1 and A.2 to assist the user in determinations regarding multiple condition entries.

Surveillance Requirements Section of Bases for ITS 3.5.2

Description of Proposed Changes

a) Duke proposes to revise the Bases discussion of SR 3.5.2.1 by including the following statement: "This SR does apply to the HPI suction header cross-connect valves, the HPI discharge cross-connect valves, the HPI discharge crossover valves, and the LPI-HPI flow path discharge valves (LP-15 and LP-16)."

b) Currently, the Bases discussion for SR 3.5.2.2 states: "Venting the HPI pump casings periodically reduces the potential that such voids and pockets of entrained gases can adversely affect operation of the HPI System. This will also minimize [emphasis added] the potential for water hammer, pump cavitation, and pumping of noncondensible gases..."

Duke proposes to revise this statement by replacing the word "minimize" with the word "reduce."

c) Duke proposes to revise the Bases discussion of SR 3.5.2.7 to reflect the proposed change to SR 3.5.2.7.

Also, additional information was added to define that the LPI-HPI flow path discharge valves must be capable of being stroked locally, and the HPI discharge crossover valves must be capable of being stroked from the Control Room.

Justification for Proposed Changes

a) Due to the complexity of the HPI System requirements, additional information was added to assist the user by defining that the positions of the HPI discharge crossover valves, the HPI discharge cross-connect valves, the HPI suction cross-connect valves, and the LPI-HPI flow path discharge valves must be verified in accordance with SR 3.5.2.1.

b) Replacing the word "minimize" with the word "reduce" is appropriate, because it corrects an inconsistency in the paragraph. The Bases states: "Venting the HPI pump casings periodically reduces the potential ..." Thus, venting can only reduce the potential for water hammer, pump cavitation, and pumping of noncondensible gases.

c) The Bases for SR 3.5.2.7 have been revised to reflect the changes to SR 3.5.2.7. The proposed changes to SR 3.5.2.7 were justified in a previous section of this attachment. Defining the locations for stroking the valves is consistent with the licensing basis for these operator actions.

References Section of Bases for ITS 3.5.2

Description of Proposed Changes

Duke proposes to add references to an NRC Safety Evaluation dated December 13, 1978, and a reference to this submittal.

Justification of Proposed Changes

The reference to the NRC Safety Evaluation dated December 13, 1978, is appropriate, because it provides the basis for the accident mitigation strategy regarding the HPI System (i.e., one HPI train automatically actuates, and the second

HPI train is aligned via manual operator actions from the Control Room within 10 minutes) and it provides the basis for operation with the HPI suction headers cross-connected.

The reference to this submittal is appropriate, because it provides part of the basis for operation of the unit for a limited period of time with Thermal Power ≤ 75% RTP and an HPI pump, HPI discharge crossover valve(s), or HPI train inoperable.

Bases for ITS 3.7.4

Description of Proposed Changes

Bases have been added for ITS 3.7.4, "Atmospheric Dump Valve (ADV) Flow Paths."

Justification for Proposed Changes

Bases have been provided to support the requirements for ITS 3.7.4.

ATTACHMENT 4, ENCLOSURE 1

SMALL BREAK LOSS OF COOLANT ACCIDENT ANALYSES

ATTACHMENT 4, ENCLOSURE 1
SMALL BREAK LOSS OF COOLANT ACCIDENT ANALYSES

Introduction

Duke has analyzed the small break loss of coolant accident (SBLOCA) at two core power levels (i.e., 100% and 75% rated Thermal Power). To account for Thermal Power measurement uncertainty, the core power was increased by 2 percent in each case.

The analysis of the SBLOCA at 100% RTP establishes the minimum complement of equipment required to ensure that the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K are met.

The analysis of the SBLOCA at 75% RTP credits one HPI train and enhanced steam generator cooling to ensure that the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K are met. It supports operation with Thermal Power less than or equal to 75% RTP with: 1) an HPI pump inoperable or one or more HPI discharge valve(s) inoperable for an extended period of time (i.e., 30 days); and 2) one HPI train inoperable for 72 hours. A description regarding the ADV flow paths is provided in Enclosure 2 of this attachment.

Methodology and Computer Code Description

The new SBLOCA analyses use the RELAP5-based Evaluation Model of BAW-10192-PA. The codes that constitute the SBLOCA Evaluation Model are identified in BAW-10192-PA, Volume II (Small Break), on p. 9-1. These codes are RELAP5/MOD2-B&W (BAW-10164) and CONTEMPT (BAW-10095A). The NRC SER for BAW-10192-PA included twelve restrictions as described in Section 6 of the SER. Each of these restrictions were reviewed for applicability to the SBLOCA analyses; an evaluation of these restrictions is provided below. Additionally, the restrictions regarding the use of RELAP5/MOD2-B&W (BAW-10164) and CONTEMPT (BAW-10095A) are addressed below.

Evaluation of Restrictions Regarding BAW-10192-PA

NRC Restriction #1: The LOCA methodology should include any NRC restrictions placed on the individual codes used in the evaluation model (EM).

Duke/FTI Response: The SBLOCA analyses are performed with the RELAP5/MOD2-B&W code, which was submitted as topical report BAW-10164. The NRC restrictions were stated in an SER dated April 18, 1990, and in an SER dated March 14, 1995. Some of the NRC restrictions placed on that code are not applicable to the B&W NSSS design or are not SBLOCA-related. The restrictions that are applicable to the Oconee HPI Technical Specification revision request are addressed as follows:

NRC SER Dated April 18, 1990: RELAP5/MOD2-B&W (BAW-10164 Revision 0 & 1)

Restriction (1): The Chen-Sundaram-Ozkaynak film-boiling correlation in the core heat transfer model and B&W auxiliary feedwater model for the once through steam generators were not reviewed and, therefore, should not be used in licensing calculations without prior review and approval by the NRC.

Duke/FTI Response: The CSO correlation is not used in any EM analyses and the B&W auxiliary feedwater model was reviewed and approved in Revision 3. FTI has verified that the Condie-Bengston IV correlation was used for the film boiling correlation.

Restriction (2): Prerupture cladding swell is not modeled because BWFC indicated that the swell is generally less than 20 percent with insignificant flow diversion effects. The acceptability of neglecting the effects of prerupture swelling is part of the LOCA EM review based on BWFCs analysis of the flow diversion effects. The SER on report BAW-10168P will address the resolution of this matter.

Duke/FTI Response: The maximum prerupture strain is 20 percent of the rupture stain. Since the maximum NUREG-0630

rupture strain is less than 90 percent, the resultant maximum prerupture strain must be less than 20 percent.

Restriction (3): The built-in-kinetics for decay heat calculations in the RELAP5/MOD2-B&W code are based on the 1973 and 1979 standards of the American Nuclear Society (ANS). Appendix K requires the use of a value that is 1.2 times the 1971 ANS standard for decay heat calculations. BWFC should ensure that the decay heat used in licensing LOCA analysis complies with Appendix K.

Duke/FTI Response: The 1973 option with a 1.2 multiplier is consistent with 1.2 times ANS 1971 decay heat and this is the option used for all Oconee SBLOCA analyses.

Restriction (4): The LOCA assessments of the Extended Henry-Fauske and Moody critical flow models were based on the use of the static properties as input to the critical flow tables. The LOCA licensing calculations should be performed accordingly.

Duke/FTI Response: FTI has verified that static properties have been used as input to the critical flow tables for Oconee SBLOCA analyses.

Restriction (5): The interphase drag model of the RELAP5/MOD2-B&W code tends to overpredict interphase drag. This overprediction may cause nonconservative predictions of loop seal clearing phenomena in that liquid is cleared even when the steam flow is not sufficiently high to drag the liquid out of the loop seal. Therefore, this model may not accurately calculate the core uncovery and the peak cladding temperature (PCT). A resolution requiring a sensitivity study to choose a proper loop seal nodalization that results in the highest PCT calculation will be addressed in the LOCA EM review.

Duke/FTI Response: Loop seal clearing is a phenomenon related to non-B&W designed plants. The reactor vessel vent valves in the B&W-designed plants provide a direct core steam venting path to cold leg break locations, such that loop seal clearing is not necessary for the B&W plant analyses.

Restriction (6): Even though noncondensible gases are not modeled in the SBLOCA system analysis, BWFC demonstrated the negligible effect that all sources of noncondensible gases will have on the overall response of the system for the range of SBLOCAs. However, BWFC noted that a 50 psi increase above the steam generator control pressure of 1150 psia could result from a worst case release of noncondensible gases. The staff believes that this pressure increase generally would not substantially reduce the injection capabilities of the charging and safety injections (SI) systems. However, because the performance characteristics of the SI pumps vary widely in the plants, verification should be made on a plant specific basis to ensure that a 50 psi pressure increase will not greatly reduce SI flow such that the PCT would increase by more than 50F. Otherwise, additional information should be provided to justify neglect of noncondensible gases, or the effect of the pressure increase caused by noncondensible gases should be included in the analysis.

Duke/FTI Response: This limitation is related to non-B&W designed plants and the reflux cooling mode of heat transfer. The reactor vessel vent valves in the B&W-designed plants provide a direct venting path for any core-generated noncondensibles to reach and be discharged out of the cold leg break. Therefore, this verification is not needed for the B&W plant analyses.

Restriction (7): For a complete safety analysis, an approved core thermal hydraulic code and CHF correlation should be used with the RELAP5/MOD2-B&W code. The noding details and inputs should be justified on a plant specific basis. The choice of constitutive models including the empirical models and correlations should be justified to ensure their use is within the ranges of applicability.

Duke/FTI Response: There are three approved CHF correlations that have been used for the core heat transfer in RELAP5/MOD2 EM analyses. These are BWC for any LOCA non-mixing vane grid assemblies (Mark-B9 and Mark-B10), BWUMV for SBLOCA mixing vane grid assemblies (Mark-B11), and BWCMV for LBLOCA mixing vane grid assemblies (Mark-B11). FTI has

verified the use of the BWUMV CHF correlation for the SBLOCA analyses based on the Mark-B11 fuel assembly type.

NRC SER Dated April 18, 1990: RELAP5/MOD2-B&W (BAW-10164 Revisions 2 & 3)

First Limitation: Use of Wallis and UPTF parameters at the tube bundle and steam generator plenum inlet are acceptable. The parameters used in the CCFL model for any other application must be validated, and the validation reviewed and approved by the staff for that application (see section 3.1.3 of this evaluation).

Duke/FTI Response: This is a limitation for recirculating steam generator plants. It is not applicable to B&W-designed plants.

Second Limitation: The BWUMV correlation is limited to pressures above 1300 psia.

Duke/FTI Response: The code heat transfer logic is programmed to use BWUMV above 1500 psia. It will linearly interpolate between Barnett and BWUMV between 1500 and 1300 psia. Below 1300 psia, Barnett and modified Barnett are used. Therefore, BWUMV cannot be used below 1300 psia.

Third Limitation: For large break LOCA ECCS evaluation model calculations, form losses due to ruptured cladding should not be excluded using the user option described in Section 3.2.4 of this evaluation.

Duke/FTI Response: The form losses due to cladding rupture are not excluded from the Oconee analyses.

Fourth Limitation: The value of the user-specified parameters listed in Table 1 of this evaluation (i.e. those used for the benchmark calculations) are the only acceptable values for LOCA licensing calculations.

Duke/FTI Response: FTI has reviewed the Oconee SBLOCA analyses for use of the user-specified parameters listed in Table 1. The parameters used were consistent with the table values except for the omission of the B&W slug-drag model

inside the SG tubes. This option was used in the benchmark cases reported in the EM appendices. Although use or non-use of this option has a negligible effect on the SBLOCA results, it is in direct contradiction of the restriction. FTI reanalyzed the two most limiting Oconee SBLOCA cases to confirm that the PCTs were similar, and in both cases the PCT was slightly less than the PCT predicted without the B&W slug-drag model option in the tubes.

NRC Restriction #2: The guidelines, code options, and prescribed input specified in Tables 9-1 and 9-2 in both Volume I and II of BAW-10192P should be used in LBLOCA and SBLOCA evaluation model applications, respectively.

Duke/FTI Response: The guidelines, code options and prescribed inputs specified in Tables 9-1 and 9-2 in Volume II (SBLOCA) of BAW-10192P provide a summary of the inputs and models used in SBLOCA analyses. FTI has verified the proper application of these inputs and models, with the clarification of two areas for which the EM interpretation is unclear. These two areas are the (1) rupture temperature ramp rate and (2) two-phase pump degradation multipliers.

The plastic-weighted time averaged ramp rate option was not specifically used for the SBLOCA analyses because a composite set of pin parameters is used to maximize the PCT prediction. See the response to NRC Restriction 5 for clarification of the time-in-life (TIL) input method.

The two-phase pump degradation model was listed as the default option. There is no default option in RELAP5/MOD2-B&W so this designation is unclear. For SBLOCA analyses, the two-phase pump degradation multiplier has little impact because the reactor coolant pumps (RCPs) coast down on loss of offsite power or on manual trip by the operator on loss of subcooling margin. Without the RCPs, the SBLOCA evolves into a low flow condition that is unaffected by the two-phase head difference multiplier table used. Nonetheless, a basis for the head multiplier curve is required. FTI used the M1 degradation model for the Oconee SBLOCA analyses. This model was shown to be the most limiting for the higher flow LBLOCA analyses, therefore it was used for the SBLOCA analyses.

NRC Restriction #3: The limiting linear heat rate for LOCA limits is determined by the power level and the product of the axial and radial peaking factors. An appropriate axial peaking for use in determining LOCA limits is one that is representative of the fuel and core design and that may occur over the core lifetime. The radial peaking factor is then set to obtain the limiting linear heat rate. For this demonstration, calculations were performed with the axial peak of 1.7. The general approach is acceptable for demonstrating the LOCA limits methodology. However, as future fuel or core designs evolve, the basic approaches that were used to establish these conclusions may change. FTI must revalidate that acceptability of the evaluation model peaking methods if: (1) significant changes are found in the core elevation at which the minimum core LOCA margin is predicted or (2) the core maneuvering analyses radial and axial peaks that approach the LOCA LHR limits differ appreciably from those used to demonstrate Appendix K compliance.

Duke/FTI Response: This limitation is primarily for LBLOCA analyses. SBLOCA analyses are analyzed at the highest core linear heat rate (LHR) limit with a core exit-skewed power peak to produce conservative PCT results.

NRC Restriction #4: The mechanistic ECCS bypass model is acceptable for cold leg transition ($0.75 ft^2$ to $2.0 ft^2$) and hot leg break calculations. The nonmechanistic ECCS bypass model must be used in the large cold leg break ($\geq 2.0\ ft^2$) methodology since the demonstration calculations and sensitivities were run with this model.

Duke/FTI Response: The SBLOCA evaluations cover break sizes up to $0.75\ ft^2$, therefore no bypass model is used.

NRC Restriction #5: Time-in-life LOCA limits must be determined with, or shown to be bounded by, a specific application of the NRC-approved evaluation model.

Duke/FTI Response: The small break evaluation model includes a provision for predicting cladding swelling and rupture based on NUREG-0630 data. Flow diversion is modeled through the use of hot and average channels, cross flow, and the axial resistance due to flow blockage at the ruptured location. Once rupture has been calculated, the heat transfer, heat conduction, and metal-water reaction models are updated for the resultant strain and the availability of interior clad surface for oxidation.

Time-in-life (TIL) calculations for SBLOCA applications are not required unless the fuel pin heatup is sufficient to cause cladding rupture. FTI evaluates the likelihood of rupture by analyzing the SBLOCA with a composite set of pin conditions that provide a conservative PCT prediction. End-of-life pin pressures are used to maximize the cladding hoop stresses, thereby improving the likelihood of rupture for those cases that do experience heatup. To maximize the cladding temperatures, the beginning-of-life (BOL) fuel stored energy and BOL oxide thicknesses are used. FTI has also used a constant normalized heating ramp rate limit of zero for some cases to maximize the likelihood of cladding rupture. Any case that predicts cladding rupture with these conditions is further parameterized by adjusting the time of rupture (via pin pressure or normalized heating ramp rate changes) to push rupture to the time of peak cladding temperature. This composite method ensures that the calculated PCT will bound any PCT predicted by a consistent TIL analysis with appropriate TIL pin parameters. A pure TIL calculation (with fuel stored energy, pin pressure, and cladding oxide thickness consistent with the TIL that produces the worst rupture time) would be performed if the composite case is judged to be overly conservative. The consistent case would also use the plastic-weighted normalized heating ramp rate to predict the fuel pin swell and rupture performance.

NRC Restriction #6: LOCA limits for three-pump operation must be established for each class of plants by application of the methodology described in this report. An acceptable approach is to demonstrate that three-pump operation is bounded by four pump LHR limits.

Duke/FTI Response: For SBLOCA analyses, three pump operation is bounded by four pump full power operation because the three pump operation is at a reduced total core power (75 percent for Oconee). The reduced power level lowers the predicted PCT because of the decreased core liquid boiloff rate.

NRC Restriction #7: The limiting ECCS configuration, including minimum versus maximum ECCS, must be determined for each plant or class of plant using this methodology.

Duke/FTI Response: This determination is applicable for LBLOCA analyses and relates specifically to ECCS flow effects on containment pressure. SBLOCA break sizes that would not unchoke before the core is refilled are unaffected by the containment pressure used as a boundary condition. If the SBLOCA analyses were performed with a maximum ECCS flow, there would be less core uncovering with little to no core heatup.

NRC Restriction #8: For the small break model, the hot channel radial peaking factor to be used should correspond to that of the hottest rod in the core, and not to the radial peaking factor of the 12 hottest bundles.

Duke/FTI Response: There are twelve assemblies modeled in the hot bundle and each pin is peaked to the hot pin radial value.

NRC Restriction #9: The constant discharge coefficient model (discharge coefficient = 1.0) referred to as the "High or Low Break Voiding Normalized Value," should be used for all small break analyses. The model which changes the discharge coefficient as a function of void fraction, i.e., the "Intermediate Break Voiding Normalized Value," should not be used unless the transient is analyzed with both discharge models and the intermediate void method produces the more conservative results.

Duke/FTI Response: FTI has verified that a constant discharge coefficient of 1.0 was used for the SBLOCA analyses.

NRC Restriction #10: For a specific application of the FTI small break LOCA methodology, the break size which yields the local maximum PCT must be identified. In light of different possible behaviors of the local maximum, FTI should justify its choice of break sizes in each application to assure that either there is no local maximum or the size yielding the maximum local PCT has been found. Break sizes down to 0.01 ft^2 should be considered.

Duke/FTI Response: For 75 percent power analyses, the 0.07 ft^2 break size gave a local maximum PCT of 1862 °F, where both the 0.075 ft^2 and the 0.065 ft^2 break sizes yielded lower PCTs. The 100 percent power analyses yielded a local maximum PCT of 1369 °F for the 0.15 ft^2 break, with the 0.125 ft^2 and 0.175 ft^2 breaks giving lower PCTs.

The fineness of these break spectrums is sufficient for identifying the limiting break sizes. A break size of 0.01 ft^2 for the full power and 75% full power cases has also been evaluated and is non-limiting.

NRC Restriction #11: B&W-designed plants have internal reactor vessel vent valves (RVVVs) that provide a path for core steam venting directly to the cold legs. The BWNT LOCA evaluation model credits the RVVV steam flow with the loop steam venting for LBLOCA analyses. The possibility exists for a cold leg pump suction to clear during blowdown and then reform during reflood before evaluation model analyses predict average core quench. Since the REFLOOD3B code cannot predict this reformation on the loop seal, FTI is required to run the RELAP5/MOD2-B&W system model until the whole core quench, to confirm that the loop seal does not reform. This demonstration should be performed at least once for each plant type (raised loop and lowered loop) and be judged applicable for all LBLOCA break sizes.

Duke/FTI Response: This is a LBLOCA specific limitation. The SBLOCA analyses will generally retain a cold leg pump suction loop seal during the PCT prediction.

Evaluation of Restrictions Regarding Codes Referenced in BAW-10192-P

The SER limitations and restrictions related to BAW-10164 and applicable to SBLOCA were addressed in the evaluation of the restrictions regarding BAW 10192-P noted above.

With regard to use of the CONTEMPT code for calculating the containment backpressure, on p. 4-27 of BAW-10192-P it is stated that since the break flow remains choked for the duration of the SBLOCA analyses including the time of peak cladding temperature, the containment backpressure does not influence the transient. Furthermore, it states that the containment pressure is not a critical factor in these accidents as long as the value used is reasonable. For these reasons, the Oconee SBLOCA analyses use an appropriate input value for containment backpressure rather than the CONTEMPT code. Consequently, any SER restrictions associated with the NRC review of BAW-10095A are no longer applicable to SBLOCA analyses.

Comparison of CRAFT-based versus RELAP5-based SBLOCA

A specific comparison between SBLOCA results from the old (CRAFT-based) and new (RELAP5-based) Evaluation Models is not available. In addition to the differences between codes, a large number of initial and boundary condition assumptions have been revised in the new analyses. In general, it can be stated that the combination of the code and assumption changes has resulted in a longer period of core uncovery and higher PCTs for SBLOCAs.

Summary of SBLOCA Analyses

Full Power, Two HPI Pump Analyses

This section addresses the consequences of a SBLOCA initiating from full power. For the SBLOCA analyses, a loss of offsite power is assumed to occur at the time of reactor trip. The reactor coolant pumps are assumed to begin to coast down at the time of reactor trip. The single failure chosen minimizes the delivered ECCS flow. This assumption

involves a power supply failure (4160 V switchgear TC, TD, or TE) that results in only one HPI pump supplying two cold legs initially, with the SBLOCA occurring on one of these two cold legs. The analysis assumes operator actions to: 1) cross-connect HPI trains at ten minutes in order to balance the HPI flow; 2) begin manually increasing steam generator levels from the natural circulation level setpoint to the loss of subcooled margin level setpoint within 20 minutes following reactor trip for one steam generator, and within 30 minutes for the second steam generator; and 3) steam one generator through an ADV flow path at 55 minutes. These actions are required by the Emergency Operating Procedure following actuation of the HPI System and a loss of subcooled margin. A discussion of the required operator actions are provided in Enclosure 3 of this attachment.

While steaming a steam generator through an ADV flow path is modeled, it is not a critical assumption for meeting the acceptance criteria of 10 CFR 50.46. For these analyses, the ADVs are opened on one or both steam generators such that a 50°F/hr cooldown rate is maintained. However, the transient analyses at 100% FP for all break sizes, except the HPI line break, were terminated prior to the opening of the ADVs.

