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ONS-2013-037

10 CFR 50.90

December 18, 2013

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852-2746

Subject: Duke Energy Carolinas, LLC
Oconee Nuclear Station, Units 1, 2, and 3
Docket Numbers 50-269, 50-270, and 50-287,
Renewed Operating Licenses DPR-38, DPR-47, and DPR-55
Licensing Basis for the Protected Service Water System - Responses to
Request for Additional Information Item Nos. 172 through 189
License Amendment Request (LAR) 2008-07 - Supplement 7

References:

1. Letter from T. Preston Gillespie, Jr., Vice President, Oconee Nuclear Station, Duke Energy Carolinas, LLC, to the U. S. Nuclear Regulatory Commission, "Tornado and High Energy Line Break (HELB) Mitigation License Amendment Requests (LARs) - Responses to Request for Additional Information," dated December 16, 2011.

2. Letter from Roy P. Zimmerman, Director, NRC Office of Enforcement, "Notice of Violation and Confirmatory Order Related to a Fire Protection Program License Condition (Oconee Nuclear Station, Units 1, 2, and 3)," dated July 1, 2013.

3. NRC RAI email from Richard Guzman (NRC) to Timothy D. Brown (Duke Energy) dated November 22, 2013.

By letter dated December 16, 2011, Duke Energy Carolinas, LLC (Duke Energy), submitted a consolidated License Amendment Request (LAR) for the Oconee Nuclear Station (ONS) proposing revisions to the High Energy Line Break (HELB) licensing bases (Ref. 1). As part of the reconstituted HELB program effort, the LAR introduced and credited into the HELB licensing basis a Protected Service Water (PSW) System for mitigation of certain HELBs at the station.

Associated with both the HELB LAR and subsequent National Fire Protection Association (NFPA) 805 enforcement actions (Ref. 2.), the Staff has requested additional information related to the PSW System. Duke Energy responses to these requests were submitted as LAR 2008-07 Supplements 1 through 6. On November 22, 2013, the Staff requested additional clarification information (Ref. 3) relating to these previous responses.

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Duke Energy provided direct calculation numbers and content in an effort to address the RAIs clearly. Duke Energy will continue to control and revise the information provided from these calculations through its normal design and engineering change processes.

The Enclosure to this letter contains Duke Energy's responses to the Staff's most recent request (Ref. 3). In addition and as a result of the RAI responses, the attachments to this letter contain Duke Energy's revisions to PSW Updated Final Safety Analysis Report section 9.7 that were originally submitted in the letter dated August 7, 2013.

If you have any questions in regard to this letter, please contact Stephen C. Newman, Regulatory Affairs Senior Engineer, Oconee Nuclear Station, at (864) 873-4388.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 18, 2013.

Sincerely,

Scott L. Batson
Vice President
Oconee Nuclear Station

Enclosure: RAI Item No. 172 through 189 Supplemental Responses
Attachment 1: Revised PSW UFSAR
Attachment 2: New and Revised UFSAR Figures

cc: (w/enclosure/attachments)

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Enclosure

Supplemental Response to RAI 172 through 189
LAR 2008-07 - Supplement 7

RAI 172 [EEEB1]

In response to RAI dated June 28, 2013, page 3, the licensee stated that for the Auxiliary Building, a new Alternate Chilled Water (AWC) system will be installed using portable chillers and permanently installed piping to select air handling units (AHUs). The chillers, AHUs and exhaust fans will be capable of being powered from a new electrical distribution system fed from the PSW switchgear with appropriate distribution centers, motor control centers and transformers.

Provide a brief description including design ratings of all the electrical equipment that are part of the AWC system. Provide a summary of the analysis performed to conclude that electrical system for PSW and its support systems continue to provide adequate capacity and capability (voltage studies, short circuit studies, protective coordination, equipment and bus loadings, etc.) needed to establish and maintain a safe shutdown condition for postulated events. Also describe if adequate margins remain on the PSW electrical system. If revision is necessary to include the AWC system, provide updated figures which were included in the licensee letter dated August 7, 2013, (Figure 9-45, PSW AC Electrical Distribution and Figure 9-46, PSW DC Electrical Distribution).

