Public Service
Electric and Gas
Company

**Louis F. Storz**
Senior Vice President - Nuclear Operations

Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609-339-5700

MAR 27 1997

LR-N97171

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

**SUPPLEMENTAL INFORMATION**
**NRC GENERIC LETTER 96-06**
**SALEM GENERATING STATION UNIT NO. 1 AND 2**
**DOCKET NOS. 50-272 AND 50-311**

Gentlemen;

Public Service Electric & Gas (PSE&G) had previously responded to this Generic Letter (GL) in correspondence dated January 28, 1997 (LR-N97072). The supplemental information contained in Attachment 1 to this letter provides a summary of the specific modifications being accomplished at Salem Unit 1 and 2 to address the concerns of GL 96-06 as they relate to the Salem Containment Fan Coil Units (CFCU). The modification based approach described in Attachment 1 fully addresses the issues identified in GL 96-06 by eliminating the potential for waterhammer, two-phase flow and thermal overpressurization. This approach was selected over alternative solutions (i.e., analysis based solutions) as it preserves existing design and safety margins by assuring the reliability of the CFCU post-accident containment cooling function.

PSE&G has determined that elevated containment temperatures which occur during Station Blackout (SBO) events also have the potential to cause boiling in the CFCU's. SBO is outside the original Salem Unit 1 and 2 design bases but was incorporated into the licensing bases in accordance with the requirements of 10 CFR 50.63 and its associated backfit analysis. Attachment 2 to this submittal describes PSE&G's planned actions to assure that NRC requirements for coping with a SBO event continue to be satisfied.

Should you have any questions regarding the enclosed information, please feel free to contact us.

Sincerely,

070058

Attachments

C Mr. H. Miller, Administrator - Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. L. N. Olshan, Licensing Project Manager - Salem
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop 14E21
Rockville, MD 20852

Mr. C. Marschall (X24)
USNRC Senior Resident Inspector

Mr. K. Tosch, Manager, IV
Bureau of Nuclear Engineering
33 Arctic Parkway
CN 415
Trenton, NJ 08625

DWD/

BC Senior Vice President - Nuclear Engineering (N19)
Senior Vice President - Nuclear Operations (X04)
General Manager - Salem Operations (S05)
Director - QA/NSR (X01)
Manager - Joint Owners/Ext. Aff. Interface (N28)
Onsite Safety Review Engineer - Salem (S12)
General Solicitor, R. Fryling, Jr. (Newark, 5G)
Perry Robinson, Esq.
Records Management (N21)
Microfilm Copy
File Nos. 1.2.1, GL 96-06, LCR S96-13

MAR 27 1997

REF: LR-N97171

STATE OF NEW JERSEY )<br>
) SS.<br>
COUNTY OF SALEM )

L. F. Storz, being duly sworn according to law deposes and says:

I am Senior Vice President - Nuclear Operations for the Public Service Electric and Gas Company, and as such, I find the matters set forth in the above referenced letter, concerning the Salem, Unit Nos. 1 and 2 are true to the best of my knowledge.

Louis F. Storz

Subscribed and Sworn to before me<br>
this 27th day of March, 1997

Kimberly Jo Brown<br>
Notary Public of New Jersey

My Commission expires on KIMBERLY JO BROWN NOTARY PUBLIC OF NEW JERSEY My Commission Expires April 21, 1998

**Background**

Five Containment Fan Coil Units (CFCU's) are provided at each Salem unit to meet normal and long term post-accident Containment cooling requirements. The CFCU's are supplied with cooling water from the Service Water System (SWS). Cooling water is supplied from two redundant safety related headers, with each header capable of providing flow to three CFCU's. The CFCU fans are supplied power from the vital AC distribution system. Two fans are powered by the B and C vital buses and one fan is supplied by the A vital bus. Three fans are required to meet post-accident Containment cooling requirements, assuming one train of the Containment Spray (CS) system performs as designed. There are six SWS pumps, with 2 pumps powered from each of the three vital AC buses. Two pumps are required to meet the post-accident cooling requirements of the SWS.

The CFCU fans normally operate in high speed with SWS flow at the low flow setpoint. In response to a Loss of Coolant Accident (LOCA) or Main Steamline Break (MSLB) with coincident Loss of Offsite Power (LOOP), the fan is tripped and allowed to coast down for a period of time before it is restarted in the low speed mode of operation. During this coastdown period, control valves in the CFCU cooling loops are automatically reset to the high flow condition. These valves close initially and are not reopened to their new settings until after power is restored to the fans.