In order to assess the significance of steaming only one steam generator for the full power cases, a sensitivity analysis was performed for the limiting 0.15 ft^2 break. This sensitivity case also assumed that emergency feedwater (EFW) was only supplied to one steam generator, following a loss of MFW at time zero. This loss of MFW assumption is consistent with the need for evaluating EFW to only one SG, since if MFW is available both steam generators could be supplied with feedwater. The analysis results show that the peak cladding temperature did not increase with only one steam generator being supplied with emergency feedwater and steamed. It is therefore concluded that whether or not the ADVs on one or both steam generators are steamed does not have a significant effect on the SBLOCA results.

Reduced Power, One HPI Pump Analyses

The performance of the ECCS was also evaluated assuming that one of the three HPI pumps is initially unavailable. The

limiting single failure results in only one HPI pump injecting following a SBLOCA. This analysis supports operation with Thermal Power less than or equal to 75% with: 1) an HPI pump inoperable or one or more HPI discharge valve(s) inoperable for an extended period of time (i.e., 30 days) and; 2) one HPI train inoperable for 72 hours. A discussion of the ADV flow paths is provided in Enclosure 2 of this attachment.

A loss of offsite power is assumed to occur at the time of reactor trip. The reactor coolant pumps are assumed to begin to coast down at the time of reactor trip. The single failure chosen minimizes the delivered ECCS flow. This assumption involves a power supply failure (4160 V switchgear TC, TD, or TE) that results in only one HPI pump supplying two cold legs, with the SBLOCA occurring on one of these two cold legs. The analysis takes credit for operator action to provide EFW to one steam generator within 20 minutes, and to provide cooldown of one steam generator within 25 minutes. Operator action to cross-connect the HPI pump discharge headers is not credited, because one HPI pump cannot supply both headers due to pump runout concerns. A discussion of the credited operator actions is provided in Enclosure 3 of this attachment.

Break Sizes Considered

The SBLOCA break spectrum for B&W lowered-loop plants like Oconee has been established historically as the LOCA Evaluation Models and analyses have evolved. The current limiting SBLOCAs have been identified and confirmed by analyses as the cold leg pump discharge break (bottom of the pipe), the core flood line break, and the HPI line break. The limiting cold leg pump discharge break size is determined for each plant and set of assumptions by analyzing a sufficiently fine break spectrum. The limiting break size is identified by the highest PCT. Since the SBLOCA PCT has always remained well below the LBLOCA PCT, there has always been margin in the SBLOCA results for Oconee. The core flood line break and the HPI line break have been identified as special SBLOCA cases, at specific locations and with specific break sizes. The core flood line break (0.44 ft^2) corresponds to the inside diameter of

the core flood nozzle insert that was installed to limit the break size. The limiting single failure and available ECCS equipment for the core flood line break are unique due to its specific location.

Similarly, the HPI line break (0.025 ft^2) corresponds to the inside diameter of the injection line where it connects to the nozzle on the cold leg. This break has unique ECCS performance due to the spilling of the HPI injection flow on the broken injection line, which results in a more adverse loss of ECCS flow. The SBLOCA spectrum does not consider failure of the HPI injection nozzle; this is an established licensing position. Thus, break sizes greater than 0.025 ft^2 associated with the nozzle breaking off the RCS and the affected HPI line being exposed to containment back pressure are not postulated. This position is shared by all B&W design plants. This submittal is not introducing any new licensing positions relative to the SBLOCA break spectrum.

Full Power, Two HPI Pumps Analyses

The full power, two HPI pump, SBLOCA analyses include cold leg pump discharge breaks (0.04, 0.07, 0.1, 0.125, 0.15, 0.175, 0.2, 0.3, 0.5, and 0.75 ft^2), and the special cases of the 0.44 ft^2 core flood line break and the 0.025 ft^2 HPI line break. Also, a break size of 0.01 ft^2 was evaluated. The limiting full power case is identified as the 0.15 ft^2 break with a PCT of 1369°F. The fineness of these break spectrums is sufficient for identifying the limiting break sizes.

Reduced Power, One HPI Pump Analysis

The 75% power, one HPI pump, SBLOCA analyses include cold leg pump discharge breaks (0.04, 0.065, 0.07, 0.075, 0.08, 0.10, and 0.20 ft^2), and the special case of the 0.025 ft^2 HPI line break. Also, a break size of 0.01 ft^2 was considered. The limiting case is identified as the 0.07 ft^2 break with a PCT of 1862°F. The fineness of these break spectrums is sufficient for identifying the limiting break sizes.

Cases Not Reanalyzed

The RELAP5 CFT and HPI line break analyses at 100% RTP performed in November 1994 were bounding and were not reanalyzed. The CFT line break analysis at 65% RTP was bounding and was not reanalyzed at 75% RTP.

The core flood line break has been analyzed by FTI at 100 percent power and 65 percent power and the core remains continuously covered and cooled with no core uncovering. The PCT is equal to the initial cladding temperature at break opening time. During the first 10 minutes following Engineered Safeguards actuation, the ECCS systems (one HPI pump feeding two cold legs and one core flood tank) combine to provide core boiloff makeup and establish a core mixture level at ten minutes post-LOCA that is more than 4 ft above the top of the core for the 100 percent power case. The minimum mixture level for the 65 percent power case was several feet higher. For the analysis conducted at 65% RTP, one HPI pump can provide 389 gpm of flow to the core at ten minutes. This flow is capable of removing 389gpm*0.1375lbm/s/gpm*(1150 - 88)Btu/lbm = 56,800 Btu/s of decay heat energy via boiloff at 14.7 psia. The decay heat fraction at 10 minutes post-LOCA is 0.0282 times the initial power level. The decay heat power for a 77 percent power case is 0.77 * 2568MWt * 0.0282 * 948Btu/s/MWt = 52,900 Btu/s. The HPI flow exceeds the decay heat boiloff, so there will be at least 4 feet of mixture above the top of the core at 10 minutes post LOCA. Therefore, the CFT line break at 75 percent power need not be analyzed because the 65% power case and a hand calculation show that the core will not uncover.

HPI Flow Rate

HPI System flow rate boundary conditions are predicted by a computer code that models the hydraulic characteristics of the system. The flow model inputs such as piping resistances and pump characteristics are sufficiently conservative to ensure that flow results bound actual test data. Boundary conditions for the model are established to obtain conservative predictions of delivered flow to the RCS

for each SBLOCA case. For the RCP discharge breaks, each HPI line is assumed to be at RCS pressure. For the HPI line break case, the broken HPI line is assumed to be at containment pressure and the remaining lines are exposed to RCS pressure.

For each specific accident analysis (i.e., core flood line break, RCP discharge break, and HPI line break), one piping injection loop is intentionally modeled to have an additional degree of flow resistance than that found in the normal hydraulic flow model. This is accomplished by increasing the hydraulic minor loss coefficient in the chosen loop. Accordingly, an artificial flow imbalance is created in the system model. Depending upon the specific accident being evaluated, the flow imbalance is conservatively adjusted to minimize injected flow to the core.

Full Power, Two HPI Pumps Analyses

The following tables provide the HPI flow for the SBLOCA analysis at 100% RTP. Only one HPI pump is injecting during the first ten minutes, and two HPI pumps are injecting thereafter.

Core Flood Line Break (1st 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	TOTAL HPI FLOW (gpm) (2 loop sum)
0	0	0	243	185	428
600	0	0	243	185	428
1200	0	0	189	144	333
1500	0	0	167	127	294
1600	0	0	159	121	280
1800	0	0	142	108	250
2400	0	0	72	55	127

Core Flood Line Break (After 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	TOTAL HPI FLOW (gpm) (4 loop sum)
0	193	196	243	185	817
600	193	196	243	185	817
1200	159	161	189	144	653
1500	139	140	167	127	573
1600	131	133	159	121	544
1800	115	117	142	108	482
2400	51	52	72	55	230

RCP Discharge Break (1st 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	HPI BROKEN LEG FLOW (gpm) (B1 Loop)	HPI INTACT LEG FLOW (gpm) (B2 Loop)	TOTAL HPI FLOW (gpm) (2 loop sum)
0	0	0	243	185	243	185	428
600	0	0	243	185	243	185	428
1200	0	0	189	144	189	144	333
1500	0	0	167	127	167	127	294
1600	0	0	159	121	159	121	280
1800	0	0	142	108	142	108	250
2400	0	0	72	55	72	55	127

RCP Discharge Break (After 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	HPI BROKEN LEG FLOW (gpm) (B1 Loop)	HPI INTACT LEG FLOW (gpm) (A1 +A2 + B2)	TOTAL HPI FLOW (gpm) (4 loop sum)
0	193	196	243	185	243	574	817
600	193	196	243	185	243	574	817
1200	159	161	189	144	189	464	653
1500	139	140	167	127	167	406	573
1600	131	133	159	121	159	385	544
1800	115	117	142	108	142	340	482
2400	51	52	72	55	72	158	230

HPI Line Break (1st 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	HPI SPILLED FLOW (gpm) (B2 Loop)	HPI INJECTED FLOW (gpm) (B1 Loop)	TOTAL HPI FLOW (gpm) (2 loop sum)
0	0	0	181	259	259	181	440
600	0	0	124	320	320	124	444
1200	0	0	48	384	384	48	432
1500	0	0	0	408	408	0	408
1600	0	0	0	408	408	0	408
1800	0	0	0	408	408	0	408
2400	0	0	0	408	408	0	408

HPI Line Break (After 10 minutes)

RCS PRESSURE (psig)	A1 Loop Flow (gpm)	A2 Loop Flow (gpm)	B1 Loop Flow (gpm)	B2 Loop Flow (gpm)	HPI SPILLED FLOW (gpm) (B2 Loop)	HPI INJECTED FLOW (gpm) (A1 +A2 + B1)	TOTAL HPI FLOW (gpm) (4 loop sum)
0	193	196	181	259	259	570	829
600	193	196	124	320	320	513	833
1200	159	161	46	383	383	366	749
1500	139	140	0	407	407	279	686
1600	131	133	0	407	407	264	671
1800	115	117	0	407	407	232	639
2400	51	52	0	407	407	103	510

Reduced Power, One HPI Pump Analyses

The HPI boundary conditions for the reduced power, one HPI pump SBLOCA analyses are as follows:

Core Flood Line Break

RCS PRESSURE (psig)	FLOW SPLIT (gpm)		TOTAL HPI FLOW (gpm) (2 loop sum)
0	221	168	389
600	221	168	389
1200	175	134	309
1500	153	117	270
1600	145	110	255
1800	128	97	225
2400	57	43	100

RCP Discharge Break

RCS PRESSURE (psig)	HPI INTACT LEG FLOW (gpm)	HPI BROKEN LEG FLOW (gpm)	TOTAL HPI FLOW (gpm) (2 loop sum)
0	167	223	390
600	167	223	390
1200	133	177	310
1500	116	155	271
1600	110	147	257
1800	96	129	225
2400	43	57	100

HPI Line Break

RCS PRESSURE (psig)	HPI INJECTED FLOW (gpm)	HPI SPILLED FLOW (gpm)	TOTAL HPI FLOW (gpm) (2 loop sum)
0	165	236	401
600	101	303	404
1200	21	378	399
1500	0	389	389
1600	0	389	389
1800	0	389	389
2400	0	389	389

Results

The following table provides the results of the full power and reduced power break spectrums using the RELAP5-based evaluation model:

Break Size (ft^2)	Initial Power Level (%)	Time of RPS trip (sec)	Time of ES signal (sec)	Transient End Time (sec)	Time of manually aligning HPI trains	Time to initiate raising SG1 level to 95%	Time to open ADVs on the first SG	PCT (°F)
0.44, core flood line	100	0.3201	8.68	700	ES+10 min.	**Note 1**	**Note 4**	715 *(Nov. 1994)*
0.025, HPI line	100	38.30	70.04	6400	ES+10 min.	ES+20 min. **Note 5**	ES+55 min. **Note 4**	715 *(Nov. 1994)*
0.04	100	22.88	47.98	2617	ES+10 min.	ES+20 min. **Note 5**	**Note 4**	715 *(Nov. 1994)*
0.07	100	11.96	30.62	1589	ES+10 min.	ES+20 min.	**Note 4**	715
0.1	100	7.28	22.76	1468	ES+10 min.	ES+20 min.	**Note 4**	1339
0.125	100	5.20	19.26	1188	ES+10 min.	**Note 1**	**Note 4**	1362
0.15	100	3.78	16.44	1000	ES+10 min.	**Note 1**	**Note 4**	1369
0.175	100	2.76	14.54	865	ES+10 min.	**Note 1**	**Note 4**	1322
0.2	100	1.96	13.32	794	ES+10 min.	**Note 1**	**Note 4**	1275
0.3	100	0.640	10.46	499	**Note 1**	**Note 1**	**Note 4**	1141
0.5	100	0.260	8.08	258	**Note 1**	**Note 1**	**Note 4**	931
0.75	100	0.160	6.84	204	**Note 1**	**Note 1**	**Note 4**	985
0.44, core flood line	65 **Note 3**	0.32	3.76	1200	**Note 2**	ES+20 min.	ES+30 min. **Note 3**	715 *(Jan. 1995)*
0.025, HPI line	75	40.0	67.14	2900	**Note 2**	ES+20 min.	ES+25 min	715
0.04	75	23.46	42.80	1700	**Note 2**	ES+20 min.	ES+25 min.	715
0.065	75	13.62	26.84	1700	**Note 2**	ES+20 min.	ES+25 min.	1669

Break Size (ft^2)	Initial Power Level (%)	Time of RPS trip (sec)	Time of ES signal (sec)	Transient End Time (sec)	Time of manually aligning HPI trains	Time to initiate raising SG1 level to 95%	Time to open ADVs on the first SG	PCT (°F)
0.07	75	12.48	24.90	1700	**Note 2**	ES+20 min.	ES+25 min.	1862
0.075	75	11.46	23.24	1700	**Note 2**	ES+20 min.	ES+25 min.	1761
0.08	75	10.54	21.84	1700	**Note 2**	ES+20 min.	ES+25 min.	1696
0.10	75	7.80	17.62	1700	**Note 2**	ES+20 min.	ES+25 min.	1619
0.20	75	2.30	10.24	720	**Note 2**	**Note 1**	**Note 4**	1224

Note 1: These cases were terminated prior to the raising on SG1 level to 95% OR and/or the time to open the ADVs. The transients were terminated because the peak cladding temperature had been determined and appropriate long-term cooling had been assured.

Note 2: For 75% RTP analyses, only one HPI pump is modeled at ES+48 seconds.

Note 3: The RELAP5 CFT line break analysis at 65% RTP bound the 75% RTP case assuming that ADV blowdown occurs at ES+25 minutes.

Note 4: For the 100% RTP analyses, the ADVs are opened on one or both steam generators such that a 50°F/hr cooldown rate is maintained. However, the transient analyses at 100% RTP for all break sizes, except the HPI line break, were terminated prior to the opening of the ADVs. For the 75% RTP analyses, the ADVs were opened only on the first steam generator. For the 0.20 ft^2 break at 75% RTP, the transient was terminated prior to the opening of the ADVs.

Note 5: The raising of SG2 level to 95% OR is modeled at ES+30 minutes.

Conclusion

The results presented for the SBLOCA reanalyses include numerous Evaluation Model conservatisms, which have been reviewed and approved by the NRC, in addition to many conservative initial and boundary conditions. The integrated application of these conservative modeling approaches and assumptions ensures a conservative result.

All of the 10 CFR 50.46 LOCA acceptance criteria were met for the Oconee SBLOCA analyses. The limiting PCTs were well within the 2200°F limit. The SBLOCA local cladding oxidation is confirmed to be less than the 17% limit. The calculated SBLOCA hot channel oxidation is less than 1%, which ensures that the whole core oxidation is less than 1%. The consequences of both thermal and mechanical deformation of the fuel assemblies in the core have been assessed, and the resultant deformations have been shown to maintain coolable core configurations. The long-term cooling of the core is ensured by maintaining ECCS flow in excess of the decay heat load, and by preventing boric acid precipitation via establishing a long-term boron concentration control process. The Oconee ECCS design and emergency operating procedures accomplish the long-term cooling function, and meet this acceptance limit.

ATTACHMENT 4, ENCLOSURE 2

INFORMATION REGARDING THE ATMOSPHERIC DUMP VALVES

ATTACHMENT 4, ENCLOSURE 2
INFORMATION REGARDING ATMOSPHERIC DUMP VALVES

Description

For each steam generator, a main steam atmospheric dump valve (ADV) flow path consists of the atmospheric dump block valve bypass (1" bypass), the atmospheric vent valve (a 12" block valve), the atmospheric dump control valve (i.e., throttle valve), and the atmospheric vent block valve (i.e., isolation valve). Each of these valves are chain operated. The throttle valve and the isolation valve are in parallel and are located downstream of the atmospheric vent valve. None of the valves are reverse acting; thus, they all open and close the same way. However, the valves are not necessarily the same type from unit to unit or steam generator to steam generator on a given unit.

The valves are located on the turbine deck just outside the Control Rooms, are easily accessible, and are clearly visible. Labels are provided which identify the valves in a manner consistent with the valve designations referenced in the emergency operating procedure.

The atmospheric vent valve should be opened prior to opening the throttle valve or isolation valve. This is accomplished by first opening the atmospheric dump block valve bypass. This equalizes the differential pressure across the atmospheric vent valve. While there would be no consequence of opening the valves out-of-sequence, it is unlikely that the atmospheric vent valve could be opened prior to opening the atmospheric dump block valve bypass (i.e., the pressure being equalized across the valve). Once the atmospheric vent valve is opened, the cooldown rate is controlled using the throttle valve. If additional relief capacity is needed, the operator can open the isolation valve. The capacity of the throttle or isolation valve exceeds decay heat loads and is sufficient to cool down the plant. A copy of the procedure that provides instructions regarding the operation of the ADVs is provided at the end of this enclosure.

The valves do not possess position indicators. Thus, Operations Management Procedure 1-2 (Rules of Practice) provides guidance for verifying valve positions. For these

valves, the means to determine position include: 1) moving the valve to determine position; 2) observation of valve stem; 3) system response (flow, noise, etc.); and 4) a peer check by another qualified individual.

Classification

A portion of the ADV flow path is designed as QA-1 and seismic. The bypass and block valves and their associated piping are QA-1 and seismic, as they form the pressure boundary of the main steam line. However, the throttle and isolation valves and their associated piping, which are downstream of the block valve, were not designed as QA-1 or seismic. This categorization is consistent with the original design and licensing basis of the plant.

Chapter 3.1.1 of the UFSAR describes the structures, systems, and components required to be QA-1 at ONS. The basis of this list is somewhat different than many other licensees in that the list was not directly generated based on functional definitions. In other words, one cannot assume a QA classification based on function. This somewhat unique definition of QA at Oconee was explained in a Duke submittal to the staff dated April 12, 1995, and confirmed in an SER from the NRC to Duke dated August 3, 1995.

The UFSAR also provides guidance on the seismic requirements. Chapter 3.2.2 states, …"A maximum hypothetical earthquake will not result in a loss-of-coolant accident (LOCA), but the simultaneous occurrence of these events will not result in loss of function to vital safety related components or systems. The simultaneous occurrence of the maximum hypothetical earthquake and a LOCA is only a design criterion. A LOCA is not postulated to occur simultaneously with a maximum hypothetical earthquake during accident analysis." A December 5, 1994, letter from the NRC to Duke reiterates this position by stating "a seismic event or an independent pipe break is not postulated to occur concurrently with a LOCA." In summary, all equipment designated as safety-related is designed seismically. Since the ADVs are not safety-related, they are not required to be seismically designed. However, a LOCA and seismic event are

not postulated to occur simultaneously; therefore, the ADVs will be able to function during the SBLOCA.

General Design Criterion 1 of 10 CFR 50, Appendix A, states that:

> "Structures, systems and components important to safety shall be designed, fabricated, erected, and tested to quality standards *commensurate with the importance of the safety functions to be performed.*" (emphasis added)

It has been previously recognized by the staff that, depending upon the importance of the function, it is acceptable to credit non-safety equipment in the mitigation of some design basis accidents. For example, many licensees have safety-related feedwater or main steam isolation systems that, if a single failure occurs, would rely on backup non-safety equipment to complete the isolation function.

As stated above, a portion of the ADV flow path is designed as QA-1 and seismic. Duke believes that including the remainder of the flow path in its QA-5 program provides quality standards commensurate with the importance of the safety function. The QA-5 program applies testing and maintenance quality controls consistent with those applied to QA-1 components. Duke believes the QA-5 program applies acceptable quality controls in lieu of reclassifying the ADV flow path to QA-1. This determination is based on the low likelihood of a SBLOCA that would require operation of these valves, the fact that a seismic event is not postulated to occur coincident with a small break LOCA, the ADVs are manual valves, and the proposed surveillance requirements for the ADV flow path that will assure continued operability of these valves. It should be noted that the QA-5 program is currently under development. It may be necessary to adopt an interim method of testing and maintenance that appropriately applies the QA-5 concepts until the formal program is implemented.

Testing

Assurance that the valves will be available when required is provided by full stroke testing on a refueling basis as part of Oconee's supplemental valve testing program. Every fifth refueling an actual steam flow test is conducted to assure throttle valve controllability. As an aside, it should be noted that these valves are included on Oconee's SQUG safe shutdown equipment list and have been successfully evaluated as being able to survive and operate after an earthquake.

EMERGENCY OPERATING PROCEDURE
EP/1/A/1800/01

ENCLOSURE 7.7
Operation of the Atmospheric Dump Valves

NOTE Communication with the Control Room will be necessary to monitor cooldown rate and SG pressure.

1.0 To establish cooldown or to lower SG pressure with the '1A' SG perform the following:

_____ 1.1 Verify closed 1MS-217 (Atmos Dump Drain).

_____ 1.2 Open 1MS-161 (MS Line 'A' Atmos Dump Block Valve Bypass).

_____ 1.3 Open 1MS-153 (MS Line 'A' Atmos Vent).

_____ 1.4 Throttle open 1MS-162 (MS Line 'A' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

_____ 1.5 IF **CANNOT** establish or maintain cooldown with 1MS-162 (MS Line 'A' Atmos Dump Control Valve),
THEN throttle open 1MS-154 (MS Line 'A' Atmos Vent Block).