Duke Energy Response

This response covers the following items:

- Brief Description of System Including Design Ratings of Equipment
- Summary of Analysis Performed
- Margin for PSW System
- Updated figure 9-45 in Duke Energy letter dated August 7,2013

Brief Description of System Including Design Ratings of Equipment

The PSW Alternate Cooling System is being provided to recover from the potential loss of normal ventilation to ensure extended operation of the PSW system. For Auxiliary Building cooling, a new chilled water system will be installed that uses portable chillers and permanently installed piping to selected air handling units. The new cooling system will be named the Alternate Chilled Water (AWC) System. The selected air handlers will provide cooling to the Control Complex, the Penetration Rooms, and the Auxiliary Building. For Containment, a diesel driven pump will take suction from Lake Keowee and feed lake water through a connection to the Low Pressure Service Water supply lines to one Reactor Building Cooling Unit (RBCU) on each unit. The RBCU fans are provided with an alternative power source from the PSW electrical system.

In order to power the PSW Alternate Cooling System equipment, a 4160/600/208V distribution system is being installed. Power to the PSW Alternate Cooling systems used for cooling both the Auxiliary Building and Containment is being provided through a new electrical power distribution system referred to as the AWC Electrical System. This distribution system is powered from PSW power through PSW switchgear B6T, breaker 8 (B6T-08) and AWC switchgear AWC1, breaker 7 (AWC-07). The new distribution system has a new 4160V switchgear used for distributing the PSW power fed from B6T-08.

The new 4160V switchgear will feed power to two (2) 600/208V distribution systems for powering selected Air Handling Units (AHU), Exhaust Fans (EF), and RBCUs. One 600/208V distribution system feeds Unit 1 and 2 loads. The other 600/208V distribution system feeds Unit

3 loads. Each distribution system will have its own dedicated 4160/600V transformer. The AWC electrical busses and breakers have been appropriately sized to carry the rated load.

The individual loads to the AHUs are fed from the new distribution system through manual transfer equipment that separates normal plant power from the new distribution system.

The 4160V switchgear also provides power to the new AWC chillers. The 4160V feed to the AWC chillers will be provided through new 4160/480V transformers.

Summary of Analysis Performed

Calculations that are in progress will be completed per the design change process with a projected completion date of late January/early February of 2014. Implementation will meet the committed PSW Milestone 5 date of February 4, 2016 from the NFPA 805 confirmatory order letter dated July 1, 2013, entitled, "Notice of Violation and Confirmatory Order Related to a Fire Protection Program License Condition (Oconee Nuclear Station, Units 1, 2, and 3)."

Verification of the capability of the AWC electrical system to operate without adversely affecting existing plant design is required by the site modification processes. The information below summarizes the notable electrical analyses being performed associated with AWC electrical system design changes.

OSC-9832, "Unit 1/2/3, PSW AC Power System – ETAP Base File" and OSC-9370, "Unit 1/2/3, PSW AC Power System Voltage and Short Circuit Analysis"
These calculations are used to evaluate and ensure proper voltage adequacy and fault duty for the PSW AC power distribution system. An initial ETAP study was performed to predict the feasibility of adding the AWC AC electrical system to the PSW AC electrical system. Results of the study indicate that the PSW AC electrical system can provide power to the AWC AC electrical system with appropriate margin. This study was performed based on engineering judgment on cable sizes, lengths, equipment impedances, ratings, etc. Various test runs were performed to optimize the design. Test runs continue to be performed as actual design parameters become available. Once the design parameters are finalized through the design change process, these calculations will be revised and issued to show the adequacy of the PSW AC electrical system with the AWC AC electrical system in service. These calculations will be updated, as required, per the design change process.

OSC-9190, "Protected Service Water (PSW) System, 125VDC Power System Analysis"
This calculation performs the discharge and short circuit analysis for the new PSW 125 VDC Battery System. This calculation has been revised to include the DC power used by breaker B6T-08 that feeds the 4160 volt AWC switchgear. Results of the analysis indicates that the PSW DC electrical system can provide power to the B6T-08 control circuit with appropriate margin. This calculation is approved.

OSC-9831, "Protective Relay Settings Associated With PSW Switchgear"
This calculation establishes setpoints for all 600V Load Center Breakers, 600V XPSW MCC, 4.16 kV Relays and 13.8 kV Relays associated with the Oconee Main PSW Switchgear 13.8/4.16 kV System. This calculation demonstrates the B6T-08 and therefore AWC-07, AWC 4160 volt switchgear incoming breaker, coordinates with upstream feeder breakers for bus B6T. Based on the addition of the AWC electrical system, this calculation is being revised, as required, per the design change process.