During initial start-up testing for Salem Unit 1, PSE&G identified unacceptable piping system vibration during the performance of the simulated LOOP test. To address this condition, a time delay was imposed on the isolation of the non-essential turbine generator area (TGA) header. The intent of this time delay was to allow an orderly transfer of SWS flow from the TGA loads to the safety related loads as they became available, thereby reducing the magnitude of the waterhammer. This modification was also incorporated into the Salem Unit 2 design during completion of plant construction

Subsequent evaluations of SWS performance have determined that waterhammer occurs in this system due to a water column separation which occurs in the downcomer leg of the CFCU. The column separation is the result of a large vertical drop in the outlet piping, and the closure time associated with the outlet flow control valve. Plant operating experience with LOOP and operator error induced waterhammer in the SWS system indicates that the CFCU piping and pipe support designs have adequate margins to tolerate these loading conditions.

As described in GL 96-06, SWS fluid conditions can depart from the assumptions of the licensing basis for LOCA/MSLB with concurrent LOOP events. The reason for this is that during fan coastdown, energy is being input to the stagnant fluid trapped in the SWS piping loops supplying the CFCU's. As a result, two-phase fluid conditions develop within these piping loops. This creates the potential for unacceptable flow restrictions and reduced heat transfer which can potentially cause detrimental waterhammer as steam voids are collapsed when the system is returned to service, and cause thermally induced overpressurization as the trapped fluid is heated. The current licensing basis for the Salem Unit 1 and 2 SWS assumes that the fluid is subcooled as it passes through the CFCU's and associated piping inside containment.

To address the conditions described above, a conceptual design has been selected and final design analysis and engineering are nearing completion. Construction has commenced for Salem Unit 2 in support of unit restart. Upon implementation, the SWS fluid conditions, as they support the CFCU Containment cooling function, will conform to the original Salem Units 1 and 2 licensing basis assumptions for the system. The following sections describe the design goals specified to address GL 96-06, the associated modifications and supporting analyses required to meet these goals, and a summary discussion of the status of GL 96-06 concerns as they relate to the modified CFCU and SWS configuration.

## Design Objectives

The issues identified in GL 96-06 require resolution to demonstrate the adequacy of the CFCUs to perform their design basis post-accident containment heat removal function. Additionally, it must be demonstrated that the SWS containment penetrations and closed portions of the piping system within containment are not susceptible to failure resulting from thermally induced overpressurization.

To address the issues identified in GL 96-06, the following design objectives must be satisfied:

1. Voids or column separation induced by siphoning effects or changes in elevation must be reduced to the greatest extent practical. Those portions of the SWS located inside containment should remain water solid during all operating and abnormal conditions. Local cavitation at valves or other restrictions is acceptable if it can be shown that voiding of the piping system and/or unnecessary flow restriction does not occur.

2. The pressure in the affected piping loop must remain above the fluid saturation pressure for all operating and abnormal conditions.

3. The SWS containment piping penetrations and the closed piping loop inside containment should be protected from postulated overpressure conditions associated with MSLB/LOCA.

**Planned Modifications**

The modifications described below are required to satisfy the specified design objectives. It should be noted that the current Technical Specification value for the overall CFCU response time is ≤45 seconds. PSE&G has proposed changing this response time to ≤60 seconds in License Change Request (LCR) S96-13. This proposed change corrects a discrepancy between the Technical Specifications and as-built plant configuration which was introduced during initial startup by the addition of the time delay associated with isolation of the non-essential TGA loads. For the design changes discussed below, changes which impact the CFCU response time have been designed to the value specified in LCR S96-13. With the exception of the CFCU response time, current Technical Specifications are not impacted by the planned modifications. Where appropriate, new Technical Specifications will be proposed within 90 days of the associated Unit's entry to Mode 2. Appropriate administrative requirements will be established for the interim period of operation.

- Installation of Storage Tanks on the CFCU SW Headers

  One of the primary concerns of GL 96-06 is the potential for voiding in the CFCU coils and downcomers and the resulting waterhammer loads when the SWS pumps are restarted following a LOCA/MSLB with concurrent LOOP. In order to preclude voiding in the CFCU downcomer piping, a 15,000 gallon storage tank will be connected to each of the SWS' two CFCU supply headers. The tanks will be pressurized with Nitrogen, and will discharge into the piping downstream of the SW51 valve in response to a LOOP. The tanks are sized to contain sufficient water inventory to keep the SW piping filled under postulated accident conditions with a single failure.