_____ 1.6 Monitor cooldown rate and SG pressure.

EMERGENCY OPERATING PROCEDURE
EP/1/A/1800/01

ENCLOSURE 7.7

Operation of the Atmospheric Dump Valves

2.0 To establish cooldown or to lower SG pressure with the '1B' SG perform the following:

_____ 2.1 Verify closed 1MS-176 (Atmos Dump Drain).

_____ 2.2 Open 1MS-163 (MS Line 'B' Atmos Dump Block Valve Bypass).

_____ 2.3 Open 1MS-155 (MS Line 'B' Atmos Vent).

_____ 2.4 Throttle open 1MS-164 (MS Line 'B' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

_____ 2.5 <u>IF</u> **CANNOT** establish or maintain cooldown with 1MS-164 (MS Line 'B' Atmos Dump Control Valve),
<u>THEN</u> throttle open 1MS-156 (MS Line 'B' Atmos Vent Block).

_____ 2.6 Monitor cooldown rate and SG pressure.

EMERGENCY OPERATING PROCEDURE
EP/2/A/1800/01

ENCLOSURE 7.7
Operation of the Atmospheric Dump Valves

NOTE Communication with the Control Room will be necessary to monitor cooldown rate and SG pressure.

1.0 To establish cooldown or to lower SG pressure with the '2A' SG perform the following:

_____ 1.1 Open 2MS-161 (MS Line 'A' Atmos Dump Block Valve Bypass).

_____ 1.2 Open 2MS-153 (MS Line 'A' Atmos Vent).

_____ 1.3 Throttle open 2MS-162 (MS Line 'A' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

_____ 1.4 IF **CANNOT** establish or maintain cooldown with 2MS-162 (MS Line 'A' Atmos Dump Control Valve),
THEN throttle open 2MS-154 (MS Line 'A' Atmos Vent Block).

_____ 1.5 Monitor cooldown rate and SG pressure.

EMERGENCY OPERATING PROCEDURE
EP/2/A/1800/01

ENCLOSURE 7.7

Operation of the Atmospheric Dump Valves

2.0 To establish cooldown or to lower SG pressure with the '2B' SG perform the following:

_____2.1 Open 2MS-163 (MS Line 'B' Atmos Dump Block Valve Bypass).

_____2.2 Open 2MS-155 (MS Line 'B' Atmos Vent).

_____2.3 Throttle open 2MS-164 (MS Line 'B' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

_____2.4 <u>IF</u> **CANNOT** establish or maintain cooldown with 2MS-164 (MS Line 'B' Atmos Dump Control Valve),

<u>THEN</u> throttle open 2MS-156 (MS Line 'B' Atmos Vent Block).

_____2.5 Monitor cooldown rate and SG pressure.

EMERGENCY OPERATING PROCEDURE
EP/3/A/1800/01

ENCLOSURE 7.7

Operation of the Atmospheric Dump Valves

NOTE Communication with the Control Room will be necessary to monitor cooldown rate and SG pressure.

1.0 To establish cooldown or to lower SG pressure with the '3A' SG perform the following:

______1.1 Verify closed 3MS-217 (Atmos Dump Drain).

______1.2 Open 3MS-161 (MS Line 'A' Atmos Dump Block Valve Bypass).

______1.3 Open 3MS-153 (MS Line 'A' Atmos Vent).

______1.4 Throttle open 3MS-162 (MS Line 'A' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

______1.5 IF **CANNOT** establish or maintain cooldown with 3MS-162 (MS Line 'A' Atmos Dump Control Valve),
THEN throttle open 3MS-154 (MS Line 'A' Atmos Vent Block).

______1.6 Monitor cooldown rate and SG pressure.

EMERGENCY OPERATING PROCEDURE
EP/3/A/1800/01

ENCLOSURE 7.7

Operation of the Atmospheric Dump Valves

2.0 To establish cooldown or to lower SG pressure with the '3B' SG perform the following:

______2.1 Verify closed 3MS-218 (Atmos Dump Drain).

______2.2 Open 3MS-163 (MS Line 'B' Atmos Dump Block Valve Bypass).

______2.3 Open 3MS-155 (MS Line 'B' Atmos Vent).

______2.4 Throttle open 3MS-164 (MS Line 'B' Atmos Dump Control Valve) to establish cooldown rate or to lower SG pressure.

______2.5 IF **CANNOT** establish or maintain cooldown with 3MS-164 (MS Line 'B' Atmos Dump Control Valve),
THEN throttle open 3MS-156 (MS Line 'B' Atmos Vent Block).

______2.6 Monitor cooldown rate and SG pressure.

ATTACHMENT 4, ENCLOSURE 3

INFORMATION REGARDING CREDITED OPERATOR ACTIONS

ATTACHMENT 4, ENCLOSURE 3
DISCUSSION REGARDING CREDITED OPERATOR ACTIONS

ANSI 58.8 was not used when the operator action times were developed for the small break LOCA analyses. Duke has reviewed the operator actions credited to mitigate SBLOCAs against ANSI-58.8. ANSI 58.8 describes a methodology for determining minimum time frames that can be credited for manual operator actions to mitigate design basis events. By this standard no actions performed outside the Control Room can be credited to occur in less than 30 minutes following initiation of the event. The standard allows for exceptions from this time limit if appropriate justification is provided. The rationale for each of the completion times is provided in the following paragraphs.

Cross-Connecting HPI Discharge Headers

For the full power case, operator action is required within 10 minutes to cross-connect the HPI discharge headers. This action is performed by one Control Room operator in the Control Room.

Cross-connecting the HPI discharge headers has been previously reviewed and approved by the staff. In a letter dated April 14, 1978, Duke notified the staff of an error in B&W's SBLOCA analyses. This letter indicated that a break on the discharge side of the reactor coolant pumps had been determined to be more limiting than the previously considered worst case break location on the suction piping of the reactor coolant pumps. In response to this issue, Duke implemented modifications to the HPI System to install cross-connect lines with valves (HP-409 and HP-410) that could be operated from the Control Room to cross-connect the HPI discharge headers and assure adequate injection. Duke's modification was described in a July 14, 1978, submittal to the staff. The staff approved the modification in a Safety Evaluation dated December 13, 1978. In its Safety Evaluation, the staff stated "we conclude that the proposed long-term modification, with the assumed operator actions, is consistent with these analyses and is acceptable as a permanent solution to the small break LOCA problem."

The SBLOCA reanalyses performed to support the proposed technical specification revision do not revise in any way

this operator action. The realignment of the HPI System is only applicable to the full power SBLOCA analyses. The new full power limiting PCT is less than 1400°F, which maintains a large margin to the 2200°F acceptance criterion in 10 CFR 50.46. This indicates that additional time beyond 10 minutes is available for this operator action before the results become unacceptable.

In order to determine that realignment of HPI will be required, the operator uses RCS pressure and HPI header flows 'A' & 'B', and compares them with a graph in the Emergency Operating Procedure. Success is verified by flow as indicated on the HPI crossover flow instruments. The required information is available on the front control board and all actions to realign HPI are performed with switches on the front control board. The instrumentation is Regulatory Guide 1.97 qualified, QA-1 instrumentation. The instruments are listed in a table provided at the end of this enclosure.

Operations Management Procedure 2-1, Enclosure 4.8 lists procedural items which all licensed operators shall have committed to memory. One of the items in this list includes verification of sufficient HPI flow in both headers within 10 minutes of a loss of core subcooling margin. Operators are expected to perform this action without procedural guidance, from memory. Additionally, in the unlikely event that the memorized actions were missed, procedural guidance is provided as follows. Immediately upon Engineered Safeguards (ES) actuation, the Emergency Operating Procedure (EOP) reader gives Section 505, ES Actuation, to a Control Room Operator (CRO) and directs him to perform it. No briefing is required since all directions are contained within the checklist and the operators are very familiar with this procedure from frequent usage in requalification training. All of the following actions are performed from within the Control Room area. The following steps reflect guidance in the current version of the EOP. Oconee is in the process of upgrading the EOP and these steps will change slightly. The CRO steps are as follows:

STEP	ACTIONS
Verify appropriate ES channels actuated	Review eight rows, at most, of blue indicating lights and eight rows of white indicating lights on the ES panels. (Failures requiring HPI cross-connection would likely be noticed at this time and action from memory to re-align HPI.)
Check Subcooling Margins (SCM)	Monitor seven indications of SCM, three for the core and two each for the loops.
If any SCM indicates 0°F, trip all RCPs.	Secure all RCPs if required.
Verify HPI header flow	
• Obtain RCS pressure	Monitor gauges on control board
• Obtain HPI header flow down each header	Monitor gauges on control board
• Determine required HPI header flow	Refer to curve in ES actuation procedure
• Determine if HPI flow is adequate	Compare actual HPI flow with required HPI flow
If HPI header flow is inadequate, open associated cross-connect valve	Hold control switch in the open position until cross-over valve is open

The operators' ability to perform the task of aligning HPI flow through the crossover valves is periodically evaluated on Annual Requal Exams using Job Performance Measure (JPM) CRO-65. (Job Performance Measures are evaluation tools used to verify tasks can be performed successfully and, where applicable, within the required time frames.) Exam results indicate that the approximate total time to perform these actions is typically less than 4 minutes. This time is well within the required 10 minute time frame.

Classroom training on the bases for this alignment and the importance for assuring adequate HPI flow is begun at the non-licensed operator (NLO) level. This is continued in License Prep class with the addition of training on the procedures where this alignment might be performed.

Additionally, simulator training is provided in License Prep class where operators are required to perform the actual steps to complete this evolution. Successful completion of the License Prep class ensures that all operators that would be expected to perform this task are adequately trained to do so. To maintain proficiency, this task is covered periodically in Licensed Requalification training and there is a Job Performance Measure on this task that is used on annual requalification exams to evaluate the ability of a cross section of operators to perform this task successfully. Some of the Active Simulator Exams used on the annual requalification exam also require this task to be completed. Only licensed operators would perform this evolution in the Control Room, and completing the requirements for licensed requalification ensures sufficient ability to do so correctly.

Feeding the Steam Generators to the Loss of SCM Setpoint with EFW

This action is performed by one Control Room operator in the Control Room. Since this is not performed at the same time as HPI realignment, the same Control Room operator can perform both actions.

The EFW System has been credited in past SBLOCA analyses as described in responses to NUREG-0565. However, actions to raise steam generator levels to the loss of subcooled margin setpoint were only assumed in the smaller small break LOCAs. When a Loss of Subcooling Margin occurs while performing the actions in the EOP, an immediate transfer is made to Section 501, Loss of Subcooling. If either Low Pressure Injection (LPI) header flow indicates less than 1000 gpm flow, step 5.0 directs initiating EFW flow to raise SG levels to the Loss of Subcooling Margin setpoint. Subcooling Margins and LPI header flows are monitored on the front control board. Regulatory Guide 1.97 qualified, QA-1 instruments are provided for each of these parameters. Success is verified by monitoring increasing SG levels using Extended Startup Range Level Instrumentation. All actions to begin feeding EFW to the SGs are performed on the front control board in the Control Room. The instrumentation is listed in a table provided at the end of this enclosure.

Note that during the time before the operator can begin to feed up to the Loss of Subcooling Margin setpoint, the Main FDW system will begin increasing SG levels as follows. When SCM is lost, all reactor coolant pumps (RCPs) are immediately secured. When all RCPs are secured, the Main FDW system will begin to increase SG levels until the operator has a chance to begin using the EFDW system to raise the levels.

This task is covered in the License Prep class including the bases for the task as well as how to perform it. Simulator training is also provided to teach the correct method to perform this evolution. Successful completion of the License Prep class ensures that all operators that would be expected to perform this task are adequately trained to do so. To maintain proficiency, this task is periodically covered in Licensed Requalification training. Some of the Active Simulator Exams used on the annual requalification exam also require this task to be completed. Only licensed operators would perform this evolution in the Control Room and completing the requirements for licensed requalification ensures sufficient ability to do so correctly.

Operator action to perform this function has been verified through simulator exercises.

<u>**Steaming SGs with the Atmospheric Dump Valves (ADVs)**</u>

The requirement to depressurize the steam generators using the ADVs is a new requirement that is most relevant to the reduced power SBLOCA cases. Two non-licensed operators (NLOs) are required to initially open the ADV flow path. Only one NLO is required to throttle the flow. The NLOs will communicate with the Control Room via a hand radio. After initial opening one NLO will be dedicated to throttling the flow through the ADV flow path. The second NLO may perform other actions following the initial opening of the ADV flow path. Other NLOs may assist depending upon availability; however the response times assumed in the SBLOCA analysis assume one operator. The action takes place on the fifth floor of the turbine building. The Control Room is located on the same elevation. This area is not expected

to have a harsh or inhospitable environment during a SBLOCA. Manual operation of the ADV flow paths involves exiting the Control Room area and walking out on to the fifth floor of the Turbine Building to the ADVs. No support personnel or equipment are required to perform this manual action.

The need to perform this action is determined by the failure of SG pressure to decrease upon an increase in Turbine Bypass Valve demand. Success is verified by observing SG Outlet Pressure decreasing below RCS pressure as ADVs are operated. Regulatory Guide 1.97 qualified, QA-1 instrumentation is provided in the Control Room for each of these parameters all located on the front control board. A list of the instrumentation is provided at the end of this enclosure.

Following a Loss of SCM on SBLOCAs, the EOP reader will end up in CP-602, SG Cooldown with Saturated RCS. Step 4.1 of this section directs maintaining SG(s) pressure < RCS pressure. Normally the Turbine Bypass Valves would be used to perform this action from the front control board. If SG pressure doesn't decrease as Turbine Bypass Valve (TBV) demand is increased, the EOP directs use of the ADVs and an operator would be dispatched to perform this action.

The EOP upgrade will require the operator to check TBV operability as part of the second step in the Subsequent Actions Section of the EOP. If the TBVs are inoperable, the NLOs will be dispatched immediately to prepare for steaming the generators with the ADVs. This action will leave only one valve to be operated if steaming is desired, and stages the NLOs at the location just outside the Control Room where the ADVs are located.

This action is a Job Performance Measure (JPM) for the NLOs and can be accomplished within the 25 minutes assumed in the accident analyses that initiate from 75% RTP. An expert panel, consisting of representatives from Operations, Operations Training, Engineering, and Licensing reviewed the EOP and the operator action necessary to depressurize one steam generator. The panel concluded that past JPMs and simulator cases for the relevant small break LOCAs support the adequacy of the assumed 25 minutes. The valves that

comprise an ADV flow path are located just outside the Control Rooms on the Turbine Deck and can be opened within a few minutes of a request by a Control Room operator. Additionally, the procedure to open the ADVs is comprised of a few relatively simple steps, and does not appear to involve any human factors problems.

Training is provided on operation of the ADVs in the classroom as well as On-The-Job training. NLOs must qualify to this task prior to assuming the watch on the associated duty station. Requalification to this task is required at least once every two years. As discussed previously, there is a JPM on this task that is used to evaluate NLOs (some but not necessarily all NLOs) at least bi-annually.

Conclusion

The operator actions required to mitigate SBLOCAs consist of the following:

1) Trip all reactor coolant pumps following a loss of subcooled margin. This action is to be taken immediately (less than two minutes).

2) If flow is not confirmed in both HPI trains, then open cross-connect valves within 10 minutes (not applicable if only one HPI pump operating).

3) Begin raising steam generator levels to the loss of subcooled margin setpoint at 20 minutes on one steam generator.

4) Begin steaming one steam generator within 25 minutes for the one HPI pump 75% power initial condition.

The first two operator actions have been in place for many years and are not new to the licensing basis. The third and fourth items have been in the emergency operating procedures for many years, although the times associated with these actions are new to the SBLOCA reanalyses and the licensing basis. The steam generator feeding and steaming actions are assumed in both steam generators for the full power cases, but have been shown by sensitivity study to only be required

in one steam generator. Therefore, the licensing basis requirement is to steam one generator to meet the acceptance criteria of 10 CFR 50.46. The Oconee design has good redundancy in both feedwater sources and steaming capabilities for SBLOCA mitigation. Based on these design features, emergency operating procedures and training, and the analysis results, successful mitigation of SBLOCAs has been demonstrated. Successful and timely operator action is a key element in this mitigation strategy and in the analyses. The margin between the PCT results and the acceptance limit, and the significant overall conservatisms in the Evaluation Model and the analyses provide some margin to offset some delays in operator actions. However, the operator actions are a required element of the mitigation strategy and licensing basis.

TABLE OF INSTRUMENTS AVAILABLE TO PERFORM OPERATOR ACTIONS

Instrument	Range	Qualification
ICCM RCS Pressure Train A	0-3000 psig	Qualified, QA-1
ICCM RCS Pressure Train B	0-3000 psig	Qualified, QA-1
HPI Flow Train A	0-750 gpm	Qualified, QA-1
HPI Flow Train B	0-750 gpm	Qualified, QA-1
HPI Crossover Flow Train A	0-750 gpm	Qualified, QA-1
HPI Crossover Flow Train B	0-750 gpm	Qualified, QA-1
ICCM Train A Core Subcooling Margin	N/A	Qualified, QA-1
ICCM Train B Core Subcooling Margin	N/A	Qualified, QA-1
OAC Core Subcooling Margin	N/A	Not Qualified
ICCM Train A Loop Subcooling Margin	N/A	Qualified, QA-1
ICCM Train B Loop Subcooling Margin	N/A	Qualified, QA-1
OAC Loop A Subcooling Margin	N/A	Not Qualified
OAC Loop B Subcooling Margin	N/A	Not Qualified
LPI Header Flow Train A	0-6000 gpm	Qualified,QA-1
LPI Header Flow Train B	0-6000 gpm	Qualified, QA-1
SG Extended S/U Range Lvl Train A Primary	0-388 inches	Qualified, QA-1
SG Extended S/U Range Lvl Train A Backup	0-388 inches	Qualified, QA-1
SG Extended S/U Range Lvl Train B Primary	0-388 inches	Qualified, QA-1
SG Extended S/U Range Lvl Train B Backup	0-388 inches	Qualified, QA-1
Total EFW Flow Trn A Primary	0-1200 gpm	Qualified, QA-1
Total EFW Flow Trn A Backup	0-1200 gpm	Qualified, QA-1
Total EFW Flow Trn B Primary	0-1200 gpm	Qualified, QA-1
Total EFW Flow Trn B Backup	0-1200 gpm	Qualified, QA-1
SG Outlet Pressure A1	0-1200 psig	Qualified, QA-1
SG Outlet Pressure A2	0-1200 psig	Qualified, QA-1
SG Outlet Pressure B1	0-1200 psig	Qualified, QA-1
SG Outlet Pressure B2	0-1200 psig	Qualified, QA-1

ATTACHMENT 4, ENCLOSURE 4

DISCUSSION REGARDING LONG TERM COOLING

ATTACHMENT 4, ENCLOSURE 4
DISCUSSION REGARDING LONG TERM COOLING

Duke's definition of long-term cooling is provided in Supplement 1 to Atomic Energy Commission (AEC)'s Safety Evaluation for Oconee Units 2 and 3 dated July 6, 1973. In this Safety Evaluation, the staff states: "long-term cooling is established in the applicant's opinion when the core is covered with mixture, more water is being supplied than leaked, the pressure is stabilized and the cladding temperature is falling."

Principally, the long-term cooling requirements of 10 CFR 50.46(b)(5) are met by the Low Pressure Injection (LPI) System which is comprised of two independent trains. As stated in Supplement 1 to the AEC's Safety Evaluation for Oconee Unit 1 dated March 24, 1972:

> "The recirculation system components [of the LPI System] are redundant so as to withstand a single failure of an active or passive component without loss of function at the required flow."

This statement is incorporated by reference into the AEC's Safety Evaluation for Oconee Units 2 and 3 dated July 6, 1973. It is also consistent with the Oconee UFSAR which states that the ECCS is designed to accommodate a single active failure in the short term or a single active or passive failure in the long-term.

However, if an accident occurs and the Reactor Coolant System (RCS) pressure remains above the shutoff head of the LPI pumps as the Borated Water Storage Tank (BWST) approaches depletion, the High Pressure Injection (HPI) System would deliver water to the RCS using the LPI discharge piping as its suction source (i.e., HPI piggyback mode of operation). There are two independent flow paths which allow the HPI System to take suction from the discharge of the LPI System by manual operator action. Thus, the HPI System is also credited in some accidents to perform the long-term cooling requirement of 10 CFR 50.46(b)(5).

Although the HPI System performs long-term cooling in accordance with 10 CFR 50.46(b)(5) when operated in piggyback, it is Duke's position that the system is not

required to be designed to withstand passive failures. This is based on the limited mission time for the HPI System as compared to the LPI System. Supplement 1 to the AEC's Safety Evaluation for Oconee Unit 1 dated March 24, 1972, states that the HPI System is designed to withstand a single failure of an active component without a loss of function. This statement is incorporated by reference into the AEC's Safety Evaluation for Oconee Units 2 and 3 dated July 6, 1973.

The HPI piggyback mode of operation mission is limited to establishing conditions which permit the use of the LPI System. The EOP has guidance to terminate HPI flow when sufficient LPI flow has been established.

Duke has reviewed the available regulatory guidance regarding single failures. 10 CFR 50, Appendix A, states, in part:

> "The conditions under which a single failure of a passive component in a fluid system should be considered in designing the system against a single failure are still under development."

The principal design criteria for Oconee, given in Section 3 of the UFSAR, were developed in consideration of the seventy General Design Criteria for Nuclear Power Plant Construction Permits proposed by the AEC in a proposed rule-making published for 10 CFR Part 50 in the Federal Register of July 11, 1967. At this time, as is evident in the current statements in Appendix A of 10 CFR 50, the requirements for consideration of passive failures were not fully developed. Based on recent discussions with the staff, SECY 77-439 was identified as providing additional guidance regarding application of the single failure criterion. A review of SECY 94-084, Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs, also references SECY 77-439 as providing the staff's guidance on passive failures.

SECY 77-439 states:

> "In the study of passive failures it is current practice to assume fluid leakage owing to gross failure of a pump or valve seal during the long-term cooling mode following a LOCA (24 hours or greater after the event) but not pipe breaks. No other passive failures are required to be assumed because it is judged that compounding of probabilities associated with other types of passive failures, following the pipe break associated with a LOCA, results in probabilities sufficiently small that they can be reasonably discounted without substantially affecting overall systems reliability."

The engineering judgment employed by the staff in 1977 is supported by the findings of the recently completed HPI System Reliability Study, submitted to the staff on December 18, 1997. This study concluded that operation with the suction and discharge headers cross-connected has a negligible impact on reliability due to the low likelihood of passive failures as compared to active failures.