OSC-10008, "Failure Modes and Effects Analysis, Protected Service Water (PSW) System - Electrical and Mechanical Equipment"
This calculation performs a Failure Modes and Effects Analysis (FMEA) on the PSW System. This calculation is revised to include the B6T-08 feeder breaker to the 4160 AWC switchgear. Results of the analysis indicates that there is no effect on the FMEA for PSW by the addition of the AWC electrical system to the PSW electrical system. This calculation is approved.

OSC-10965, "Failure Modes and Effects Analsis, Auxiliary Water Chilled (AWC) System – Electrical Equipment"
This calculation is to perform an FMEA on the electrical portion of the AWC System. Based on the addition of the AWC electrical system, this calculation is being generated, as required, per the design change process.

OSC-10319, "Oconee Units 1, 2, 3 NFPA 805 Breaker and Fuse Coordination Study"
This calculation performs an NFPA 805 breaker/fuse coordination study. Based on the addition of the AWC electrical system, this calculation is being revised, as required, per the design change process.

OSC-7729, "Oconee-Keowee Underground Power Cable Replacement Calculations"
This calculation addresses the interaction between the Keowee Underground power path to CT-4 and the Keowee Underground power path to PSW. Based on the addition of the AWC electrical system, this calculation is being revised, as required, per the design change process.

OSC-10962, "PSW Underground Ductbank Cable Pull Calculation - Segment 9"
This calculation evaluated the stresses to which cables are exposed during installation to ensure that the duct bank system and installation procedures do not cause excessive cable stresses during installation. This calculation was generated for the feeder cable installation between the PSW switchgear through the PSW Cable Vault. This cable is the feeder cable for the new AWC switchgear. This calculation is approved .

Margin for PSW System

The following calculations will demonstrate that adequate margins remain on the PSW electrical system.

OSC-9190, "Protected Service Water (PSW) System, 125VDC Power System Analysis"
As previously stated, this calculation was revised to include the DC power used by breaker B6T-08 that feeds the 4160 volt AWC switchgear. This calculation demonstrates that there is adequate margin on the PSW 125VDC system after installation of the AWC system.

OSC-9370, "Unit 1/2/3, PSW AC Power System Voltage and Short Circuit Analysis"
This calculation performs the voltage adequacy and fault duty for the PSW AC power distribution system. Also, this calculation demonstrates that there is margin on the PSW AC distribution system. The design change process requires that the new AWC AC electrical system be designed such that margin be maintained. Once the AWC electrical system design parameters are finalized through the design change process, this calculation will be revised and issued to show the margin of the PSW AC electrical system with the AWC AC electrical system in service is acceptable.

Updated figure 9-45 in the Duke Energy letter dated August 7,2013

Figure 9-45 "PSW AC Electrical Distribution" is revised to reflect the addition of feeding the AWC AC Electrical Distribution System and is included in Attachment 2.

The AWC electrical system is an AC system with the only impact to the PSW 125VDC system being the usage of the PSW breaker B6T-08. The usage of the PSW 125VDC system was analyzed in calculation, OSC-9190. There is no design change to the PSW 125VDC Batteries, Chargers, and busses. Therefore, Figure 9-46 is not impacted.

RAI 173 [EEEB2]

During the public meeting on October 3, 2013, the licensee mentioned that about 7 components were identified inside the reactor building (components such as solenoid valves, limitorque valves, BIW cables etc.) which could not be analytically shown to operate for the entire 30 days following a loss of containment cooling. Please provide a brief description of the equipment which are part of the environmental qualification (EQ) program and clarify if any of this equipment need to remain qualified in accordance with 10 CFR 50.49. The licensee further stated that existing safety systems and components that interface with the PSW system will retain their qualification in accordance with 10 CFR 50.49. Provide a summary of the licensee's evaluation to demonstrate how this equipment will retain their environmental qualification.