  The limiting single failure for sizing the storage tanks is the case of one SW223 control valve failing open after the loss of power. For this case, the SWS pumps coast down and the CFCU flow stops in several seconds. The SW223 valve is postulated to fail open concurrent with the loss of power. As the pump flow decreases, the storage tank will discharge into the piping. A detailed thermal/hydraulic model was developed to determine the flow required to provide makeup water at the necessary rate to prevent voiding in the storage tank discharge and CFCU piping. The model results show that a tank volume consisting of 10,000 gallons of water at a Nitrogen overpressure of 150 psig, is sufficient to maintain water solid conditions in the associated piping without injecting nitrogen into the CFCU supply piping.

  Since the tank water will be nitrogen saturated, the potential exists for some nitrogen to be released from solution as the tank water enters the system. The results of hydraulic and heat transfer calculations show that the impact of the nitrogen is insignificant. In the worst case, the resulting containment pressure and temperature following a LOCA are less than 0.1 psi and 0.1°F greater than the present design basis calculation results and are still less than the Salem containment design parameters. The MSLB containment response is unaffected as the licensing basis analysis conservatively assumes CFCU heat transfer rates below the design rate.

The hydraulic response of the modified system during a LOOP or LOCA/MSLB+LOOP event was determined using a transient hydraulic model of the SW system. The transient model includes the large bore safety related piping associated with the Emergency Diesel Generators (EDG's), the CFCU and the Component Cooling Water Heat Exchangers (CCHX). Features are included in the model to account for the effect of the other safety related loads (room coolers, chillers) and the non safety related loads (turbine area, traveling screens, etc.). The model was initially validated by comparing the model results to existing steady state model solutions and transient results derived from previous SW system testing performed to determine system response following a LOOP. Benchmarking of the transient model will be accomplished through post-modification integrated system testing.

Transient analyses were performed for the expected range of system initial conditions for the limiting cases, including single failures. These analyses show that the pressures in the CFCU piping remain above the saturation pressure for the entire transient. The maximum discharge out of a single tank is less than the 10,000 gallons available in the tank . In addition, analyses were performed to show that if an inadvertent opening of the discharge valves occurred during normal operation, the effect on the system would be minimal without large loads on the piping or significant pressure fluctuations.

The storage tank discharge valves (21(22)SW534 & 21(22)SW535) will be 10" air operated butterfly valves designed to open under spring pressure. The valve response time is critical to assuring that tank discharge occurs prior to the CFCU header pressure decaying below the saturation pressure associated with normal operating conditions. As such the valves must begin to open in no more than 0.7 seconds. The solenoid valves associated with the discharge valves will be powered from redundant safety related 125 VDC channels. The controls are designed such that the solenoids are energized to vent air from the operator and open the valves. The valves will fail open on loss of air and fail closed on a loss of DC power. This design assures one of the two flow paths for each tank will be available in the event of a single failure. Valve actuation signals will come from dedicated undervoltage relays installed on each of the 4KV vital buses. Dedicated undervoltage relays are required to eliminate the 2-3 second time delay associated with existing undervoltage relays and signal processing through the Safeguards Equipment Controller (SEC). The response time requirements for these valves will be incorporated into the response time testing procedures for the CFCU's. No new Technical Specification requirements are required for these valves.

The storage tanks are designed and fabricated to the requirements of Section III, Subsection ND of the ASME Boiler & Pressure Vessel Code, 1989 Edition. The storage tanks are designed to satisfy seismic Category 1 requirements. The tanks will be located outside of existing buildings. The design and installation requirements for the storage tank discharge piping are consistent with the remainder of the safety related SWS piping. Protection against external hazards (i.e., tornado, seismic, flooding, freezing) will be provided consistent with Salem Unit 1 and 2 licensing basis commitments

The Nitrogen makeup system will utilize permanently mounted supply bottles connected to a supply manifold. The bottles will be refilled through a truck connection. Each supply bank will have sufficient capacity to restore the tank to its required pressure. Redundant relief valves and pressure regulators will be provided to pressurize the SW supply tanks. Pressurizing the tanks will be performed manually at the SW supply tank by plant Equipment Operators. The SW supply tanks will be manually filled from the SWS using a makeup water pump located at each storage tank. Nitrogen and SW makeup system equipment and controls will be non-safety related.