SECY 77-439 further states:

> "In some licensing review areas, the staff does impose a passive failure in addition to the initiating event, while in others it does not. As previously mentioned, an example of the application of a passive failure requirement is the approach to long-term recovery subsequent to a loss-of-coolant accident. Applicants are required to consider degradation of a pump or valve seal and resulting leakages in addition to the initiating failure (LOCA). The rationale for applying this type of failure is a recognition of the relatively extended periods of required operation of systems that are expected to be on a standby status throughout the plant life. The likelihood of accelerated wear of such components as pump and valve seals would be increased after the adverse conditions following a LOCA. Extended operation during the long term (up

> to months) requires that these types of failures be considered in designing the plant."

Thus, Duke believes that the intent of considering passive failures is to address long-term operation (up to months) of systems required to remove decay heat. Operation of the HPI System in the piggyback mode is required for some small break LOCAs. However, this is not an extended or indefinite mode of operation. Operation of the HPI System in the piggyback or recirculation mode may last from a few hours to a day or so. As the decay heat load drops, the RCS will depressurize to the point where the LPI pumps are used for extended (up to months) decay heat removal. Thus, for this reason, passive failures in the HPI System were not considered in the design and licensing of the plant.

Oconee has also reviewed BAW-10103A, Rev. 3, ECCS Analysis of B&W's 177-FA Lowered-Loop NSS, regarding long term cooling requirements. Chapter 10 of BAW-10103A, Rev. 3, addresses the establishment of long-term cooling in a generic manner for the lowered-loop B&W class plants. This topical report states:

> "The exact duration of long-term cooling will vary depending on several factors, including the size of the break and the radiation release. A realistic assessment of the duration of the long-term cooling period for the worst case is approximately one month. As a maximum, assuming the worst-case calculational results and corresponding radiation releases to the building, long-term cooling may be required for periods on the order of one year."

BAW-10103A, Rev. 3, is consistent with SECY 77-439 in that it characterizes the duration of long-term cooling as several months. Chapter 10 of this topical report does not describe the HPI piggyback mode as a long-term means of core cooling. It specifically refers to long-term cooling via operation of the LPI System taking suction from the reactor building sump. In this section, the only mention of cooling by the HPI System is as an alternative for a short duration while maintenance is being performed on normal plant equipment. However, BAW-10103A, Appendix C, Small Break

Analysis, contains several discussions regarding the establishment of long-term cooling with the HPI system.

In summary, based on the limited period of time the HPI System may operate in the piggyback mode, Duke concludes that passive failures do not need to be postulated for this system in the deterministic design basis analyses for the plant.

Note that the HPI System does contain isolation valves that would allow the operators to address certain passive failures. In addition, Duke's reliability analyses have concluded that postulated passive failures have a negligible impact on system reliability.

Attachment 5

No Significant Hazards Determination

Pursuant to 10 CFR 50.91, Duke Power Company (Duke) has made the determination that this amendment request involves a No Significant Hazards Consideration by applying the standards established by the NRC regulations in 10 CFR 50.92. This ensures that operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated:

No. The HPI System is utilized to mitigate the consequences of an accident. Failure of the HPI System is not a precursor to any accident evaluated in the UFSAR. Thus, the proposed changes do not have any impact upon the probability of any accident which has been evaluated in the UFSAR.

The proposed changes do not have any impact upon the ability of the HPI System to add soluble poison to the Reactor Coolant System. The remaining potential impact is upon the ability to mitigate the consequences of a small break LOCA, which is addressed below. The small break LOCA is the limiting design basis accident with respect to HPI System operability requirements.

The Technical Specification requirements for the HPI System are supported by a spectrum of small break LOCA analyses based on the approved Evaluation Model described in FTI topical report BAW-10192P. These small break LOCA analyses demonstrate that the acceptance criteria of 10 CFR 50.46 are satisfied.

The requirements of LCO 3.5.2 assure that flow can be provided via two HPI trains (i.e., one HPI train responds automatically upon an ESPS signal, and the second HPI train is aligned within 10 minutes via operator actions in the Control Room) following a small break LOCA and a single active failure. The full power small break LOCA analyses supporting this proposed license amendment have been performed in accordance

with the approved Evaluation Model described in FTI topical report BAW-10192P.

If enhanced steam generator cooling is not credited in the accident analysis, two HPI trains are required to mitigate specific small break LOCAs with Thermal Power ≤ 75% RTP. However, if equipment not qualified as QA-1 (i.e., an ADV flow path for one steam generator) is credited for enhanced steam generator cooling, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a small break LOCA on the discharge of the reactor coolant pumps if Thermal Power ≤ 75% RTP. An ADV flow path for each steam generator is credited as a compensatory measure in Actions B and C of LCO 3.5.2 to permit operation to continue with THERMAL POWER ≤ 75% RTP: a) for 30 days with an HPI pump or one or more HPI discharge crossover valve(s) inoperable; and b) for 72 hours with one HPI train inoperable. This provides additional defense-in-depth, because the ADV flow path for each steam generator is required to be operable while only one is needed to perform the function. Additionally, a risk-informed assessment (Attachment 7) concluded that operating the plant in accordance with the Required Actions was acceptable.

The proposed changes involve crediting additional operator actions (i.e., feeding a steam generator from the EFW System, and steaming that steam generator through an ADV flow path) that have not previously been reviewed and approved by the staff for licensing basis small break LOCA analyses. However, these operator actions have been included in the Emergency Operating Procedure for many years. The times for completing these operator actions are new to the small break LOCA analysis and the licensing basis, and are considered reasonable. Crediting these actions in the safety analyses does not result in any substantive change to the operator's response to a small break LOCA.

In summary, the technical analyses described in this license amendment justify the adequacy of this specification and assure that operability of the HPI

System is maintained in a manner consistent with the requirements of the design basis accidents. Therefore, it is concluded that this amendment request will not significantly increase the probability or consequences of an accident previously evaluated.

(2) Create the possibility of a new or different kind of accident from any kind of accident previously evaluated:

No. The proposed changes do not create any new initiating events or potentially unanalyzed conditions. Therefore, this proposed amendment will not create the possibility of any new or different kind of accident.

(3) Involve a significant reduction in a margin of safety.

No. The requirements of ITS 3.5.2 continue to assure that operability of the HPI System is maintained in a manner consistent with the requirements of the design basis accidents. The requirements are supported by small break LOCA analyses which demonstrate that the acceptance criteria of 10 CFR 50.46 are satisfied. These analyses were performed in accordance with the Evaluation Model described in FTI topical report BAW-10192P.

Therefore, it is concluded that the proposed amendment request will not result in a significant decrease in the margin of safety.

Duke has concluded, based on the above, that there are no significant hazards considerations involved in this amendment request.

Attachment 6

Environmental Assessment

Pursuant to 10 CFR 51.22 (b), an evaluation of the license amendment request (LAR) has been performed to determine whether or not it meets the criteria for categorical exclusion set forth in 10 CFR 51.22 (c) 9 of the regulations. The LAR does not involve:

1) A significant hazards consideration.

   This conclusion is supported by the determination of no significant hazards contained in Attachment 5.

2) A significant change in the types or significant increase in the amounts of any effluents that may be released offsite.

   This LAR will not change the types or amounts of any effluents that may be released offsite.

3) A significant increase in the individual or cumulative occupational radiation exposure.

   This LAR will not increase the individual or cumulative occupational radiation exposure.

In summary, this LAR meets the criteria set forth in 10 CFR 51.22 (c) 9 of the regulations for categorical exclusion from an environmental impact statement.

ATTACHMENT 7

RISK-INFORMED ANALYSES

IN ACCORDANCE WITH REGULATORY GUIDES 1.174 and 1.177

Introduction

On March 31, 1997, Duke submitted a license amendment request (LAR) to resolve several deficiencies with Current Technical Specification (CTS) 3.3.1. CTS 3.3.1 provides operability requirements for the High Pressure Injection (HPI) System. In this LAR, Duke requested the ability to operate Oconee Units 1, 2, and 3 for an indefinite period of time with Thermal Power less than 75% RTP, with one HPI pump inoperable, one or more HPI discharge crossover valve(s) inoperable, and the HPI suction header not cross connected. This request was based on utilizing the atmospheric dump valve (ADV) flow path for one steam generator to mitigate the consequences of the accident.

Duke supplemented this request with additional information on February 9, 1998, and June 17, 1998. The staff of the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) on July 16, 1998. To resolve the questions raised by the NRC, a substantial revision to the proposed license amendment was required. Also, in verbal discussions, the NRC staff highly recommended that the revised license amendment request include a risk-informed justification in accordance with Regulatory Guides 1.174 and 1.177. Thus, on November 4, 1998, Duke withdrew the license amendment request submitted on March 31, 1997. Additionally, Duke noted that another LAR would be submitted regarding the issues associated with the HPI System. This submittal provides the noted LAR.

Some of the proposed changes rely upon a small break loss of coolant accident (SBLOCA) analysis which credits equipment that is not qualified as QA-1 to provide enhanced steam generator cooling (i.e., the ADV flow path for one steam generator). These proposed changes permit operation to continue with Thermal Power ≤ 75% RTP: a) for 30 days with an HPI pump or one or more HPI discharge crossover valve(s) inoperable; and b) for 72 hours with an HPI train inoperable. To provide additional justification for these proposed

changes, this attachment contains a risk-informed analysis conducted in accordance with Regulatory Guides 1.174 and 1.177.

Description of Proposed Change

HPI System Description

The HPI System consists of two independent trains, each of which splits to discharge into two Reactor Coolant System (RCS) cold legs, so that there are a total of four HPI injection lines. Each train takes suction from the Borated Water Storage Tank (BWST), and has an automatic suction valve and discharge valve which open upon receipt of an Engineered Safeguards Protective System (ESPS) signal. The two HPI trains are designed and aligned such that they are not both susceptible to any single active failure including the failure of any power operating component to operate or any single failure of electrical equipment.

There are three ESPS actuated HPI pumps; the discharge flow paths for two of the pumps are normally aligned to automatically support HPI train "A" and the discharge flow path for the third pump is normally aligned to automatically support HPI train "B." The discharge flow paths can be manually aligned such that each of the HPI pumps can provide flow to either train. At least one pump is normally running to provide RCS makeup and seal injection to the reactor coolant pumps. Suction header crossover valves are normally open. The discharge crossover valves (HP-409 and HP-410) are normally closed; these valves can be used to bypass the normal discharge valves and assure the ability to feed either train's injection lines via HPI pump "B." For each discharge valve and discharge crossover valve, a safety grade flow indicator is provided to enable the operator to throttle flow during an accident to assure that runout limits are not exceeded.

A suction header supplies water from the BWST or the reactor building sump (via the LPI-HPI flow path) to the HPI pumps. HPI discharges into each of the four RCS cold legs between the reactor coolant pump and the reactor vessel. There is one flow limiting orifice in each of the four injection headers that connect to the RCS cold legs. If a pipe break were to occur in an HPI line between the last check valve and the RCS, the orifice in the broken line would limit the HPI flow lost through the break and maximize the flow supplied to the reactor vessel via the other line supplied by the HPI header.

The HPI pumps are capable of discharging to the RCS at an RCS pressure above the opening setpoint of the pressurizer safety valves. The HPI pumps cannot take suction directly from the sump. If the BWST is emptied and HPI is still needed, a cross-connect from the discharge side of the LPI pump to the suction of the HPI pumps would be opened. This is known as "piggy backing" HPI to LPI and enables continued HPI to the RCS.

Description of the Proposed Technical Specification Change

In this License Amendment Request (LAR), Duke is proposing a number of changes to the Oconee Improved Technical Specifications (ITS). A complete description of the proposed changes is provided in Attachment 4 of the LAR. While most of the proposed changes are justified via traditional methods, Duke determined that the proposed changes which rely upon a SBLOCA analysis crediting enhanced steam generator cooling via an ADV flow path needed to be supported by a risk-informed evaluation conducted in accordance with Regulatory Guides 1.174 and 1.177. These proposed changes are:

1) The proposed changes to Condition B of ITS 3.5.2;

2) The proposed changes to Condition D of ITS 3.5.2 (renamed Condition C) regarding continued operation with Thermal Power $\leq$ 75% RTP;

3) The addition of the ITS 3.7.4 requirements regarding the ADV flow path; and

4) The resultant proposed changes to the ITS Bases.

Reason for Requested Change

Duke is submitting this LAR to resolve deficiencies associated with Current Technical Specification (CTS) 3.3.1. CTS 3.3.1 provides requirements regarding the HPI System. These requirements were converted into the Improved Technical Specifications (ITS) as ITS 3.5.2.

The principal deficiency being resolved was reported in Licensee Event Report (LER) 269/90-15. In the LER, Duke reported that the SBLOCA analysis was non-conservative in that one HPI train was inadequate to mitigate a break of an HPI injection line when reactor power was < 60% full power. As a result, Duke imposed additional requirements upon the operation of Oconee Nuclear Station Units 1, 2, and 3 with reactor power < 60% full power. These additional requirements were equivalent to the requirements for operation with reactor power > 60% full power (i.e., a third HPI pump and HPI discharge crossover valves were required to be operable, and the HPI suction headers were required to be cross-connected).

The proposed changes will reduce unnecessary burdens associated with the additional self-imposed administrative requirements. They permit operation to continue with Thermal Power ≤ 75% RTP: a) for 30 days with an HPI pump or one or more HPI discharge crossover valve(s) inoperable; and b) for 72 hours with an HPI train inoperable. This additional time could prevent an unnecessary plant transient (i.e., an unplanned shutdown) and its associated challenges. The 30-day Completion Time for Required Actions B.3 and B.4 of ITS 3.5.2 provides time for rebuilding a spare pump or obtaining a replacement part (e.g., a replacement motor) from an outside source.

Traditional Engineering Considerations

Compliance with Current Regulations

Enclosure 1 of Attachment 4 of this submittal provides the technical justification regarding the small break loss of coolant accident (SBLOCA) analyses. It concludes that all of the 10 CFR 50.46 LOCA acceptance criteria were met for the Oconee SBLOCA analyses. Specifically,

a. The limiting peak clad temperatures are well within the 2200°F limit;

b. The SBLOCA local cladding oxidation is confirmed to be less than the 17% limit;

c. The calculated SBLOCA hot channel oxidation is less than 1%, which ensures that the whole core oxidation is less than 1%;

d. The consequences of both thermal and mechanical deformation of the fuel assemblies in the core have been assessed, and the resultant deformations have been shown to maintain coolable core configurations; and

e. The long-term cooling of the core is ensured by maintaining ECCS flow in excess of the decay heat load, and by preventing boric acid precipitation via establishing a long-term boron concentration control process. The Oconee ECCS design and emergency operating procedures accomplish the long-term cooling function, and meet this acceptance limit.

Defense-in-Depth

Normal Operation

If enhanced steam generator cooling is not credited in the SBLOCA analysis, two HPI trains are required to mitigate specific SBLOCAs. One HPI train is required to respond automatically upon an Engineered Safeguards Protective System (ESPS) signal, while the second HPI train is required to be manually aligned via operator actions from the Control Room within 10 minutes. The technical justification of the SBLOCA analyses is provided in Enclosure 1 of Attachment 4.

ITS LCO 3.5.2 requires the HPI System to be operable with:

a. Two HPI trains operable;

b. An additional HPI pump operable;

c. Two LPI-HPI flow paths operable;

d. Two HPI discharge crossover valves operable;

e. HPI suction headers cross-connected; and

f. HPI discharge headers separated.

These requirements apply whenever a plant is in Mode 1, Mode 2, or Mode 3 with the RCS temperature > 350°F. For the vast majority of time that ITS 3.5.2 is applicable, its requirements will be met in full. The requirements of ITS LCO 3.5.2 ensure that two HPI trains can supply makeup flow to the reactor coolant system in the event of a SBLOCA coincident with a single active failure.

Operation with a Degraded HPI System

If the HPI System is degraded, operation is permitted to continue for a limited period of time provided the HPI System remains capable of performing its safety

function, barring a single failure. If the HPI System is not capable of performing its safety function, the plant is required to be placed in a condition for which the LCO does not apply. Typically, the determination regarding the ability of the HPI System to perform its function is based on the SBLOCA analysis performed at 100% rated Thermal Power (RTP) which does not credit enhanced steam generator cooling to satisfy the criteria of 10 CFR 50.46. However, there are two Conditions which base this determination upon a SBLOCA analyses conducted at 75% RTP which credits equipment not qualified as QA-1 for enhanced steam generator cooling (i.e., the ADV flow path for one steam generator). In this case, the safety analyses have determined that the capacity of one HPI train is sufficient to mitigate a SBLOCA.

Single failures are not typically considered once the plant has entered a condition defined in the Technical Specifications. When the plant is operating under the terms defined in the action, the plant typically is not able to cope with a single failure. However, additional single active failures have been considered in proposed Actions B and C of ITS 3.5.2.

With an HPI pump or one or more HPI discharge crossover valve(s) inoperable, the HPI System remains capable of performing its safety function, barring an additional single failure and without taking credit for the ADV flow path for one steam generator. However, to permit operation to continue at a reduced power level for an extended period of time (i.e., 30 days with Thermal Power ≤ 75% RTP), Duke has proposed to add a compensatory measure which requires the ADV flow path for each steam generator to be operable. Thus, if a SBLOCA were to occur while the plant was operating in accordance with Condition B of ITS 3.5.2, the SBLOCA could be mitigated even given a single active failure of the HPI System, and a single failure affecting an ADV flow path.

With an HPI train inoperable, the HPI System remains capable of performing its safety function if the HPI

train can be automatically actuated or manually aligned via operator action from the Control Room, barring an additional single failure and without taking credit for the ADV flow path for one steam generator. However, if an HPI train is inoperable and incapable of being automatically actuated or manually aligned, the HPI System is not capable of mitigating a SBLOCA without taking credit for the ADV flow path for one steam generator and reducing Thermal Power to ≤ 75% RTP. Action C of ITS LCO 3.5.2 permits operation to continue with Thermal Power ≤ 75% RTP for 72 hours with an HPI train inoperable provided the ADV flow path for each steam generator is operable. This compensatory measure provides additional assurance that the plant would be capable of mitigating a SBLOCA; it requires two ADV flow paths to be operable, while the SBLOCA analyses conducted at 75% RTP only requires one ADV flow path.

Other Considerations

Typically, the steam generators would be depressurized by the Turbine Bypass System. The ADV flow paths provide an alternative means to depressurize the steam generators.

Safety Margin

The safety margins have been maintained, because:

1. All of the 10 CFR 50.46 LOCA acceptance criteria were met for the Oconee SBLOCA analyses supporting these proposed changes (see Enclosure 1 of Attachment 4 of this LAR); and

2. Containment performance is not affected by these proposed changes.

Evaluation of Risk Impact

A number of changes have been proposed for ITS 3.5.2, "High Pressure Injection (HPI)." Some of these

proposed changes may have an impact on the Oconee risk results. These changes are evaluated in accordance with the guidance provided in Regulatory Guides 1.174 and 1.177. The impact of the proposed changes on various accident sequences is considered. The impact is assessed by considering the following parameters: the change in core damage frequency (CDF), the incremental conditional core damage probability (ICCDP), the change in large early release frequency (LERF), and the incremental conditional large early release probability (ICLERP). Where adequate, the impact of the proposed change on these parameters is addressed qualitatively.

Assessment of Technical Specification Changes on Risk Models

Functions of HPI

The HPI system performs several functions that are important in preventing core damage. These include the normal operating function of providing RCP seal injection and also accident mitigation functions for LOCAs and transients. In order to determine the risk impact of the proposed Technical Specification change, the reliability of HPI to provide each of these functions must be evaluated for all the potential conditions allowed by the proposed Technical Specification. The reliability of the Oconee HPI system to provide the following functions will be evaluated:

- *Reactor Coolant Pump seal injection*
- *Injection of BWST contents following loss of primary coolant.*
- *Forced cooling through the pressurizer PORV and safety valves following loss of steam generator cooling.*
- *Suction from the LPI system during sump recirculation*

Potential Configurations with Proposed Tech Spec

Scenarios Permitted by Proposed Condition B of ITS 3.5.2

SCENARIOS INVOLVING HPI PUMP A INOPERABLE	**SCENARIOS INVOLVING HPI PUMP B INOPERABLE**	**SCENARIOS INVOLVING HPI PUMP C INOPERABLE**	**SCENARIOS NOT INVOLVING AN INOPERABLE HPI PUMP**
HPI pump A inop.	HPI pump B inop.	HPI pump C inop.	HP-409 inop.
HPI pump A inop. HP-409 inop.	HPI pump B inop. HP-409 inop.	HPI pump C inop. HP-409 inop.	HP-410 inop.
HPI pump A inop. HP-410 inop.	HPI pump B inop. HP-410 inop.	HPI pump C inop. HP-410 inop.	HP-409 inop. HP-410 inop.
HPI pump A inop. HP-409 inop. HP-410 inop.	HPI pump B inop. HP-409 inop. HP-410 inop.	HPI pump C inop. HP-409 inop. HP-410 inop.	

Scenarios Involving HPI Pump A Inoperable

Currently, if HPI pump A is inoperable, the HPI System is aligned to permit HPI pump C to provide normal makeup and RCP seal injection. This is accomplished by: 1) closing HP-27; 2) opening HP-116; 3) starting HPI pump C; and 4) securing and placing in auto HPI pump B. This configuration results in cross connecting the HPI discharge headers. Condition E of proposed ITS 3.5.2 would limit operation with this configuration to 72 hours.

To utilize the 30-day Completion Time permitted by proposed Condition B of ITS 3.5.2, HPI pump B would be utilized to supply normal makeup and seal injection, and HP-116 would remain closed.

Scenarios Involving HPI Pump B Inoperable

Currently, if HPI pump B is inoperable, the HPI System is aligned to permit HPI pump C to provide normal makeup and RCP seal injection. This is accomplished by: 1) closing HP-27; 2) opening HP-116; 3) starting HPI pump C; and 4) securing and placing in auto HPI

pump A. This configuration results in cross connecting the HPI discharge headers. Condition E of proposed ITS 3.5.2 would limit operation with this configuration to 72 hours.

To utilize the 30-day Completion Time permitted by proposed Condition B of ITS 3.5.2, HPI pump A would be utilized to supply normal makeup and seal injection, and HP-116 would remain closed.