Duke Energy Response

With the exception of the pressurizer heater components, the credited Protected Service Water (PSW) Instrument & Control (I&C) and Electrical equipment located inside the Oconee Nuclear Station (ONS) Units 1, 2 and 3 Reactor Buildings (RBs) were analytically evaluated to determine their capability to function in certain loss of containment cooling event scenarios for PSW events. The pressurizer heater components are being modified as part of the PSW project. The capability of the pressurizer heater components to operate during PSW scenarios will be completed as part of the design changes associated with the PSW project (Milestone 5). The seven (7) other components evaluated are required to function in a PSW event. These components also have Equipment Qualification (EQ) test reports that qualify them for Design Basis Events (DBE) such as a Loss of Coolant Accident (LOCA). The PSW loss of containment cooling scenario results in a slow increase in containment temperature to a peak value that occurs ~ 72 hours.

The component EQ DBE test curves were obtained from the applicable EQ test report. The evaluation considered several component variables including the limiting material activation energy, required mission time and margin when it compared the component EQ test curve with the PSW scenario curves.

The PSW components evaluated were determined to function acceptably assuming no containment cooling for 30 days during a PSW scenario with the exception of seven (7) component types. These seven (7) component types do not necessarily represent component failures but rather limitations of the available component test data. The components that could not be analytically determined to function for the entire 30 days of the PSW scenario were as follows:

- Rosemount (model 1154 and 1154H) transmitters
- MINCO / Westinghouse Resistance Temperature Detectors (RTDs)
- Boston Insulated Wire cables
- Viking electrical penetrations
- Limitorque motor operated valves (MOVs)
- Tape Splice – Scotch 130C /EGS – SAIC

- Power Operated Relief Valve Solenoid (note that no ONS plant-specific test reports were available for the Power Operated Relief Valve solenoid component type)

Resolution of the above component limitations will be through a combination of additional component testing, component replacement, and/or providing containment cooling to reduce the containment temperature profile. Containment cooling will be provided through delayed initiation of a Reactor Building Cooling Unit (RBCU) during the PSW scenario. When a RBCU is used with a specific initiation delay time (i.e., 30 hours), the only remaining components that cannot be analytically shown to function for the entire PSW Cooling event are the Boston Insulated Wire (BIW) cable and the Power Operated Relief Valve (PORV) solenoid. The BIW cable and the PORV solenoid are currently under evaluation and the failure of those components to function for the entire PSW scenario will be addressed by further testing or component replacement.

The failure of the components listed previously to function for the PSW scenario does not affect any of the existing environmental qualifications of those EQ components associated with the other events required by 10 CFR 50.49. Since they have been previously qualified (i.e. EQ test report) for the other events as required by 10 CFR 50.49, they will continue to function acceptably if one of those events occurs (e.g., a LOCA). The previous qualification performed for other events in accordance with 10 CFR 50.49 remains acceptable and no further evaluation is required.

RAI-174 [EEEB3]

Is the PSW system a safety system? If not, provide technical and regulatory basis to demonstrate that the existing Class 1E onsite power system independence and electrical separation are maintained by the proposed plant modification.

Duke Energy Response

The term "safety-related system" as defined in 10 CFR 50.2, means a system that is relied upon to remain functional during and following design basis events to assure:

1. the integrity of the reactor coolant pressure boundary
2. the capability to shut down the reactor and maintain it in a safe shutdown condition; or,
3. the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in 10 CFR 50.34(a)(1) or 10 CFR 100.11.

The Protected Service Water (PSW) system is not classified as a "safety system" in that it is not required to mitigate design basis events. However, Duke Energy has designed and is installing the system in accordance with Duke Energy Quality standards that are applied for a safety-related system (QA Condition 1). The PSW system is a standby system, meaning it provides additional "defense-in-depth" protection by serving as a backup to existing safety systems and as such, the system is not required to comply with the single failure criterion. The Keowee Hydroelectric Units (KHUs) were modified to supply electrical power to the PSW system.