Each storage tank will have redundant, non-safety related level, temperature and pressure instruments which input to a common Programmable Logic Controller (PLC) unit. The PLC unit will provide input to a common "tank trouble" overhead annunciator located in the control room. An individual alarm is provided for each storage tank. Local instrumentation will include level, temperature, and pressure indications. The non-safety classification is considered acceptable on the basis that critical system parameters will be periodically monitored during normal operation to assure operational readiness of the system. Following the onset of the LOOP, no operator actions are required in response to tank instrumentation readouts. New Technical Specification surveillances will be established for the tank level, pressure and temperature. A separate LCR will be submitted after the modifications have been installed and acceptance testing is complete. These parameters will be incorporated into existing procedures and administratively controlled prior to the system being declared operable.

- Installation of Relief Valves

Relief valves will be added to each CFCU SWS cooling loop to prevent thermal overpressurization of the piping. These valves will be connected to the existing piping section between the SW72 and SW223 valves and will discharge to the common CFCU return header. The relief valve setpoints will be low enough to prevent overpressurization during accident conditions and high enough to prevent saturation conditions being achieved.

- SW57 and SW223 Valve Operator Volume Boosters

Each CFCU is provided with an SW57 and SW223 valve. These are identical air operated valves. . Volume boosters are being added to improve the overall response time characteristics of these valves. The SW57 valves maintain the desired pressure (50 psig) at the inlet to the associated SW223 valve. The SW223 valves are located on the outlet of each CFCU and control the flowrate through the CFCU unit. The SW57 and SW223 valves are required to open in the same time frame in order for the CFCU response time requirement to be satisfied. Reliable SW223 valve closure times are also essential to limiting drain down of the downcomer leg when a CFCU is manually removed from service. Improved SW223 valve response times also limit the drawdown on the makeup tanks during LOOP conditions. The volume boosters are qualified by the vendor to the same standards of the existing air operators. This modification includes the installation of a needle valve between the volume booster and the air regulator to allow adjustments needed to obtain the appropriate valve operating characteristics. The valves are capable of operating at the required response times without damage to the valve or the operator.

- SW223 Valve Control Modifications

The SW223 valves are designed to control flow through the CFCU's. The valves are designed to open on spring pressure and require air to close. The valves control flow at the high flow setpoint upon loss of 125 VDC power. Loss of AC and DC power would result in the valves going to the full open condition. At most, 2 CFCU's will be affected by the loss of a DC control power channel. When the associated CFCU fan is not running, air is applied to the valve operators to close the valves and prevent drainage from the CFCU's.

The planned modification alters the valve logic such that the valves close upon loss of 125 VDC power but can be opened manually from a remote location for Appendix R purposes. The logic for the solenoid valves will be changed so that the solenoid valves are deenergized to close the SW223 valves when the CFCU's are not running or 125VDC power is lost. The solenoid valves would be energized to apply the pneumatic control signal to the valves operator to modulate the SW223 valves when the CFCU's fan are running. The instrument tubing from the valves positioner (mounted on the valve) to the valves operator will be modified to include a remote, air-operated 3-way valve that, when manually operated, will block control air to the SW223 operator and vent the operator. This will allow the spring to open the valve.

- Installation of Redundant SW51 Check Valves

The SW51 check valves prevent backflow out of the CFCU's supply piping and back into the SW headers. If these check valves have significant leakage, the CFCU inlet legs can drain, creating the possibility of void formation in the inlet leg or in the coils. It is not practical to install storage tanks with sufficient capacity to continually flood the CFCU SW piping based on leaking check valves. Redundant check valves will therefore be added in series with the existing SW51 valves (a total of two new valves). This will provide defense in depth against unacceptable leakage.

The SW system hydraulic calculations have been revised to include the additional flow resistance of the new check valves. These calculations show that the modified system is acceptable.

- SW57 Valve Control Modifications

The SW57 valves are located on the supply side of each CFCU. During normal operation the valves control flow to maintain 50 psig at the inlet to the SW223 valves. During accident conditions, the valves go open to allow full flow through the CFCU cooling loops.

During normal operation, the SW57 valves are designed to control pressure through the CFCU. The valves are designed to open on spring pressure and require air to close. When their solenoids are energized a pneumatic signal from a pressure controller is imposed on the associated SW57 operator to modulate the valve. When deenergized, the solenoid vents the SW57 valves actuator and opens the associated SW57.