Scenarios Involving HPI Pump C Inoperable

Currently, if HPI pump C is inoperable, the HPI System is aligned to permit HPI pump B to automatically supply HPI train B. This is accomplished by closing HP-27 and opening HP-116. This configuration results in cross connecting the HPI discharge headers. Condition E of proposed ITS 3.5.2 would limit operation with this configuration to 72 hours.

To utilize the 30-day Completion Time permitted by proposed Condition B of ITS 3.5.2, the HPI System would have to be aligned such that HPI pump A was supplying normal makeup to the RCS, HPI pump B was providing RCP seal injection flow, and the discharge of HPI pump A is hydraulically separated from the discharge of HPI pump B. This would be performed by: 1) ensuring one HPI pump (A or B) is running; 2) starting the other operable HPI pump (B or A); 3) closing HP-27; 4) closing HP-115; and 5) opening HP-116.

Scenarios Not Involving an Inoperable HPI Pump

If proposed Condition B of ITS 3.5.2 is entered due to one or both of the HPI discharge crossover valves being inoperable, no adjustment to the HPI System configuration is made. In this case, both HPI trains remain capable of automatically performing its safety function. Also, the condition would not affect the ability of the HPI System to supply normal makeup to the RCS and RCP seal injection via HPI pump A or B; thus, the auto backup capability for RCP seal injection remains available.

Overview

A review of these configurations suggests that a simplified approach to the HPI modeling is available. Figure 1 is a simplified diagram of the Oconee Unit 3 HPI system. Figure 2 has indicated components that may be unavailable as identified above with a large **X**. Figure 3 depicts the equivalent system with all of these components out of service. This is the most conservative configuration. It is seen that in this condition the HPI system looks much like the traditional two-train system. While in Condition B, the HPI system is analyzed as a two-train system and the system reliability is estimated by assuming two identical trains.

Scenarios Involving Entry Into Multiple Conditions of ITS 3.5.2

Proposed ITS 3.5.2 contains Conditions A through H. There could be scenarios which require multiple Conditions to be entered concurrently. In these cases, a determination must be made regarding whether the HPI System remains capable of performing its safety function. If the HPI System remains capable of performing its safety function, at least one of the conditions will have to be resolved within 72 hours. The 72-hour Completion Times of Required Action C.3 when Thermal Power is > 75%, Condition A, D, E, and F have not been analyzed via this risk-informed analysis. They are justified via other methods. The 72-hour Completion Time of Required Action C.3 when Thermal Power is ≤ 75% RTP is supported via this risk-informed evaluation. If the HPI System does not remain capable of performing its safety function, Condition H of ITS 3.5.2 or ITS LCO 3.0.3 will require the plant to be placed in a condition for which ITS LCO 3.5.2 does not apply.

Accident Sequences and Success Criteria

The following accident initiators are evaluated for any potential impact on the CDF associated with these

initiators as a result of the proposed changes to the Technical Specifications.

- Small LOCAs
- Medium LOCAs
- Large LOCAs
- Transients
- Steam Generator Tube Ruptures (SGTRs)
- Interfacing-systems LOCA (ISLOCA)
- Reactor Pressure Vessel Failure
- External Events

Small LOCA
The HPI system is relied upon for mitigating small LOCA events. The applicable success criteria for HPI are discussed below.

Medium LOCA
The HPI system is relied upon for mitigating medium LOCA events. The applicable success criteria for HPI are discussed below.

Large LOCA
The HPI system is not relied upon for mitigating large LOCA events. There is no change in CDF associated with this initiator.

Transients
The HPI system is relied upon to mitigate the consequences of certain transients. The applicable success criteria for HPI are discussed below.

SGTRs
The HPI system is relied upon for mitigating SGTR events. The applicable success criteria for HPI are discussed below.

ISLOCA
The ISLOCA initiator is assumed to result in core damage. The HPI system plays no role in mitigating this accident. No change in CDF is associated with this initiator.

Reactor Pressure Vessel Failure
The reactor vessel failure initiator is assumed to result in core damage. The HPI system plays no role in mitigating this accident. No change in CDF is associated with this initiator.

External Events
The impact of external events on the Oconee plant as analyzed in the PRA is to cause the failure of major support systems, (i.e., ac power, service water, or structural failures). These support system failures result in HPI system failure along with other systems needed for accident mitigation. Independent failures of individual components in the HPI system do not contribute to the CDF results for these initiators. Because loss of these major support systems results in failure of HPI regardless of the number of pumps available, no meaningful impact on the CDF from external event initiators is expected. This contribution is negligible compared to the impact from those initiators already considered in this analysis.

The following accident initiators have been identified as relying on HPI for accident mitigation. These initiators are considered in the analysis of the risk impact. Figures 4 through 9 are the event trees constructed to identify the core damage sequences.

- Small LOCA (random location)
- Limiting Small Break (HPI line) LOCA
- Medium LOCA
- SGTR
- Transients that lead to forced cooling
- Transient induced RCP seal LOCAs

The success criteria for the accident sequences being considered are discussed in the following.

Small and Medium LOCAs and Steam Generator Tube Ruptures

For random small LOCAs, occurring at locations other than the HPI line and RCP discharge, medium LOCAs and SGTRs, one HPI train provides sufficient flow to maintain RCS inventory and prevent core damage. Even with failure of the HPI system, core damage for the small LOCAs and SGTRs can be prevented if EFW is available and the operators initiate a rapid depressurization to LPI conditions, as directed by procedure.

For the limiting break locations, the HPI line and RCP discharge, some HPI flow is lost from the break. The analysis in Reference 1 has shown that, if the only operating HPI train is injecting into the broken loop, depressurization of the RCS using the steam generators is required to successfully mitigate the accident.

Success criteria are assumed as follows:

Random Small Break and SGTR

One HPI train
or,
EFW and operator depressurization to LPI conditions.

Limiting Small Break Location

Two HPI trains
or,
one HPI train and EFW with operator initiated depressurization.

Medium LOCA

One HPI train

Feed and Bleed

The HPI pumps are high head pumps and provide significant flow even at the pressurizer safety valve setpoint. Analyses performed in Reference 1 indicate

that two HPI pumps are required during the injection phase. It is not necessary to have flow through both HPI discharge headers (e.g., HPI pumps A and B injecting through HP-26 into the A header is a success). Only one HPI pump is needed in the recirculation phase. This is a result of the lower decay heat level and the additional HPI flow resulting from having the suction aligned to the LPI pump discharge. For simplicity and conservatism, it is assumed in the risk analysis that the success criterion is two trains of HPI.

Reactor Coolant Pump Seal Performance
The HPI system along with the component cooling system function to maintain the integrity of the reactor coolant pump seals. If all seal cooling (thermal barrier cooling and seal injection) is lost, the potential exists that the loss of reactor coolant through the seals could increase to levels that may result in core uncovery within a few hours. The most likely condition following a loss of seal cooling, however, is for the seals to remain intact and limit the loss of coolant to a value of approximately 20 gpm/pump, Reference 3.

It is assumed in this study, for simplicity and conservatism, that a seal LOCA will result following a complete loss of seal cooling. Successful seal cooling is maintained if HPI seal injection (one pump needed) is supplied or if RCP thermal barrier cooling is maintained by a component cooling pump.

High Pressure Recirculation
Some sequences may require a transition to high pressure recirculation. In this mode, only one HPI pump is needed to maintain sufficient injection flow. For simplicity, this analysis has not differentiated between the HPI requirements for the recirculation phase versus the injection phase. The simplified approach for this analysis assumes that the number of trains required for injection are also needed for recirculation.

HPI Train Reliability

In Reference 2, the reliability of the HPI system to mitigate LOCAs was evaluated. While the train reliability was not estimated in the course of this study, the component failure data can be used to estimate a train failure probability by considering the combined failure probability of those components that would constitute a train of HPI. For purposes of this simplification, a train is assumed to consist of: a pump, a discharge MOV, a suction MOV, 5 manual valves, and 5 check valves. The following failure rates are taken from Reference 2.

Motor-operated Valve Fails to Open	2.47E-03/demand
Motor-operated Valve Transfers Closed	1.04E-07/hr
Manual Valve Transfers Closed	3.75E-8/hr
Check Valve Fails to Open	8.15E-05/demand
Check Valve Transfers Closed	1.38E-07/hr
HPI Pumps Fails To Start	1.18E-03/demand
HPI pump Fails To Run	1.47E-05/hr
HPI Train Fails Due To Latent Human Error	3.0E-03

Conservatism in this estimate is assured by assuming a standby condition for the train. A pump start is assumed to be required and all MOVs and check valves are assumed to be initially closed. Estimated in this manner, a train failure probability of approximately 0.01 is obtained. The mission time assumed in this analysis is 24 hours which includes the recirculation phase. The normally running HPI train is subjected to fewer failure modes than is the standby train. In response to proposed Condition B, both HPI pumps may be running initially.

To provide additional conservatism, the train failure probability is conservatively assumed to be 0.03 for this study.

Other failure modes that may impact the HPI system, such as the operator failure to swap to high pressure recirculation, BWST failure, or some failures involving the letdown storage tank, are common to all available HPI pumps. These failures modes are not impacted by the proposed T/S changes and do not contribute to the change in core damage frequency.

Maintenance is not included for the conditions being analyzed, because: 1) for Condition B, an HPI pump or HPI discharge crossover valve is inoperable; 2) for Condition C, an HPI train is inoperable. If additional HPI components were inoperable in coincidence with either Condition B or Condition C, an evaluation would have to be made to determine if the HPI System remained capable of performing its safety function. As stated previously, if the HPI System remains capable of performing its safety function, at least one of the conditions will have to be resolved within 72 hours. If the HPI System does not remain capable of performing its safety function, Condition H or ITS LCO 3.0.3 will require the plant to be placed in a condition for which ITS LCO 3.5.2 does not apply.

Tier 1 - Calculation of Risk Parameters

The method selected is to provide a simplified assessment of the CDF and LERF impact associated with proposed Conditions B and C of ITS LCO 3.5.2. The parameter values selected for the system reliability are intended to be somewhat conservative, because the method is simplified compared to a detailed fault tree analysis. The simplified approach is expected to more readily identify the specific sequences of interest and promote understanding of the issues than would be expected via analysis with a large integrated fault tree.

Methodology for Evaluating Proposed Condition B of ITS 3.5.2

Currently, Duke operates the Oconee units in accordance with a self-imposed administrative requirement that is more restrictive than the current Technical Specification. These additional requirements are equivalent to the requirements for operation with reactor power > 60% full power (i.e., a third HPI pump and HPI discharge crossover valves are required to be operable, and the HPI suction headers are required to be cross-connected). With an HPI pump or one or more HPI discharge crossover valve(s) inoperable, Duke limits operation to 72 hours. After 72 hours, the administrative requirement requires the unit to be shut down.

With an HPI pump or one or more HPI discharge crossover valve(s) inoperable, proposed Condition B of ITS 3.5.2 will permit continued operation at reduced power for 30 days provided the ADV flow path for each steam generator is verified to be operable. Thus, the evaluations focus on the difference between being shut down and operating at reduced power while the HPI pump or HPI discharge crossover valve(s) is being repaired. Because both the administrative requirement and the proposed Condition A for ITS 3.5.2 permit operation to continue for 72 hours with an HPI pump or one or more HPI discharge crossover valve(s) inoperable, this time period does not contribute to the change in CDF. The subsequent 27 days of operation at reduced power permitted in proposed Condition B of ITS 3.5.2 does contribute to the change in CDF.

Methodology for Evaluating Proposed Condition C of ITS 3.5.2

Condition D of ITS LCO 3.5.2 addresses one HPI train being incapable of being automatically actuated but capable of being manually actuated with Thermal Power > 60% RTP or one HPI train being inoperable with Thermal Power ≤ 60% RTP. If either of these condition exists, Required Action D.1 requires the restoration of

the capability to automatically actuate the HPI train within 24 hours, and Required Action D.2 requires the HPI train to be restored to an operable status within 24 hours.

Proposed Condition C is entered when one HPI train is inoperable. If the inoperable HPI train is capable of being automatically actuated or manually aligned, proposed Condition C allows 72 hours to restore the HPI train. If the train is incapable of being automatically actuated or manually aligned, Thermal Power is required to be reduced to ≤ 75% RTP. If an HPI train is inoperable with Thermal Power ≤ 75% RTP, then operability of the ADV flow path for each steam generator is required to be verified and the train is required to be restored to an operable status within 72 hours. The evaluations focus on the difference between being shut down and operating at reduced power while the HPI train is being repaired. It does not evaluate the extension of time permitted for operation with Thermal Power > 75% RTP, provided the HPI train remains capable of being automatically actuated or manually aligned from the Control Room. Because both the current ITS and the proposed ITS permit operation to continue for 24 hours with reduced Thermal Power, this time period does not contribute to the change in CDF. The subsequent 48 hours of operation permitted in proposed Condition C of ITS 3.5.2 does contribute to the change in CDF.

Description of Condition B

If an inoperable HPI pump or HPI discharge crossover valve is not restored to an operable status within 72 hours, proposed Condition B requires Thermal Power to be reduced to ≤ 75% RTP and the ADV flow path for each steam generator be verified operable. This condition is permitted for a maximum of 30 days (27 days beyond the initial 72 hours). The additional 27 days of operation at reduced power is a change from the current self-imposed administrative requirements. The change in CDF associated with this operating condition is evaluated. The HPI system is designed with two injection headers

supplied by three pumps. The suction headers are required to be cross-connected. The discharge headers are normally separated, but are capable of being cross-connected to compensate for various potential failure modes. Proposed Condition B permits combinations of equipment unavailabilities that essentially reduce the HPI system to a traditional two train system. Combinations that would eliminate a train of HPI would place the HPI system into proposed Condition C.

Figure 1 is a simplified diagram of the Oconee Unit 3 HPI system. Figure 2 has indicated components that may be unavailable as identified above with a large **X**. Figure 3 depicts the equivalent system with all of these components out of service. It is seen that in this condition the HPI system looks much like the traditional two-train system. Analyzing the HPI system as a typical two-train system estimates the reliability in the most conservative configuration.

Description of Condition C

Proposed Condition C is entered when one HPI train is inoperable. While two HPI pumps may be available to inject into this header, other components may represent single failure points. In this situation, the HPI system can be conservatively represented by a single train of equipment.

Assumptions

The change in CDF is based on the assumption that proposed Conditions B and C of ITS 3.5.2 are entered once per year.

CDF and ICCDP Analysis

<u>Small Loss of Coolant Accidents (LOCAs)</u>

<u>Condition B</u>

Small break loss of coolant accidents could occur anywhere in the RCS or connected piping. One HPI pump has been shown to be sufficient to mitigate these LOCAs

when no HPI injection flow is being lost from the break location. For these "random break" locations, the change in CDF is evaluated by considering the change in HPI reliability from a three-train system to a two-train system. While not strictly a three-train system, the availability of the various cross-connect options do create a system that looks much like a three-train system except for the occurrence of some low probability passive failures. Because the system does not contain all of the redundancy of a true three-train system, an analysis that considers a loss of an HPI pump to be a reduction from three trains to two trains is conservative in its assessment of the change in system reliability.

The change in core damage for the small LOCAs is calculated by considering the sequence of events that lead to failure of the mitigating systems. The initiating frequency, hardware failures and operator actions are considered. The operator action to depressurize the RCS is assigned a relatively large error probability, as shown below. Hardware failure contributions from failure of EFW or of the ADVs are expected to be very small relative to this value. These hardware failures are not explicitly included in the calculations, but are assumed to be embedded in the failure of the operator action.

The parameters required for the analysis of the small LOCA are:

Small LOCA frequency 2/3 assumed as random 1/3 assumed for HPI/RCP	1.5E-03 1.0E-03 5.0E-04
HPI single train failure probability	3.0E-02
Operators fail to depressurize RCS	1.0E-01
Fractional increase in AOT (27/365)	7.4E-02
Fraction of year in AOT (30/365)	8.2E-02
CCF multiplier for 2 of 2 trains	1.0E-01
CCF multiplier for 3 of 3 trains	3.0E-02

The value for the non-recovery probability for the operator action to depressurize the RCS to sufficiently low pressure to allow an LPI pump to inject is taken from the Oconee PRA, Revision 2. The two common cause failure (CCF) multipliers are assumed generic values for the train failure combinations being evaluated and are expected to be conservative.

For the random small breaks, core damage occurs when all HPI fails, and the operators fail to cool down to the LPI entry conditions. The HPI failure probability is evaluated by estimating the reliability of the system based on the train reliability calculated earlier. The system failure probability in each condition is estimated as the sum of the independent failure of the trains plus the common cause contribution. The common cause contribution is the CCF multiplier times the random failure probability for a train.

- Failure of a three train HPI system is calculated as $0.03^3 + 3.0E\text{-}02 \times 0.03 = 9.3E\text{-}04$
- Failure of a two train HPI system is calculated as $0.03^2 + 1.0E\text{-}01 \times 0.03 = 3.9E\text{-}03$

The resulting change in CDF is estimated by the following formula.

- δCDF = (Random small LOCA IE frequency) x (change in HPI system failure probability) x (failure to depressurize to LPI) x (fractional increase in AOT)
- δCDF = 1E-3 x (3.9E-3 - 9.3E-4) x 1E-1 x 7.4E-2 = 2.2E-08

The incremental conditional core damage probability is calculated in a similar manner. For simplicity and conservatism, the conditional core damage probability is to be considered the incremental as well. That is, the base case CDF as a result of HPI failure is assumed to be zero. The time period for consideration is now 30 days.

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Random small LOCA IE frequency) x (HPI failure probability) x (failure to depressurize to LPI) x (fraction of the year in AOT)
- ICCDP = 1E-3 x (3.9E-3 - 9.3E-4) x 1E-1 x 8.2E-2 = 3.2E-08

For the limiting break locations, if the train injecting into the intact header fails then the operators must depressurize the RCS to achieve the needed HPI flow into the RCS. This can be accomplished with either the turbine bypass system or the atmospheric dump valves. The failure to depressurize is assumed to be dominated by the operator action given its large failure probability and the unlikely failure of both means of depressurizing. Since the base case PRA has not explicitly included the HPI line break in the modeling, the entire CDF from this sequence is included as a change in the CDF.

The resulting change in CDF is estimated by the following formula.

- δCDF = (Limiting small LOCA IE frequency) x [(HPI single train failure probability) x (probability that failed HPI train is on the intact header) x (failure to depressurize) + (change in HPI system

failure probability) x (failure to depressurize to LPI)] x (fractional increase in AOT)

- δCDF = 5E-4 x [(3.0E-2 x 0.5 x 1E-1) + ((3.9E-3 - 9.3E-4) x 0.1)] x 7.4E-2 = 6.6E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Limiting small LOCA IE frequency) x [(HPI single train failure probability) x (probability that failed HPI train is on the intact header) x (failure to depressurize) + (HPI failure probability) x (failure to depressurize to LPI)] x (fraction of the year in AOT)
- ICCDP = 5E-4 x [(3.0E-2 x 0.5 x 1E-1) + (3.9E-3 x 0.1)] x 8.2E-2 = 7.7E-08

The total change in CDF, from small LOCAs for Condition B, is the sum of these two components and is estimated to be δCDF = 8.8E-08. The total ICCDP, from small LOCAs for Condition B, is the sum of these two components and is estimated to be ICCDP = 1.1E-07.

Condition C

Condition C allows operation for up to 72 hours with one train of HPI unavailable. This is an extension of 48 hours over the current requirement of the Technical Specifications. The change in CDF associated with the proposed Condition C results from the additional 48 hours of operation allowed with a train of HPI unavailable at reduced power. The 48 hour time period is 5.5E-03 years.

This condition is modeled by considering the HPI system to be reduced to a single train with a reliability as estimated previously. This is conservative for the following reasons: there may be a second HPI pump available for which no credit is taken and an HPI pump is normally running which eliminates certain failure modes included in the train failure probability. The HPI system reliability is normally quite high. For this analysis, the change in reliability is estimated by assuming that the normal failure probability is practically zero, and that the change in failure

probability is equal to the single train failure probability.

For the random small breaks, core damage occurs when all HPI fails, and the operators fail to cool down to the LPI entry conditions. The resulting change in CDF is estimated by the following formula.

- δCDF = (Random small LOCA IE frequency) x (HPI failure probability) x (failure to depressurize to LPI) x (fractional increase in AOT)
- δCDF = 1E-3 x 3E-2 x 1E-1 x 5.5E-3 = 1.7E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Random small LOCA IE frequency) x (HPI failure probability) x (failure to depressurize to LPI) x (fraction of the year in AOT)
- ICCDP = 1E-3 x 3E-2 x 1E-1 x 8.2E-3 = 2.5E-08

For the limiting break location, core damage occurs if the break occurs on the header of the available pump and the operators fail to depressurize to increase flow, or if the available HPI train fails and the operators fail to depressurize to LPI entry conditions. The resulting change in CDF is estimated by the following formula.

- δCDF = (Limiting small LOCA IE frequency) x [(probability that failed HPI train is on the intact header) x (failure to depressurize) + (HPI failure probability) x (failure to depressurize to LPI)] x (fractional increase in AOT)
- δCDF = 5E-4 x [(0.5 x 1E-1) + (3.0E-2 x 0.1)] x 5.5E-3 = 1.5E-07

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Limiting small LOCA IE frequency) x [(probability that HPI break is on the available header) x (failure to depressurize) + (HPI failure probability) x (failure to depressurize to LPI)] x (fraction of the year in AOT)

- ICCDP = 5E-4 x [(0.5 x 1E-1) + (3.0E-2 x 0.1)] x 8.2E-3 = 2.2E-07

The total change in CDF, from small LOCA events for Condition C, is the sum of these two components and is estimated to be δCDF = 1.7E-07. The total ICCDP, from small LOCA events for Condition C, is the sum of these two components and is estimated to be ICCDP = 2.5E-07.

Medium Loss of Coolant Accidents (LOCAs)

Condition B

As in the small LOCA case, considering the change in HPI reliability from a three-train system to a two-train system with the previously calculated reliability provides a conservative approach to estimating the impact of proposed Condition B of ITS 3.5.2.

For the medium LOCA initiator, the HPI success criterion is one HPI pump. Failure of all HPI pumps is therefore required to lead to core damage.

As with the small LOCA, the medium LOCA initiator frequency is taken from Reference 2, a value of 3E-04/year.

The resulting change in CDF, from medium LOCAs for Condition B, is estimated by the following formula.