If the pressure control valve for a CFCU does not open, or continues to modulate following an SEC signal, the service water flow to the associated CFCU would be significantly reduced. The resulting high pressure drop across the SW57 valve, coupled with a low service water flow, would cause flashing and steaming to occur in the affected CFCU.

The modification changes the circuit for the solenoid valves that control the air to their respective SW57 valves. Only when the CFCU fans are running in high speed (normal mode) will the solenoid valves be energized. The solenoid valves are deenergized when the associated CFCU is off or running in low speed (accident mode). Operation of the SW57 valves in response to their associated pneumatic signals will remain the same. A new limit switch is being added to the SW57 valves in order to provide a start permissive interlock with the associated CFCU's low speed fan circuit. This interlock requires that the respective SW57 valve be fully open before the CFCU fan can be started in the accident mode.

- SW122 Valve Control Modifications

The SW122 valve is currently designed to control flow through the Component Cooling Heat Exchanger (CCHX) and is required to close in response to LOCA/MSLB with concurrent LOOP. Flow to the CCHX is reestablished in accordance with the Emergency Operating Procedures (EOP's). Operator action to reestablish flow takes place at the local control station. Presently, a dual coil solenoid valve is used to align control air to the SW122 operator. When coil A is energized, the solenoid aligns a pneumatic signal to the valve operator to modulate valve position. When coil B is energized, the solenoid valve aligns control air header pressure to the valve operator to close the valve. Upon loss of 125 VDC power, the solenoid will remain in its last position (i.e., coil A energized with valve modulated).

In the case of a LOOP+LOCA/MSLB with concurrent loss of a DC control power channel (single failure), one SW122 valve would potentially remain in the modulated position. The loss of a DC channel would also result in the loss of the associated EDG, which in turn would result in only two service water pumps being available to meet system demand. With the SW122 valve in the modulated position, the SW pumps would potentially be operating in a runout condition.

The planned modification replaces the existing dual coil solenoid valve with a single coil solenoid valve that returns when deenergized. A seal-in relay and contact will be added to the existing spring-return-to center switch circuit. This relay will maintain the solenoid coil open to control valve position during normal operation. Upon loss of 125 VDC power, the solenoid will return to the deenergized position, removing the control air positioning signal and aligning control air header pressure to close the valve.

The modifications to this valve do not affect the operability of the Component Cooling Water System (CCW). All active components that are considered vital to the cooling function of the CCW system are redundant. Any single active or passive failure (e.g., loss of a DC bus leading to a closure of a SW122 valve) in the system will not prevent the system from performing its design function. In the event of an accident, one of the two heat exchangers is capable of fulfilling full system cooling requirements.

- SW122 Valve Operator Volume Booster

The SW122 valves control flow to the CCW heat exchangers and close to isolate those components following a LOCA or MSLB with concurrent LOOP. Hydraulic evaluations show that for certain single failure assumptions (e.g., failure of a SW pump to start) the pressure at the outlets of the CFCU coils is insufficient to prevent flashing of the fluid leaving the coils until both SW122 valves are closed (i.e., the saturation pressure of the CFCU exit is greater than the calculated pressures). Thus, the SW122 valves are required to close in approximately 30 to 40 seconds. For this reason, a volume booster is being added to improve the closing characteristics for these valves (similar to the SW57 and SW223 valves). The volume boosters are qualified by the vendor to the same standards required for the existing air operators. The valves will open and close as desired without damage to the valves or their operators. A needle valve will be provided between the volume booster and the air regulator to allow adjustment of the respective valve's closing characteristics.

- Replace 21 & 23 SW20 and SW26 Motor Operator Components

The 21 & 23 SW20 and SW26 valves are motor operated valves that close to isolate the Turbine Building cooling loads in the event of an accident. The Turbine Building cooling loads can be significant, ranging up to approximately 26,000 gpm. Presently, there is a 30 second delay (Agastat relay) prior to the valve getting a closure signal. The valve closure times are approximately ten seconds. The timing relay is being "replaced" by a new set of gears (and other internals) for the valve motor operators. This change will accomplish several design objectives:

- Maintain the gradual transfer of SW flow from the Turbine Building loads to the CFCUs, thereby reducing the potential for waterhammer in the CFCU piping.
- Avoids the potential for a failure of the timing relay, thereby improving the overall reliability of the closure function.
- Reliably sets the closure time in the desired 30 to 40 second range.