- δCDF = (Medium LOCA IE frequency) x (change in HPI system failure probability) x (fractional increase in AOT)
- δCDF = 3E-4 x (3.9E-3 - 9.3E-4) x 7.4E-2 = 6.6E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Medium LOCA IE frequency) x (HPI failure probability) x (fraction of the year in AOT)
- ICCDP = 3E-4 x 3.9E-3 x 8.2E-2 = 9.6E-08

The total change in CDF, from medium LOCA events for Condition B, is estimated to be δCDF = 6.6E-08. The

total ICCDP, from medium LOCA events for Condition B, is estimated to be ICCDP = 9.6E-08.

Condition C

As in the small LOCA case, considering the HPI system to be a one-train system with the previously calculated reliability provides a conservative approach to estimating the impact of proposed Condition C of ITS 3.5.2.

The resulting change in CDF, from medium LOCAs for Condition C, is estimated by the following formula.

- δCDF = (Medium LOCA IE frequency) x (HPI failure probability) x (fractional increase in AOT)
- δCDF = 3E-4 x 3.0E-2 x 5.5E-3 = 5.0E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Medium LOCA IE frequency) x (HPI failure probability) x (fraction of the year in AOT)
- ICCDP = 3E-4 x 3.0E-2 x 8.2E-3 = 7.4E-08

The change in CDF, from medium LOCA events for Condition C, is estimated to be δCDF = 5.0E-08. The ICCDP, from medium LOCA events for Condition C, is estimated to be ICCDP= 7.4E-08.

Transients

Transient initiators typically proceed to core damage through one of two paths.

1) If all sources of feedwater to the steam generators fail, a loss of secondary side heat removal (SSHR), then HPI is relied upon to provide core cooling through a feed and bleed. Core damage results if feed and bleed fails.
2) Failure to maintain cooling to the reactor coolant pump (RCP) seals may result in leakage through the seals that uncovers the core in a relatively short period of time (a few hours). The HPI system, along with component cooling, provide this seal cooling function. Core damage results if the seal LOCA is not mitigated.

Transients Requiring Feed and Bleed

The dominant transients leading to a loss of all SSHR are those where main feedwater is lost and not recovered. The transients most likely to lead to this condition are:

- Loss of Instrument Air
- Loss of Main Feedwater
- Reactor Trip with failure to restore main feedwater

Loss of Instrument Air - Main feedwater relies on instrument air for its operation. If instrument air is unavailable, main feedwater is assumed lost and not recoverable. The frequency for the loss of instrument air initiator is conservatively assumed to be 0.05/year. This is slightly higher than the value from the Oconee PRA Revision 2, Reference 5.

Loss of Main Feedwater - Following a loss of main feedwater initiating event, there is a potential for restoring feedwater to one or both steam generators. This recovery potential is based on actual experience as documented in the Oconee PRA Revision 1 (the IPE submittal), and subsequently used in Revision 2 of the PRA, Reference 5. The failure to recover main feedwater in time to prevent core damage is estimated at 0.1. This non-recovery probability is combined with a loss of feedwater initiating event frequency of 0.4/year to arrive at a frequency for a loss of main feedwater transient for which main feedwater is not recovered. This transient frequency is therefore 0.04/year.

Reactor Trip - Following a normal reactor trip, main feedwater is available to feed the steam generators. In some cases, main feedwater has not been readily available following a trip. The frequency for reactor trips with loss of main feedwater is based on historical experience and is estimated to be 0.2/year. As with the loss of main feedwater initiator, main feedwater can be subsequently recovered. The frequency of reactor trips with loss of main feedwater and no

recovery of main feedwater is calculated to be 0.02/year.

The total frequency of transient initiators for which main feedwater is not available is the sum of the three contributors. It is estimated as 0.11/year. Other initiating events that occur with much lower frequency than those just identified can result in a similar plant state. In order to provide some margin for these transients not explicitly included, the initiating frequency for transients with no main feedwater is assumed to be 1.5E-01/year.

For core damage to occur as a result of failure of HPI to perform the feed and bleed function, the following sequence must occur: 1) the failure of EFW, 2) the failure to recover EFW from another unit, and 3) the SSF failure to supply ASW. The probabilities are estimated from the Oconee PRA Revision 2 Report, Reference 5.

- Transient with loss of main feedwater
- Failure of EFW on the unit (failure probability of 2E-03)
- Failure to recover EFW from another unit (failure probability of 5E-02)
- Failure of auxiliary service water (ASW) from the SSF (failure probability of 1.5E-01)
- Failure of feed and bleed

In estimating the SSF-ASW failure probability, the SSF diesel generator failures have not been included since the majority of the transient frequency being considered does not involve a loss of offsite power. Furthermore, it has been assumed that EFW, the recovery of EFW from another unit, and the SSF-ASW are independent failures. Referring to Figure 10, it can be seen that a small number of component failures may impact one or more of these potential sources. The number of components involved is quite small and any increase in the overall failure probability for SSHR is considered negligible for this analysis. Significant

conservatism has been retained in other aspects of this evaluation.

Transients Requiring Seal Cooling
All transients not involving a breach of the RCS boundary require that seal cooling be maintained in order to prevent a loss of RCS integrity via a seal LOCA. Examples of transients that may be of concern for seal cooling include: reactor trip, loss of main feedwater, loss of offsite power, and loss of low pressure service water.

Since HPI provides the normal source of seal injection, the reliability of HPI to perform this function may be impacted by some of the potential configurations allowed by proposed Conditions B and C of ITS 3.5.2. Two scenarios are considered in the analysis. First, the ability of HPI to maintain seal injection following a transient is analyzed. Second, the potential for an HPI failure to initiate a transient is analyzed.

Condition B
Previously, the change in HPI system reliability was assessed by considering a change from a three-train system to a two-train system when proposed Condition B is entered. Since this approach conservatively estimates the change in HPI failure probability, this approach is also used here.

Feed and Bleed
The probability that HPI may fail to satisfy the assumed feed and bleed success criterion of two trains of HPI is evaluated as follows.

Failure of two of three trains is required when all equipment is available. Using the train failure probabilities developed earlier and assuming a generic CCF multiplier for 2 out of 3 trains of 0.1, the base HPI reliability is:

- Failure of 2/3 HPI trains is calculated as $0.03^2 + 0.1 \times 0.03 = 3.9E-03$

For a two-train system, failure of either train means failure to satisfy the success criterion.

Therefore, the change in feed and bleed failure probability is:
0.03 - 3.9E-03 = 2.6E-02.

The resulting change in CDF, from transient induced feed and bleed scenarios in Condition B, is estimated by the following formula.

- δCDF = (Transient with loss of main feedwater IE frequency) x (Failure of EFW on the unit) x (Failure to recover EFW from another unit) x (Failure of auxiliary service water from the SSF) x (change in HPI system failure probability) x (fractional increase in AOT)
- δCDF = 1.5E-1 x 2.0E-3 x 0.05 x 1.5E-1 x 2.6E-2 x 7.4E-2 = 4.3E-09

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Transient with loss of main feedwater IE frequency) x (Failure of EFW on the unit) x (Failure to recover EFW from another unit) x (Failure of auxiliary service water from the SSF) x (HPI failure probability) x (fraction of the year in AOT)
- ICCDP = 1.5E-1 x 2.0E-3 x 0.05 x 1.5E-2 x 0.03 x 8.2E-2 = 5.5E-09

RCP Seal LOCA

<u>Response to an Initiating Event</u>
A transient may proceed to core damage if all seal cooling is lost. A seal LOCA may result and failure to mitigate the LOCA leads to core damage. The sequence of events for accidents proceeding along this path include the following:

- Transient initiator,
- Loss of HPI seal injection,
- Loss of component cooling (failure probability assumed to be 0.001),

- Failure of the SSF seal injection (failure probability assumed to be 0.2),
- Failure to mitigate the LOCA.

When proposed Condition B of ITS 3.5.2 applies, only one pump is aligned to provide seal injection, there is no automatic backup. In the worst case, operation of a manual valve (HP-116) would be required in order to reestablish seal injection. Normally, the HPI reliability to maintain seal injection is quite high. For this analysis, the change in reliability is estimated by assuming that the normal failure probability is practically zero, and that the failure probability in the alternate alignment is equal to the change. The assumed initiating event frequency is 3/year. This is conservatively high and is dominated by the reactor trip frequency.

The resulting change in CDF, from transient induced seal LOCA scenarios in Condition B, is estimated by the following formula.

- δCDF = (Transient IE frequency) x (Failure of component cooling) x (Failure of the running HPI pump) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI) x (fractional increase in AOT)
- δCDF = 3 x 1.0E-3 x 3.6E-04 x 0.2 x 3.0E-2 x 0.1 x 7.4E-2 = 4.8E-11

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Transient IE frequency) x (Failure of component cooling) x (Failure of the running HPI pump) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI) x (fraction of the year in AOT)
- ICCDP = 3 x 1.0E-3 x 3.6E-04 x 0.2 x 3.0E-2 x 0.1 x 8.2E-2 = 5.3E-11

<u>Loss of HPI Seal Injection as Initiating Event</u>

While operating in proposed Condition B of ITS 3.5.2, no automatic backup to the RCP seal injection function

is available. The analysis of this condition for its potential as an initiating event is very similar to the analysis just completed for the response to a transient. In this case, however, the initiating event is the loss of the running HPI pump with 27 days as the assumed mission time for the pump supplying seal injection.

The resulting change in CDF, from HPI failure induced seal LOCA scenarios in Condition B, is estimated by the following formula.

- δCDF = (Failure of the running HPI pump) x (Failure of component cooling) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI)
- δCDF = 9.7E-3 x 1.0E-3 x 0.2 x 3.0E-2 x 0.1 = 5.8E-09

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Failure of the running HPI pump) x (Failure of component cooling) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI)
- ICCDP = 1.1E-2 x 1.0E-3 x 0.2 x 3.0E-2 x 0.1 = 6.6E-09

The total change in CDF, from transient events for Condition B, is the sum of these three components and is estimated to be δCDF = 1.0E-08. The total ICCDP, from transient events for Condition B, is the sum of these three components and is estimated to be ICCDP = 1.2E-08.

Condition C
Previously when considering proposed Condition C, the change in HPI system reliability was assessed by considering a one-train system. Since this approach conservatively estimates the change in HPI failure probability, this approach is also used here.

Feed and Bleed
With only one train of HPI, the feed and bleed failure probability is 1.0. The change in feed and bleed failure probability is, therefore,
1.0 - 3.9E-03 = 1.0.

The resulting change in CDF, from transient induced feed and bleed scenarios in Condition C, is estimated by the following formula.

- δCDF = (Transient with loss of main feedwater IE frequency) x (Failure of EFW on the unit) x (Failure to recover EFW from another unit) x (Failure of auxiliary service water from the SSF) x (HPI failure probability) x (fractional increase in AOT)
- δCDF = 1.5E-1 x 2.0E-3 x 0.05 x 1.5E-1 x 1.0 x 5.5E-3 = 1.2E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Transient with loss of main feedwater IE frequency) x (Failure of EFW on the unit) x (Failure to recover EFW from another unit) x (Failure of auxiliary service water from the SSF) x (HPI failure probability) x (fraction of the year in AOT)
- ICCDP = 1.5E-1 x 2.0E-3 x 0.05 x 1.5E-1 x 1.0 x 8.2E-3 = 1.8E-08

RCP Seal LOCA

<u>Response to an Initiating Event</u>
When proposed Condition C of ITS 3.5.2 applies, only one train of HPI is assumed to be available. This is obviously conservative for this condition, since it would be expected that a second pump is available that could be aligned to the available header. Normally, the HPI reliability to maintain seal injection is quite high. For this analysis, the change in reliability is estimated by assuming that the normal failure probability is practically zero, and that the change in failure probability is equal to the train failure probability in the alternate alignment. The assumed initiating event frequency is 3/year. This is

conservatively high and is dominated by the reactor trip frequency.

The resulting change in CDF, from transient induced seal LOCA scenarios in Condition C, is estimated by the following formula.

- δCDF = (Transient IE frequency) x (Failure of component cooling) x (Failure of the running HPI pump) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI) x (fractional increase in AOT)
- δCDF = 3 x 1.0E-3 x 3.6E-4 x 0.2 x 1.0 x 0.1 x 5.5E-3 = 1.2E-10

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Transient IE frequency) x (Failure of component cooling) x (Failure of the running HPI pump) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI) x (fraction of the year in AOT)
- ICCDP = 3 x 1.0E-3 x 3.6E-4 x 0.2 x 1.0 x 0.1 x 8.2E-3 = 1.8E-10

<u>Loss of HPI Seal Injection as Initiating Event</u>
While operating in proposed Condition C of ITS 3.5.2, no automatic backup to the RCP seal injection function is assumed to be available. The analysis of this condition for its potential as an initiating event is very similar to the analysis just completed for the response to a transient. In this case, however, the initiating event is the loss of the running HPI pump with 48 hours as the assumed mission for the pump supplying seal injection.

The resulting change in CDF, from HPI failure induced seal LOCA scenarios in Condition C, is estimated by the following formula.

- δCDF = (Failure of the running HPI pump) x (Failure of component cooling) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI)

- δCDF = 7.2E-4 x 1.0E-3 x 0.2 x 1.0 x 0.1 = 1.4E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (Failure of the running HPI pump) x (Failure of component cooling) x (Failure of RCM from the SSF) x (HPI failure probability) x (failure to depressurize to LPI)
- ICCDP = 1.1E-3 x 1.0E-3 x 0.2 x 1.0 x 0.1 = 2.2E-08

The total change in CDF, from transient events for Condition C, is the sum of these three components and is estimated to be δCDF = 2.6E-08. The total ICCDP, from transient events for Condition C, is the sum of these three components and is estimated to be ICCDP = 4.0E-08.

Steam Generator Tube Rupture (SGTR)

The requirements for HPI during a SGTR is very similar to that for the small LOCA. One train of HPI is needed in order to assure that the RCS inventory is maintained. The analysis for the SGTR initiator proceeds very much like that for the small LOCA. As in the small LOCA case it is assumed that given a failure of HPI, the operators can cool down to the DHR entry conditions to prevent core damage. The non-recovery probability is assumed to have a value of 0.1, from Reference 5. The SGTR initiating frequency is assumed to be 5.3E-03/year, from Reference 5.

Condition B

As was done previously, the change in HPI reliability is assumed to be that resulting from a change from a three-train system to a two-train system.

The resulting change in CDF is estimated by the following formula.

- δCDF = (SGTR IE frequency) x (change in HPI system failure probability) x (failure to depressurize to DHR) x (fractional increase in AOT)

- δCDF = 5.3E-3 x (3.9E-3 - 9.3E-4) x 1E-1 x 7.4E-2 = 1.2E-07

The resulting ICCDP is estimated by the following formula.

- ICCDP = (SGTR IE frequency) x (HPI failure probability) x (failure to depressurize to DHR) x (fraction of the year in AOT)
- ICCDP = 5.3E-3 x 3.9E-3 x 1E-1 x 8.2E-2 = 1.7E-07

The total change in CDF, from SGTRs events for Condition B, is estimated to be δCDF = 1.2E-07. The total ICCDP, from SGTRs events for Condition B, is estimated to be ICCDP = 1.7E-07.

Condition C

As was done previously, the change in HPI reliability is assumed to be the failure probability of a single train system.

The resulting change in CDF is estimated by the following formula.

- δCDF = (SGTR IE frequency) x (HPI failure probability) x (failure to depressurize to DHR) x (fractional increase in AOT)
- δCDF = 5.3E-3 x 3E-2 x 1E-1 x 5.5E-3 = 8.7E-08

The resulting ICCDP is estimated by the following formula.

- ICCDP = (SGTR IE frequency) x (HPI failure probability) x (failure to depressurize to DHR) x (fraction of the year in AOT)
- ICCDP = 5.3E-3 x 3E-2 x 1E-1 x 8.2E-3 = 1.3E-07

The total change in CDF, from SGTRs for Condition C, is estimated to be δCDF = 8.7E-08. The total ICCDP, from SGTRs for Condition C, is estimated to be ICCDP = 1.3E-07.

LERF

Detailed calculations to determine the impact on the large early release frequency are not required. The

large early release frequency for Oconee is dominated by the ISLOCA and external event initiators. The HPI system unavailabilities that are the issue for proposed Conditions B and C of ITS 3.5.2 play no role in these accident sequences. Containment isolation and containment failures play less significant roles in the estimated LERF. Failures of the containment isolation and containment pressure control system would occur independently from the situations permitted by proposed Conditions B and C of ITS 3.5.2. Thus, the proposed changes to ITS 3.5.2 can only influence LERF in proportion to the increase in CDF that they represent. These increases have been shown to be acceptable and the increases in LERF will also be acceptable.

Results

The change in CDF and ICCDP have been calculated for proposed Conditions B and C of ITS 3.5.2. These estimates have been conservatively estimated and the actual change is expected to be significantly less than the values presented below.

<u>Condition B</u>

ΔCDF

The total change in CDF for Oconee, as a result of proposed Condition B, is estimated as the sum of the changes from the individual initiators. The combined change in CDF is calculated to be ΔCDF = 2.8E-07/year.

ICCDP

The total ICCDP for Oconee, as a result of proposed Condition B, is estimated as the sum of the changes from the individual initiators. The combined ICCDP is calculated to be ICCDP = 3.8E-07.

<u>Condition C</u>

ΔCDF

The total change in CDF for Oconee, as a result of proposed Condition C, is estimated as the sum of the changes from the individual initiators. The combined change in CDF is calculated to be ΔCDF = 3.2E-07/year.

ICCDP

The total ICCDP for Oconee, as a result of proposed Condition C, is estimated as the sum of the changes from the individual initiators. The combined ICCDP is calculated to be ICCDP = 4.8E-07.

The results are summarized in the following table.

Initiator	Condition B ΔCDF	Condition B ICCDP	Condition C ΔCDF	Condition C ICCDP
Random Small LOCA	2.2E-08	3.2E-08	1.7E-08	2.5E-08
Limiting Small LOCA	6.6E-08	7.7E-08	1.5E-07	2.2E-07
Medium LOCA	6.6E-08	9.6E-08	5.0E-08	7.4E-08
Transient (Feed and Bleed)	4.3E-09	5.5E-09	1.2E-08	1.8E-08
Transient (seal LOCA)	4.8E-11	5.3E-11	1.2E-10	1.8E-10
Transient (Seal LOCA Initiator)	5.8E-09	6.6E-09	1.4E-08	2.2E-08
SGTR	1.2E-07	1.7E-07	8.7E-08	1.3E-07
Total	2.8E-07	3.9E-07	3.3E-07	4.9E-07

Sensitivity/Uncertainty of the Results

No formal sensitivity studies or uncertainty analyses are conducted on the HPI system reliability estimate. The failure probabilities for the HPI trains have been calculated in a conservative manner. The component

failure data, taken from the HPI Reliability Study, produced an HPI train failure probability of approximately 0.01. This has been increased in this study by a factor of 3 in order to assure conservatism in the analysis. Other factors, such as assuming the same failure rate for both HPI trains even though one is normally operating and not subject to certain failure modes, also make the train reliability estimates used in this analysis conservative. While selections of other component failure rates could lead to different results for a train failure probability, an overall train reliability of 97%, when maintenance need not be included, is not judged to represent an optimistic value for the train reliability.

One significant factor that impacts the estimated ΔCDF of the proposed ITS 3.5.2 is the number of times that Conditions B or C are entered per year. The analysis assumed one entry per year, however, the actual experience may be different than this assumption. The following table presents the results for the ΔCDF assuming the conditions are entered once every ten years and twice per year.

Frequency of condition	Condition B ΔCDF	Condition C ΔCDF
0.1/year	2.8E-08	3.3E-08
2.0/year	5.6E-07	6.6E-07

It is expected that the results for the 0.1/year case are more representative of what will be the actual Oconee experience than the results at 2/year or the base case.

The conservative approaches taken to estimate the HPI reliability and calculate the CDF impact make it very unlikely that the results underestimate the risk impact of proposed ITS 3.5.2.

Conclusions

The change in CDF as a result of the proposed Technical Specification changes has been conservatively estimated to be less than 1E-06, for both conditions B and C, and represents an insignificant contribution to the calculated CDF for Oconee. The ICCDP has been conservatively estimated to be less than 5E-07 for both conditions B and C.

The LERF and ICLERP contributions are also negligible.

Tier 2 - Avoidance of Risk Significant Plant Configurations

The objective of the second tier is to provide reasonable assurance that risk-significant plant equipment outage configurations will not occur when an HPI pump is out of service. If risk-significant configurations do occur, then enhancements to Technical Specifications or procedures, such as limiting unavailability of backup systems, increased surveillance frequencies, or upgrading procedures or training, can be made that avoid, limit, or lessen the importance of these configurations.

Assessment of Tier 2 for the Proposed HPI Technical Specification

The primary functions of the HPI system in controlling risk are to provide RCS inventory control following a loss of coolant accident, provide an alternate means of core cooling when a loss of secondary side heat removal occurs, and provide a means to maintain RCS integrity by providing RCP seal cooling and prevent excessive seal leakage.

Those systems that in conjunction with HPI serve to perform these same functions may experience an increase in their relative importance in the plant as a result of the small decrease in HPI reliability associated with operation in proposed Conditions B or C of ITS 3.5.2. The impact on these systems is discussed qualitatively.

Component Cooling

CC along with HPI maintains RCP seal cooling. Proposed ITS 3.5.2 would permit operating conditions during which the HPI system's ability to maintain seal injection is degraded. The relative importance of the CC function does increase when an HPI pump is out of service. A review of the Tier 1 calculations suggests that an increase in the CC failure probability, as might be associated with having a pump out of service, would have a significant impact on the frequency of transients initiated by a loss of seal injection. It is prudent to control CC maintenance while in this condition. This will be included in the maintenance rule configuration management program.

SSF-RCM

The SSF provides an alternate means of seal injection. The connection between the HPI seal injection function and the SSF is recognized and controlled through the maintenance rule configuration management program, WPM-607. This practice should continue.

EFW

The EFW system interacts with the HPI in two ways. A loss of EFW contributes to the need to use feed and bleed as the means of core cooling. Additionally, depressurizing the steam generators to make LPI useful is a means to mitigate LOCAs when HPI fails. The importance of EFW is expected to increase when an HPI pump or train is out of service. This increase is controlled, however, by the other means to maintain SSHR. Main feedwater, EFW from another unit, and the SSF-ASW all provide alternate means to maintain a source of feedwater to the steam generators. The connection between HPI and EFW has been recognized in and controls on concurrent unavailability have been implemented through the maintenance rule configuration management program, WPM-607. No new controls are necessary as a result off the conditions allowed by proposed ITS 3.5.2.

Steam Generator Depressurization

Depressurizing the steam generators is required to mitigate failure of the HPI system. Steam generator depressurization is accomplished via the turbine bypass system or the atmospheric dump valves. This action has been credited in the Oconee PRA. While this action is not new in the PRA analysis, the frequency with which such an action may be required may increase during periods of reduced HPI reliability. The failure to depressurize is assumed to be dominated by human errors associated with this action. Hardware failures and maintenance unavailabilities do not have a significant impact on the assumed reliability for this action. As a result, no significant benefit in the CDF calculation is expected if controls on ADV availability are considered. From a risk informed perspective, no program for assuring ADV availability is required.

Tier 3 - Risk Informed Configuration Control

The objective of the third-tier is to ensure that the risk impact of out-of-service equipment is evaluated prior to performing any maintenance activity. As stated in DG-1065, "a viable program would be one that is able to uncover risk-significant plant equipment outage configurations as they evolve during real-time, normal plant operation." The third-tier requirement is an extension of the second-tier requirement, but addresses the limitation of being able to identify all possible risk-significant plant configurations in the second-tier evaluation.

Safety Function Determination Program

As part of the ITS, Oconee will implement a Safety Function Determination Program (SFDP). This program implements the requirements of ITS LCO 3.0.6. In the event a supported system Limiting Condition for Operation (LCO) is not met solely due to a support system LCO not being met, LCO 3.0.6 requires an evaluation to be performed in accordance with ITS 5.5.16, "Safety Function Determination Program (SFDP)."

This evaluation is performed to determine if a loss of safety function exists. If a loss of safety function is determined to exist by the SFDP, the appropriate Conditions and Required Actions of the ITS LCO in which the loss of safety function exists are required to be entered.

ITS 5.5.16 states that the SFDP contains the following:

a. Provisions for cross train checks to ensure a loss of the capability to perform the safety function assumed in the accident analysis does not go undetected;

b. Provisions for ensuring the plant is maintained in a safe condition if a loss of safety function condition exists;

c. Provisions to ensure that an inoperable supported system's Completion time is not inappropriately extended as a result of multiple support system inoperabilities; and

d. Other appropriate limitations and remedial or compensatory actions.

Maintenance Rule Configuration Control

As part of the Maintenance Rule implementation, Oconee already has in place a configuration risk management program which provides a proceduralized risk-informed assessment to manage the risk associated with equipment inoperability. The Oconee PRA Revision 2 model was used to help identify combinations of equipment that should not be out of service at the same time. This risk information was provided to the Maintenance Rule Expert Panel who developed a matrix, that when used in conjunction with Technical Specifications will:

- protect safety function redundancy,
- will protect the ability to mitigate transients and
- will protect against important PRA sequences.

Use of the PRA Matrix is directed by Work Control Procedure WMP-607 "Maintenance Rule Assessment Of Equipment Removed From Service". This procedure requires that the matrix be used by the scheduling group when they are developing schedules for removal of equipment from service and also by operations prior to removing equipment from service.

In addition to the PRA Matrix and WPM-607, Oconee is currently developing a computerized assessment tool called ORAM/Sentinel that will also provide a risk informed perspective to help manage the risk associated with equipment inoperability. Use of ORAM/Sentinel is directed by the Work Control Procedures WPM-608, "Outage Risk Assessment Utilizing ORAM-SENTINEL" and WPM-609 "Innage Risk Assessment Utilizing ORAM-SENTINEL".

Avoidance of Shutdown Risk

One of the benefits of proposed ITS 3.5.2 is avoiding the risk associated with a plant shutdown and the ensuing startup. Proposed ITS 3.5.2 will help avoid plant shutdowns by allowing additional time to complete repair activities and restoration of parameters to within limits.

The value for the core damage frequency that is incurred during a plant shutdown and subsequent restart is expected to fall in the range of 1E-07 to 5E-07. The risk that can be avoided due to an avoided plant shutdown is comparable to or greater than the risk increase associated with proposed ITS 3.5.2.

Quality of the PRA

Although the Oconee PRA and the HPI reliability study are not used directly in the risk assessment supporting this Technical Specification submittal, they were used to develop some of the parameters for the analysis.

Also, the PRA helps to provide a basis for configuration risk assessment process used to address the Tier 3 requirement of the Reg. Guide. Therefore, it is prudent to describe the process that Duke uses to assure that its PRA studies are of appropriate quality.

Qualifications and Organization of PRA Group

Duke Power has a long history of performing full scope level three PRA studies for all its plants. Beginning in 1980 with the NSAC-60 study of Oconee, Duke has maintained PRA expertise located at its company headquarters in Charlotte, North Carolina. By performing the PRA analysis in-house, Duke maintains a level of experience in both the development and application of its PRAs.

Work Place Procedures to Guide Analyses

Duke Power uses Workplace Procedures to assure that PRA analyses are performed consistently and correctly. These procedures provide guidance on many aspects of performing and applying PRAs. This includes NSM reviews, data development, and evaluation of operating experience.

Past peer reviews

Over the long history of PRA at Duke, there have been many different reviews of the Oconee PRA and other Duke PRA analyses. These reviews by organizations outside of Duke have consistently found that the methods and practices of the Duke team produce a high quality product that produce realistic estimates of risk. These "peer" reviews include:

- An Independent Peer Review of the NSAC-60 Study, "A Probabilistic Risk Assessment of Oconee Unit 3". This peer review team included such names as Norman Rasmussen, Jerry Fussell and John Garrick.
- NUREG/CR-4374, A Review of the Oconee-3 Probabilistic Risk Assessment, Brookhaven National Lab, 1986.

- Keowee Probabilistic Reliability Study submitted to and reviewed by NRC in 1995.
- HPI Reliability Study submitted to and reviewed by the NRC in 1997.
- Independent Audit by the Duke QA group in 1997.
- Evaluation and Assistance Visit by INPO in 1998.

Participation in Industry PRA Quality Programs

Duke Power is currently participating in several industry and NRC initiatives to stay abreast of PRA methods and practices. These programs include participation in Peer Review projects underway in both the Westinghouse Owners Group and the B&W Owners Group. Additionally, Duke is participating with the NRC and others in the ASME effort to develop a PRA standard.

Implementation and Monitoring Program

Programs already in place to meet the intent of the Maintenance Rule will be used to assure that the HPI Technical Specification change does not lead to unforeseen risk vulnerability. The two Maintenance Rule Programs used to monitor the HPI system are the Systems level performance criteria for HPI and the Maintenance Rule Periodic Assessment.

The objective of these programs is to assure that plant systems important to safety, including HPI, are monitored to verify that their performance is consistent with their importance to safety, and assure that appropriate corrective measures are taken when performance is not acceptable. Performance criteria are established using a combination of risk insights and operational experience. Program effectiveness is monitored through periodic assessments of the risk impact of actual SSC unavailability and functional failures.

References

1. Oconee Mk B-11 76% FP SBLOCA Summary, FTI Doc. # 86-1266126-00.
2. HPI Reliability Study, Duke Power Company, December 1997.
3. Reactor Coolant Pump Seal Performance Following A Loss of All ac Power, WCAP-10541 Revision 2.
4. Pipe Failure Study Update, EPRI TR-102266, April 1993.
5. Oconee PRA Revision 2, Duke Power Company, December 1996.

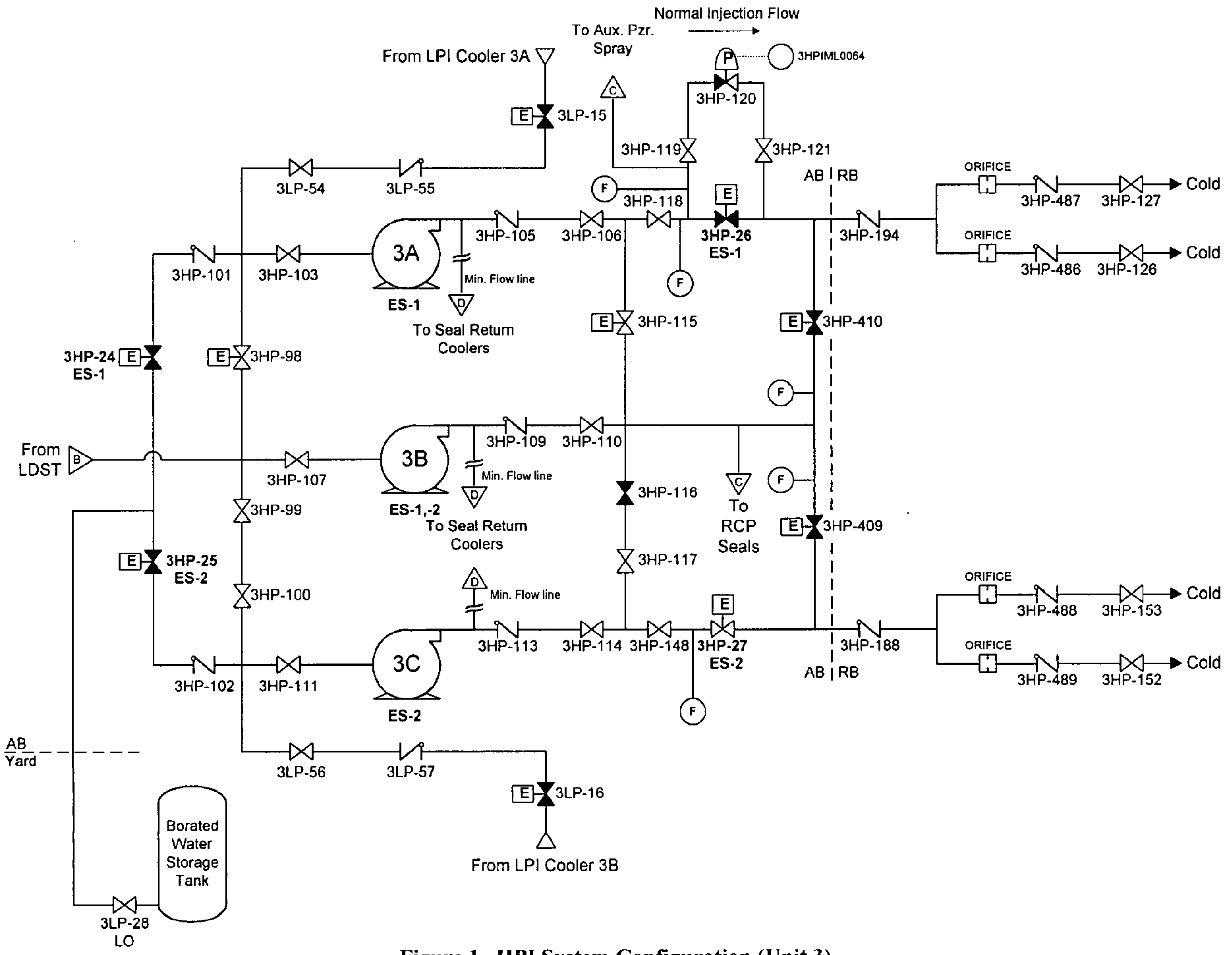

Figure 1 HPI System Configuration (Unit 3)