The valves will begin closing on the LOCA or MSLB signal, following restoration of power to the vital buses. Valve timing requirements will be included in the CFCU response time surveillance procedures. No new Technical Specifications are required for this modification.

- CFCU SW Piping Support Modifications

During normal operation, the CFCU fans run at 1200 rpm and the SW223 control valves are set at about 900 gpm. Following an accident, the fans reset to 600 rpm and the SW223 control valves reset to approximately 2650 gpm. These flowrates include 50 gpm diverted to the CFCU motor cooler. The existing analyses for maximum heat transfer in the CFCU coils (with zero fouling) show that the maximum CFCU outlet temperature reaches about 195°F based on a SW inlet temperature of 90°F. If the SW223 control valve controller were in the low flow position as a result of the high speed fan breaker failing to open, the affected CFCU outlet temperature would initially peak at 221°F, and gradually decrease to approximately 200°F over the next hour of operation. The associated CFCU cooling loop valves, valve internals, valve operators and penetration seal materials are not affected by the 221°F pipe temperature.

The I&C components will be unaffected by the increased temperature. A few temperature indicators will overrange at 200°F, but will continue to operate (not sustaining any damage at 221°F), once the temperature drops below 200°F. These temperature indicators do not affect operation of the Service Water system, and are not used as a basis for operator actions following a design basis event. As such, the temporary loss of temperature indication has no consequences.

- **Operator Awareness Aids**

The possibility of operator error was considered in the FMEA. Misoperation of the SW20, 22, 58 or 72 valves in the SWS under accident conditions could result in two-phase flow in the CFCU cooling loops. The SW20, and 22 valves are header isolation valves provided for leak isolation and maintenance purposes. The SW58 and 72 are containment isolation valves installed on the inlet and outlet of each CFCU cooling loop. All of the above valves are manually operated from the control room and do not receive any automatic actuation or control signals.

The probability of misoperation is judged to be low in all cases. The valve control bezels are discretely arranged on the control board and are not in close proximity with other controls which are required to be manipulated in response to a LOCA or MSLB event. None of the referenced valves are required to be operated to mitigate the consequences of a LOCA or MSLB. As such, physical modifications to the control logic is not considered necessary. Operator aids will be established to reinforce the need to, "Stop, Think, Act and Review," when manipulating these control bezels.

**Post Modification Testing**

Sufficient post-modification component level and integrated testing will be completed to demonstrate that the modifications made to eliminate the potential for void formation and waterhammer in the CFCU piping operate in accordance with design assumptions. Testing will simulate LOOP only conditions. This testing cannot match the LOCA/MSLB+LOOP condition where there is heat input.

Component level testing will verify the installation and operation of individual components and portions of the complete modification. This testing includes initial set up and timing of valves, logic tests for circuits designed to preclude certain failures and dynamic valve testing where required.

Integrated testing will be used to validate/benchmark the transient hydraulic model. This will be accomplished by establishing a system alignment as close to the bounding alignment/single failure as practical and mimicking the Loss of Offsite Power sequence. The model will be validated based on test results matching those predicted by the model (i.e., no voiding or waterhammer). This benchmarking process validates model results not practical to prove by test.

Integrated testing cannot validate the effects of nitrogen saturation on heat exchanger performance. Testing will be performed to verify that nitrogen saturation does not affect the ability of the flow instrumentation to perform its function to control flow through the CFCU's after actuation of the system.

The integrated test data will be reviewed to determine if there are any unanticipated affects, such as pressure transients due to fast valve action.

**Background**

The requirement to evaluate plant response under Station Blackout conditions (i.e., a complete loss of all AC power) originates in 10 CFR 50.63 and requires plant specific analyses be performed to establish an appropriate coping duration, develop specific coping procedures, and where necessary, to make modifications to assure that the plant can cope for the specified event duration. The scenario applicable to Salem Units 1 and 2 consists of an SBO condition on one unit with an orderly shutdown of the non-SBO unit. An accident is not taken concurrent with this event. A single failure is postulated on the non-SBO unit only. With regards to Salem, the limiting failure is taken as a loss of the non-SBO units "C" vital bus. This failure is limiting in that it disables the non-SBO units Emergency Control Air Compressor ECAC which in turn leads to a loss of control air at both units. PSE&G installed a backup diesel powered SBO air compressor to mitigate this condition. The SBO compressor is started manually within an hour of the onset of the event.