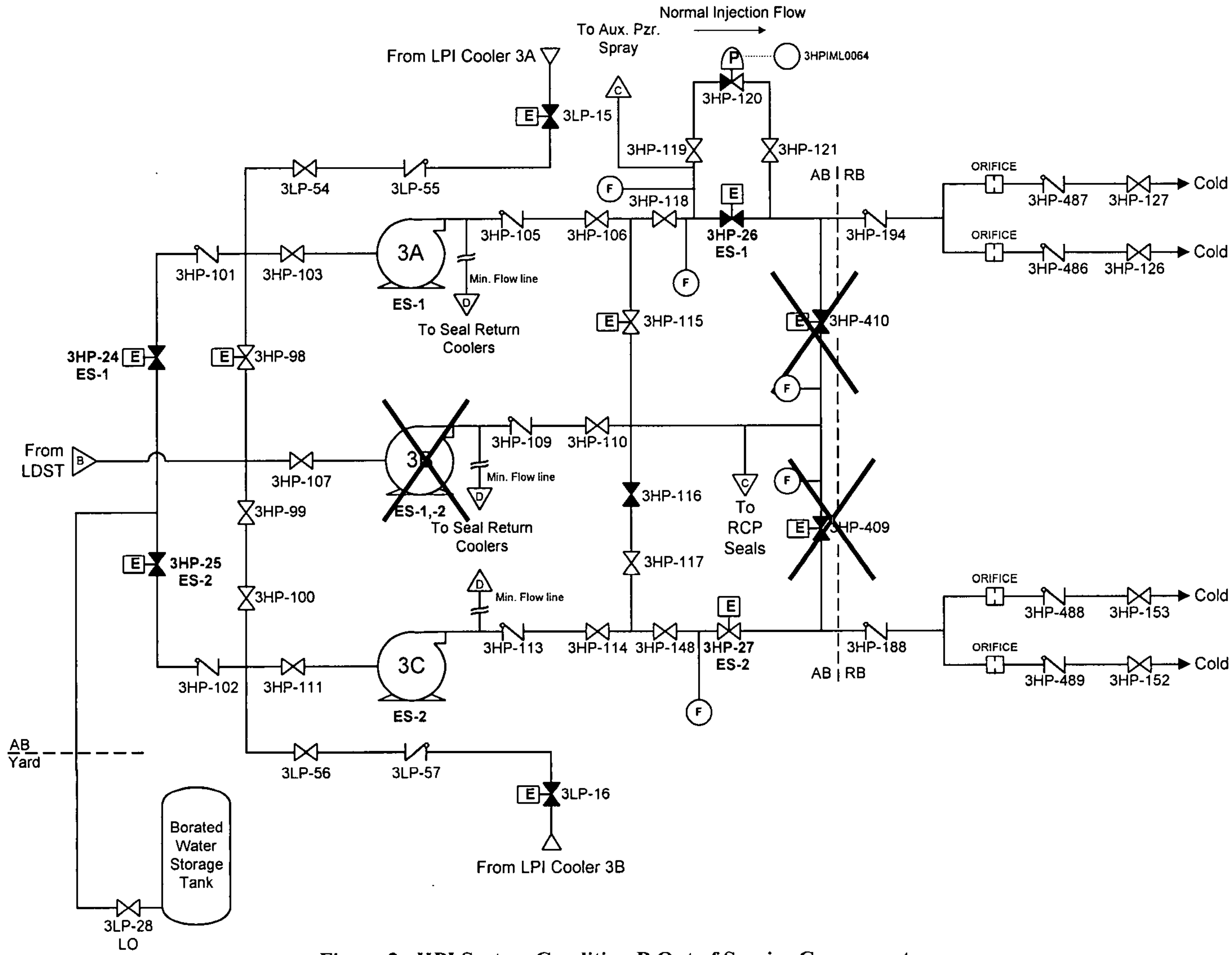

Figure 2 HPI System Condition B Out of Service Components

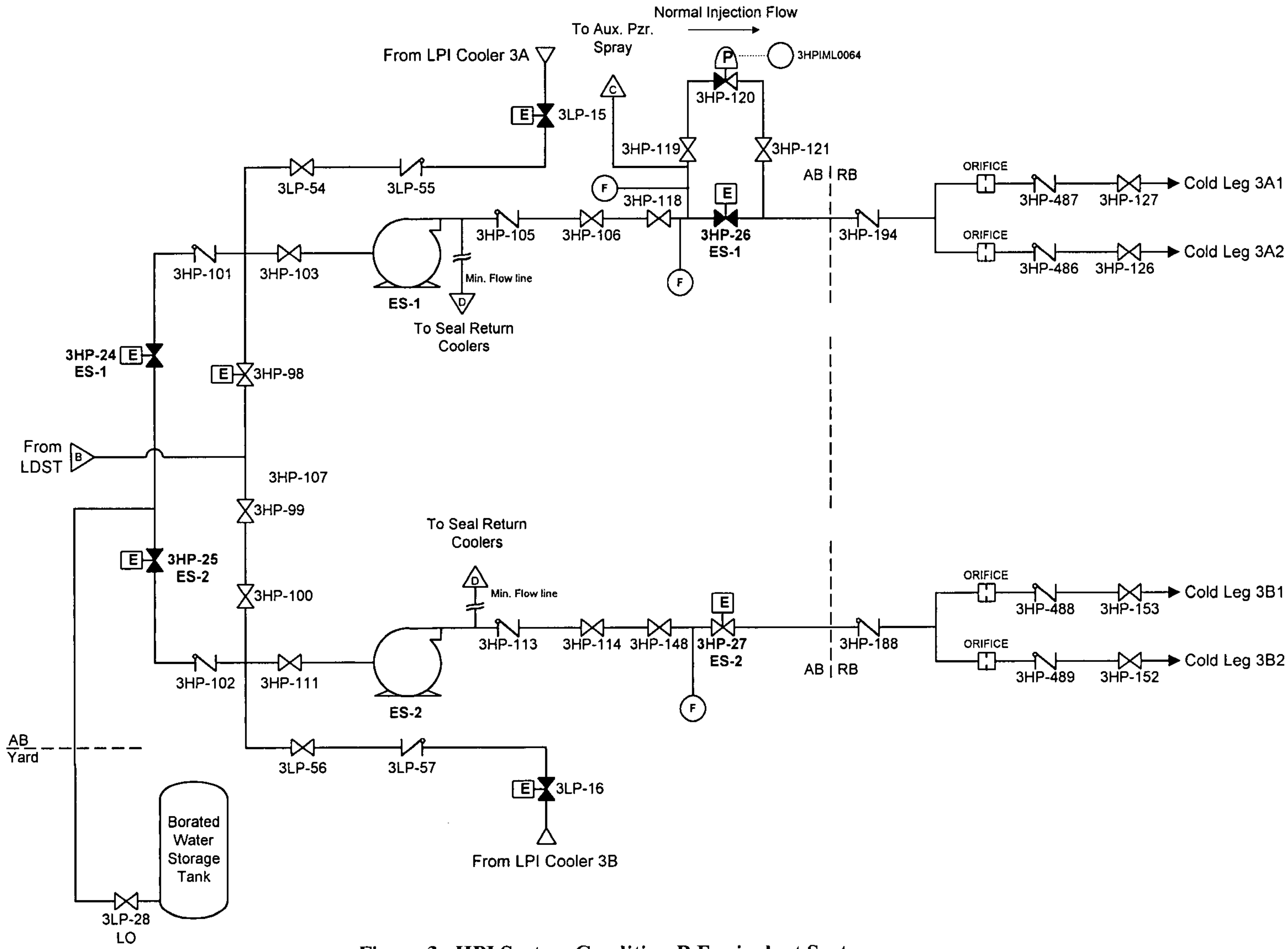

Figure 3 HPI System Condition B Equivalent System

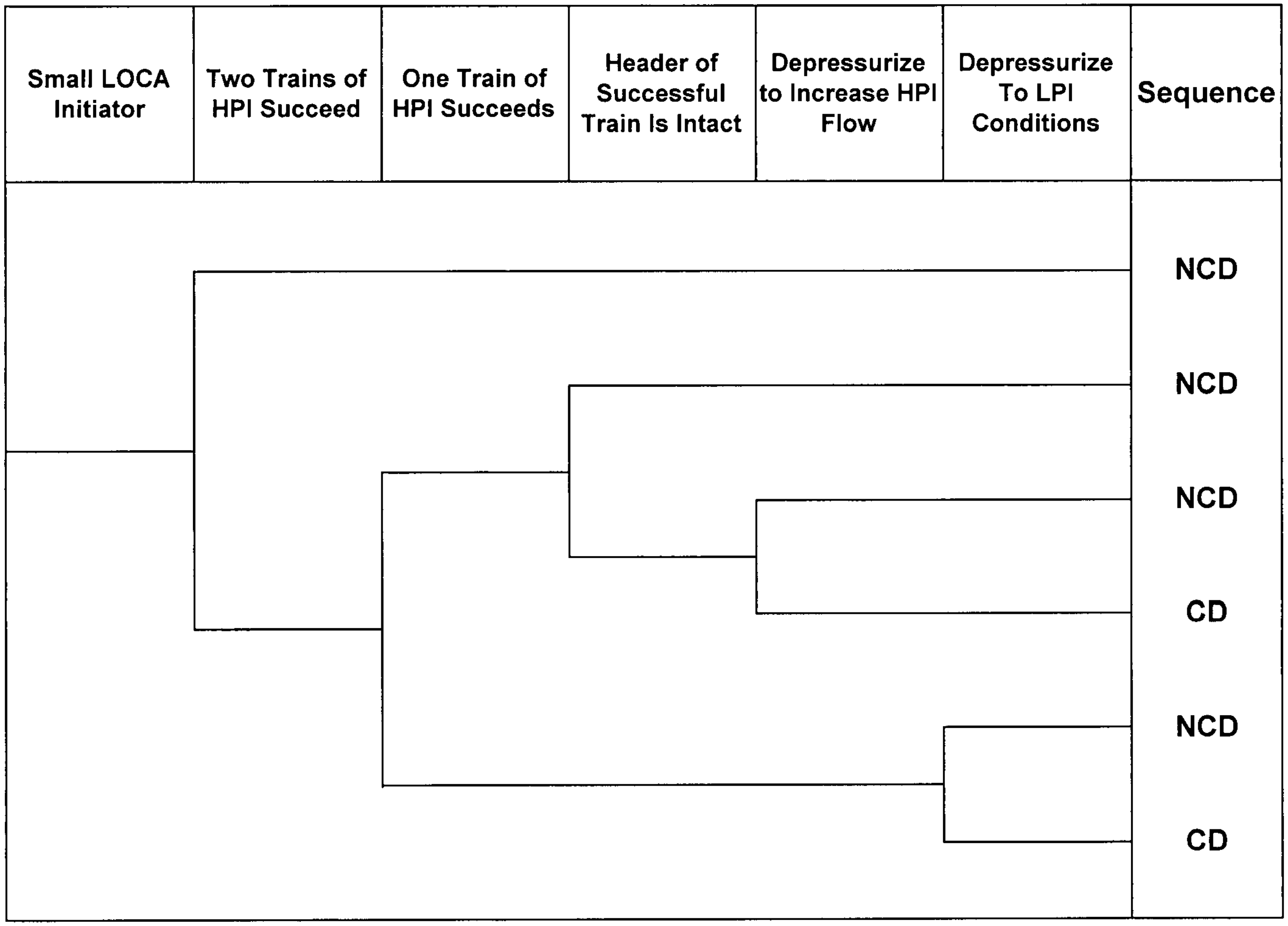

Figure 4 - Small LOCA Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

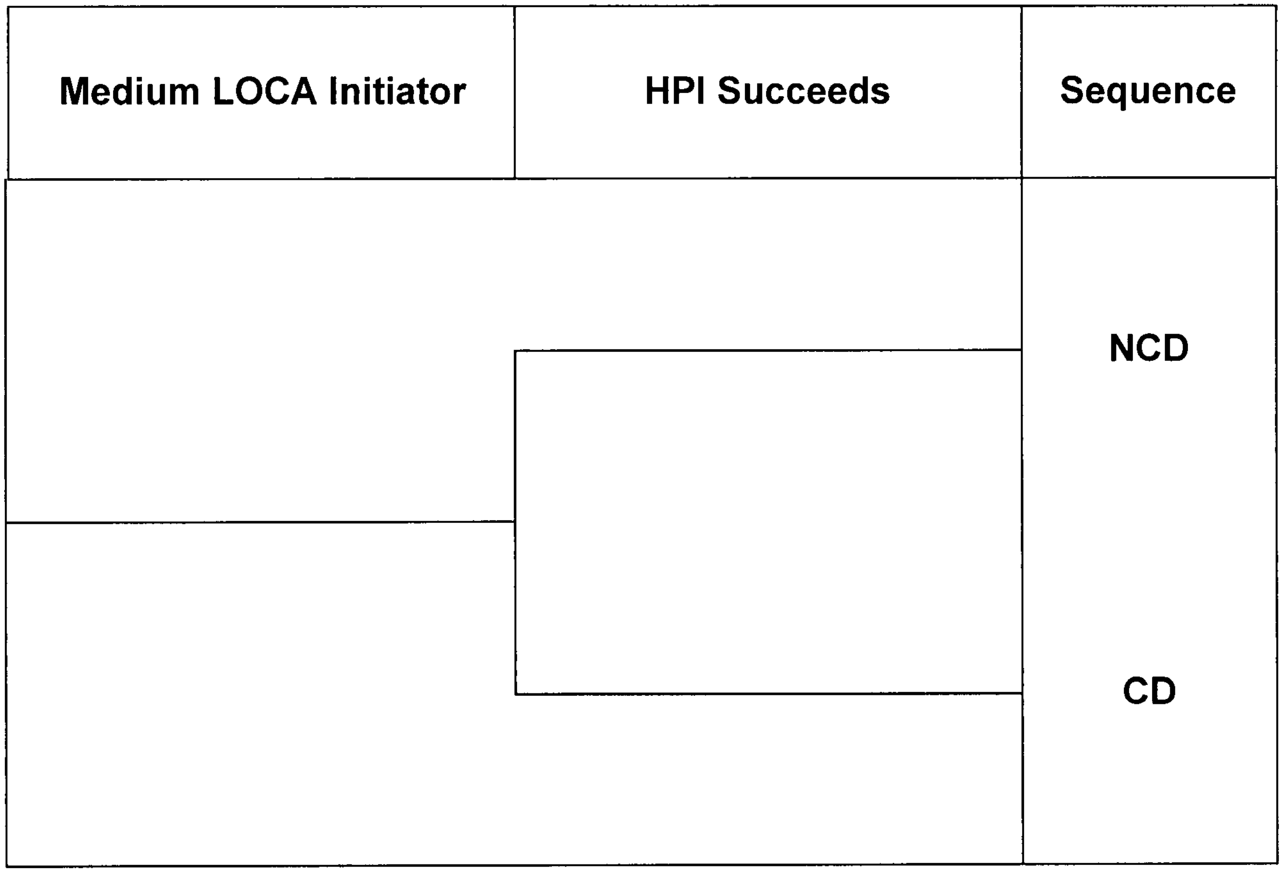

Figure 5 - Medium LOCA Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

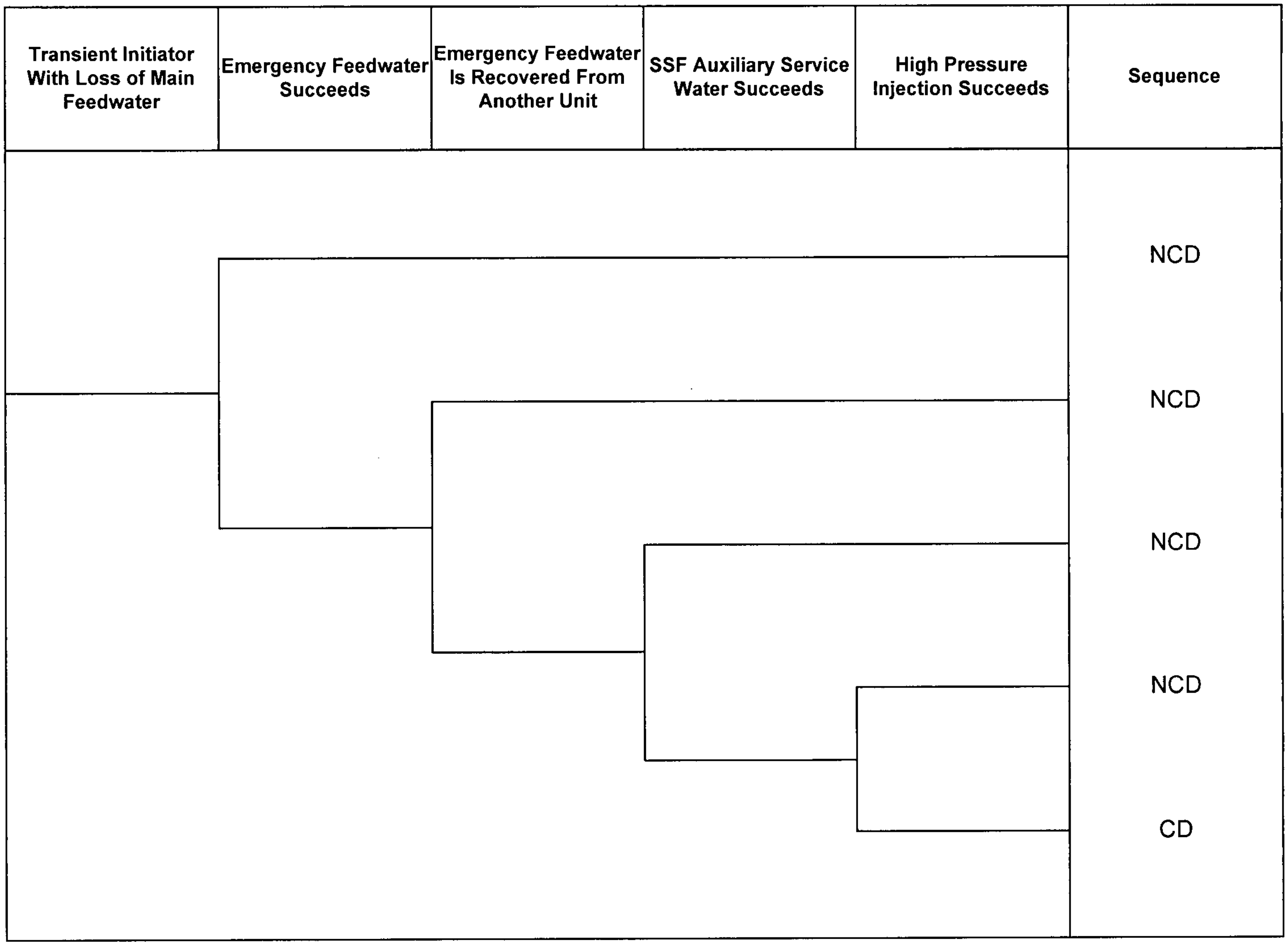

Figure 6 - Feed and Bleed Transient Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

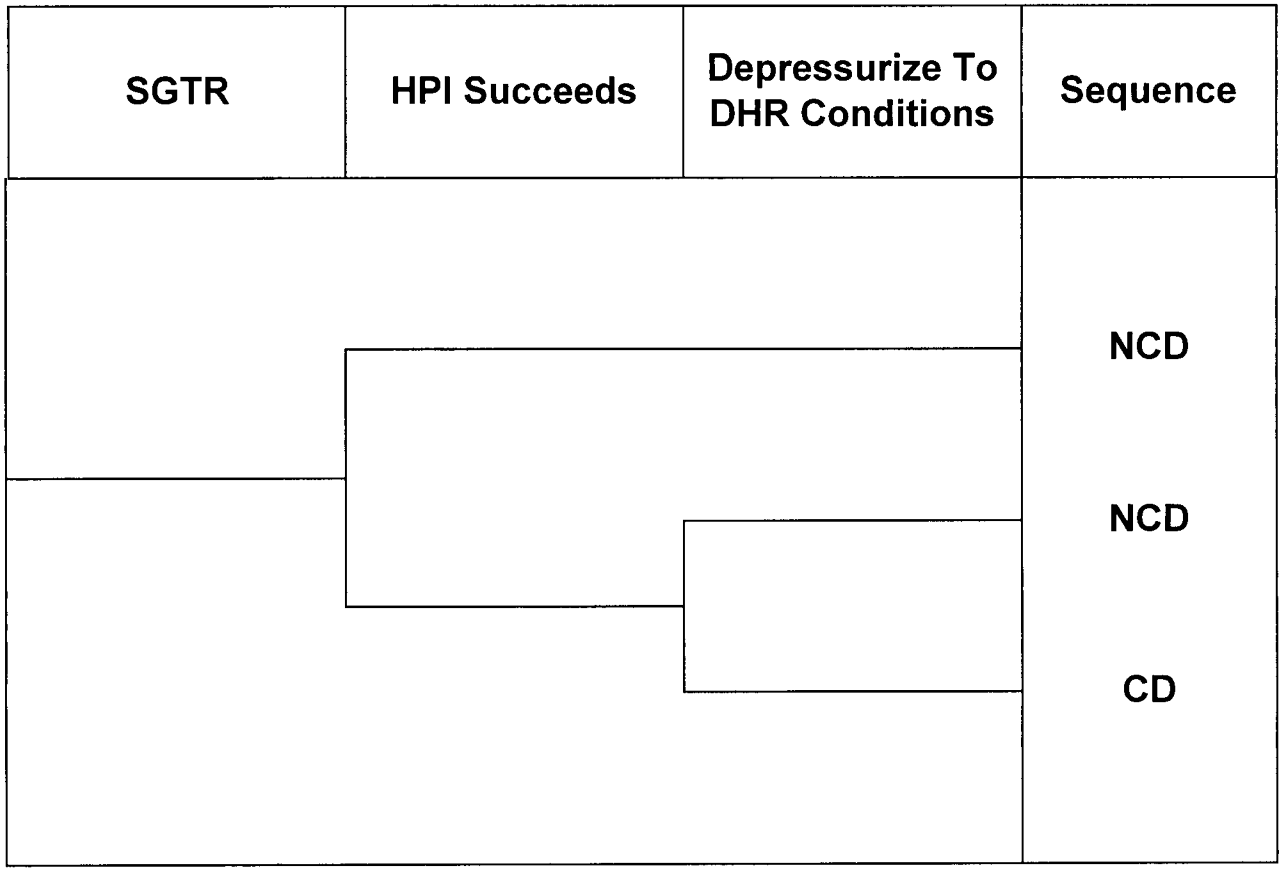

Figure 7 - Steam Generator Tube Rupture Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

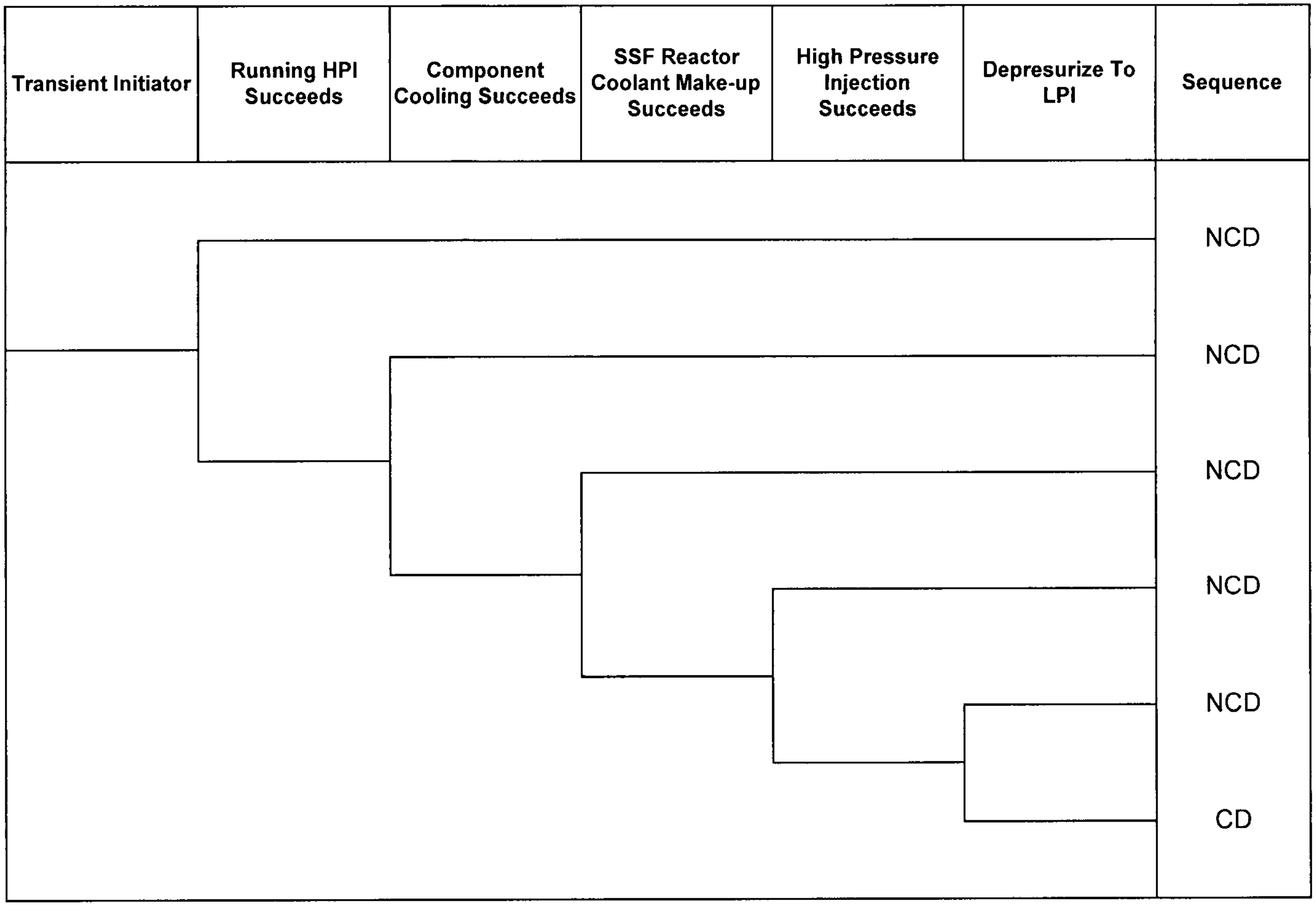

Figure 8 - Seal LOCA Transient Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

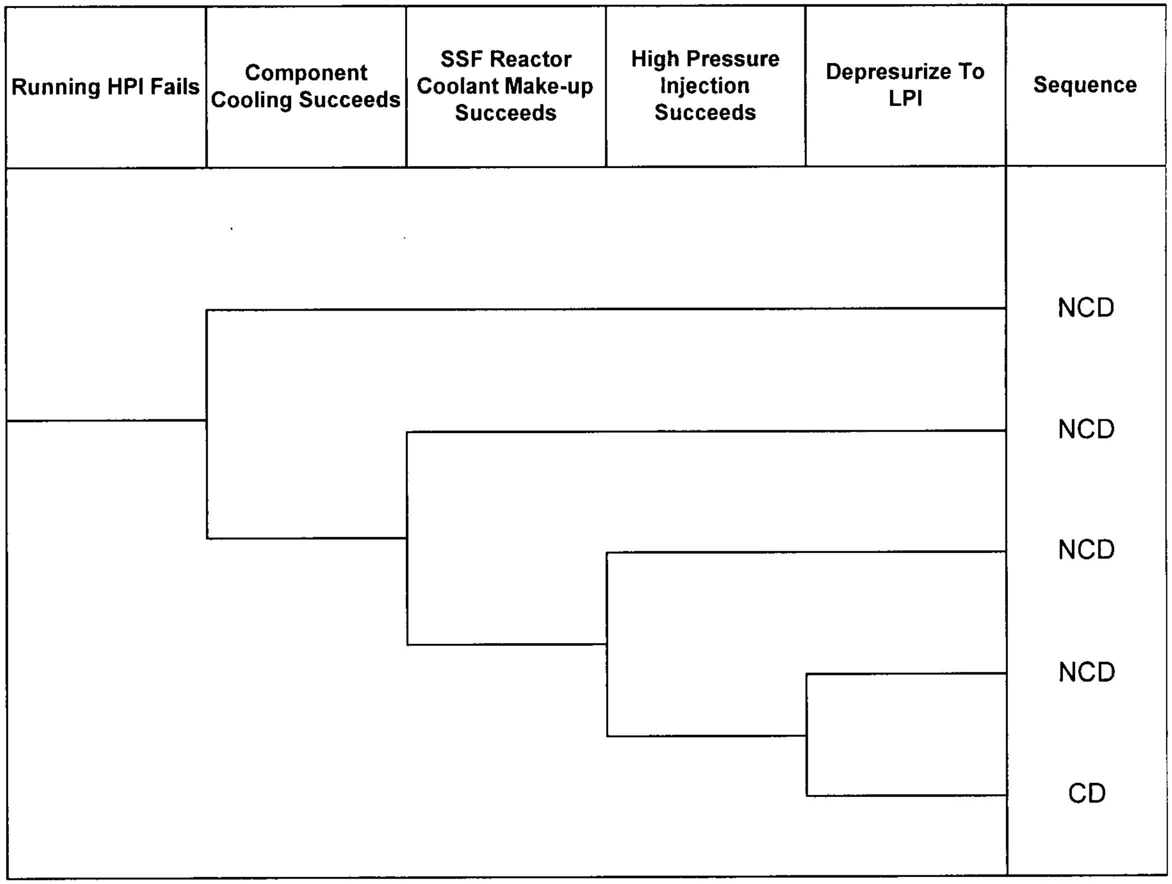

Figure 9 - Seal LOCA Initiator Transient Event Tree

Notes: Function success is up branch
NCD = No Core Damage
CD = Core Damage

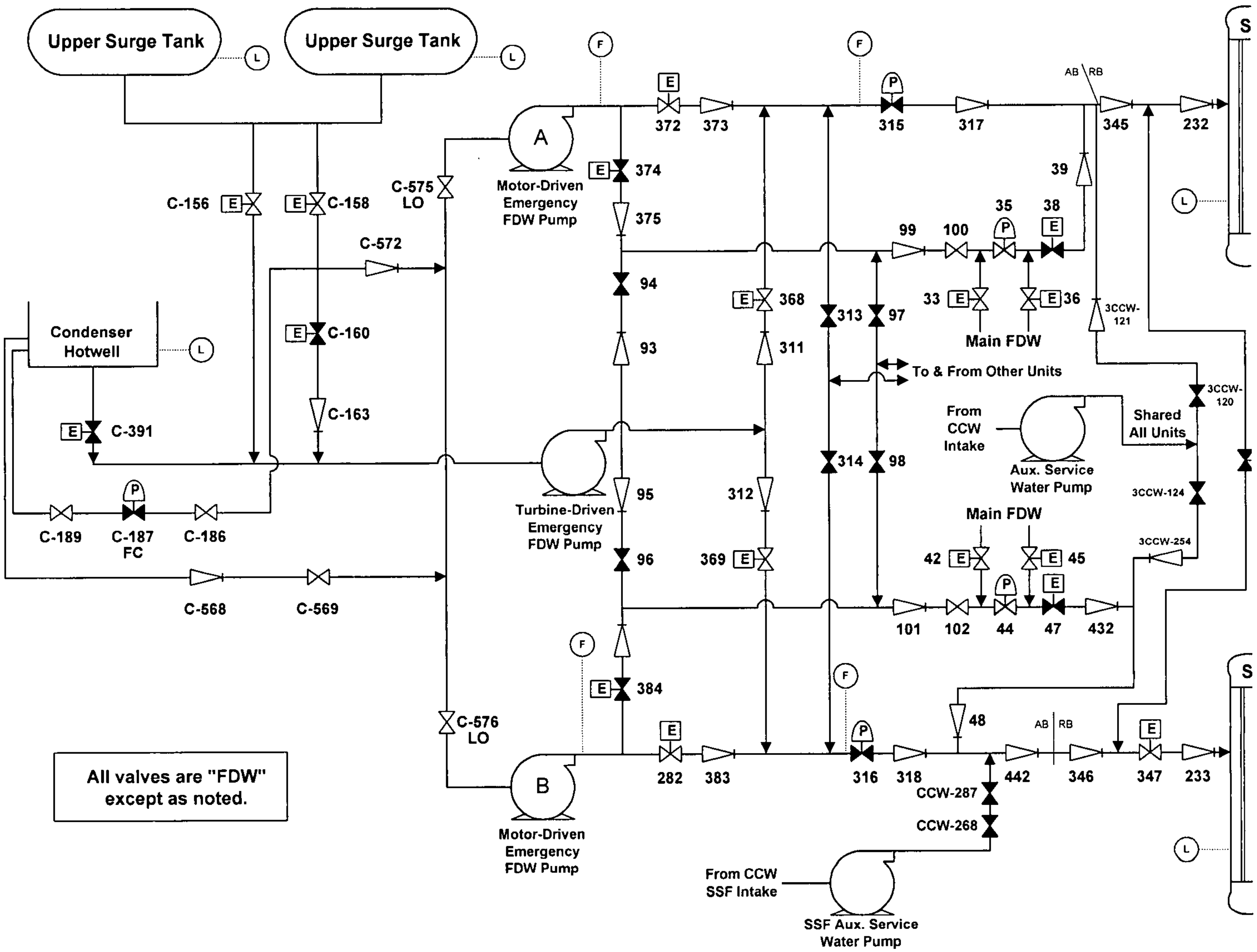

Figure 10 Oconee EFW System Simplified Diagram