**Impact of GL 96-06 Planned Modifications**

Initially, upon loss of power, the makeup tank discharge valves will open to maintain the CFCU SWS headers in a filled condition. At the same time, the control air header pressure will be decreasing. The makeup tank discharge valves will close following a suitable time delay (approximately 40 seconds) to prevent injecting Nitrogen into the CFCU supply headers. The tank discharge valves are provided with dedicated air accumulators to maintain the valves closed until the SBO compressor is brought on-line approximately one hour into the event. After the tank discharge valves are closed but prior to the SBO compressor starting, control air header pressure will decrease below the pressure required to hold the CFCU outlet flow control valves closed. When the outlet flow control valves go open, the water in the CFCU discharge piping will drain and a column-separation will occur. The CFCU outlet flow control valves will re-close upon restoration of control air header pressure with the SBO compressor.

Whether or not boiling occurs in the CFCU's under this scenario is a function of the containment air temperature. Four hours into an SBO event, the containment ambient temperature will be about 190°F. The initial SW pressure in the CFCUs at the onset of the SBO would be less than 2 psia. At this pressure, boiling can be expected to occur at temperatures exceeding 115°F. Because the containment heat up is gradual, occurring over the four hour event duration, the coil temperature can be expected to follow the containment temperature. Thus, the equilibrium CFCU coil temperature will approach 190°F and boiling will occur in the coil.

One of the potential SBO recovery scenarios involves power restoration using the onsite emergency diesel generators (EDG's). Restoration of required equipment is accomplished manually under this scenario and, restoration of SWS flow is a priority in order to assure cooling to the EDG's. When the SWS pumps are restarted, waterhammer will occur in each of the CFCU cooling loops as the water columns impact the closed SW223 valves. Any steam voids which have formed will also be collapsed upon restart of the pumps.

**Analysis**

Regulatory Guide 1.155 requires that the ability to maintain "appropriate containment integrity" be evaluated in the coping analysis. Section 3.2.7, item 4 would allow exclusion of the CFCU cooling loops on the basis of their being part of a closed system inside containment, provided that the system is not expected to be breached during an SBO event. While considered unlikely given Salem's operational experience with waterhammer in these cooling loops, the possibility of waterhammer induced piping failures, must be considered under this requirement.

The Salem Unit 1 and 2 SBO coping analyses were performed using the NUMARC 87-00 guidance. Section 7.2.5 and Appendix I of NUMARC 87-00 provide guidance and clarification on containment isolation requirements as follows;

- Penetrations which would have to be closed (i.e., normally open, fail open containment isolation valves) to achieve containment isolation should be provided with position indication and closure capability which is independent of the preferred AC or Class 1E power sources.
    - The CFCU cooling loop containment isolation valves have installed open/closed limit switches with position indication provided in the control room. Following the onset of the SBO event, control room indication will be available. The valve positions can also be determined locally at the valves by observing the valves stem and their limit switches. Accessibility to the containment isolation valves under SBO induced environmental conditions is being evaluated.
    - As previously stated, the SBO compressor is started in accordance with the Salem Unit 1 and 2 SBO coping procedure. When header pressure is recovered, the valves would be closed from the control room if necessary. Operability of the containment isolation valves under SBO induced environmental conditions is being evaluated.
- Containment integrity need only be established if core damage is imminent.
    - The Salem Unit 1 and 2 coping analysis concludes that adequate core cooling is available for the duration of the SBO event. Hence, core damage is not expected. It should also be noted that the coping analysis credits cooldown and depressurization of the Reactor Coolant System (RCS) using the main steam

atmospheric relief valves. As such, the Pressurizer Relief Tank rupture disc should remain intact, thereby limiting any potential release to the containment atmosphere.

Single failures are not required to be postulated (unless they are a direct result or consequence of the SBO condition).

- A single isolation valve is provided outside containment on the inlet and outlet of the CFCU cooling loops. Operability of the containment isolation valves under the associated SBO environmental conditions is being evaluated.

PSE&G believes that the outstanding questions regarding operability and accessibility for the CFCU containment isolation valves can be successfully resolved. Supporting analyses and plant modifications, if required, will be completed prior to entry to Mode 2. This schedule is consistent with the initiating conditions specified for SBO events (i.e., 100% power).