Each of the KHU generator buses have been modified installing a power feed to the PSW Electrical Distribution system such that either KHU could be aligned to supply electrical power. A bolted connection was made to each of the generator buses. Flexible electrical connections were installed on each of the segregated phase buses and connected to the newly installed transition junction boxes. Cable terminations were made inside the transition junction boxes

and the cables were routed to new Keowee electrical breakers (KPF-9 and KPF-10). The new Keowee breakers are part of the new 13.8 kV switchgear located at Keowee. The new Keowee breakers KPF-9 (on Switchgear KPF1 for KHU1) and KPF-10 (on Switchgear KPF2 for KHU2) provide separation between the KHU design basis function to supply emergency power to engineered safeguards equipment and power to the PSW Electrical Distribution system. These breakers are maintained normally open with their closing springs de-energized to prevent spurious closure. There are no automatic closure signals provided to close the breakers. The power alignment from a KHU to PSW is a manually controlled function. An electrical interlock prevents the operator from connecting both KHUs to a common electrical pathway to the PSW Electrical Distribution system. The equipment used to provide this electrical connection is QA-1 and seismically qualified.

In a letter dated June 11, 2012, the Staff requested that Duke Energy discuss the seismic qualification method(s) used for electrical and mechanical equipment credited for the PSW system (RAI 160). In response to RAI 160, Duke Energy described that the QA-1 electrical equipment installed by the PSW project was seismically qualified in accordance with IEEE 344-1975 as documented in a letter dated July 20, 2012. It was not evident to the Staff that Duke Energy's response to RAI 160 included the seismic qualification for the new 13.8 kV switchgear at Keowee that provide power to the PSW system; therefore, a new RAI was received in an email from the NRC dated September 17, 2012, requesting Duke Energy clarify the seismic qualification. This new RAI was re-numbered as RAI 166 in Duke Energy's response contained in a letter dated November 2, 2012. In the response to RAI 166, Duke Energy confirmed that the 13.8 kV switchgear located at Keowee for the PSW system was seismically qualified in accordance with IEEE 344-1975.

The new power cables installed have been routed to meet the existing separation requirements in Oconee Specification OSS-0218.00-00-0019 (Cable and Wiring Separation Criteria Specification). The control cables for the operation of Keowee Breakers KPF-9 and KPF-10 have also been routed to meet the separation criteria described in Oconee Specification OSS-0218.00-00-0019. In a letter dated July 6, 2009, the Staff requested additional information (RAI 3) to explain how the redundancy and independence of the Class 1E power system is maintained as a result of the proposed modification and (RAI 5) how the licensing basis for physical independence and separation criteria are met for the PSW electrical system. Duke Energy responded in a letter dated September 2, 2009 that the power feeds from the KHUs to both the Oconee Nuclear Station and the PSW electrical system are isolated by separate breakers and disconnect switches. Independence is maintained as required by Duke Energy Design Criteria (DC) 3.13. DC 3.13 was provided to the NRC as an attachment to the letter.

Duke Energy provided marked-up Updated Final Safety Analysis Report (UFSAR) pages addressing the PSW modification in response to RAI 109(a) in a letter dated March 16, 2012. Subsequently, the Staff requested additional information in a letter dated June 11, 2012, that Duke Energy provide a copy of the revised UFSAR pages reflecting the design basis information for the PSW system electrical equipment (RAI 110) and that Duke Energy explain how the QA-1 electrical equipment was designed and installed consistent with QA-1 standard for Class 1E equipment as described in the proposed UFSAR section 9.7.1.2.2 (RAI 124). In response to RAI 110 and RAI 124, Duke Energy clarified that the PSW power system was QA Condition 1, not Class 1E as documented in a letter dated July 11, 2012.

Duke Energy provided UFSAR Figure 9-45 depicting the PSW Electrical Distribution system in response to RAI 109(a) in a letter dated March 16, 2012. An updated version of the UFSAR markups were provided by Duke Energy in a letter dated August 7, 2013. The PSW Electrical Distribution system, as depicted on UFSAR Figure 9-45, is not a Class 1E power system. It is however, designed to QA-1 standards and seismically qualified. The "Keowee Hydro" breakers

as shown on Figure 9-45 are the incoming breakers on the 13.8kV/4160V PSW Switchgear located inside the PSW Building. Although these breakers are QA-1/seismically designed, they do not provide the electrical separation and independence between the KHUs. Electrical separation and independence between the KHUs are provided by upstream breakers (KPF-9 and KPF-10) located at Keowee.

RAI-175 [AHPB1]

In its response to RAI 170 as provided in letter dated June 28, 2013, the licensee described the use of Air Handling Units as a part of the alternate cooling strategy for maintaining an acceptable temperature for the control complex and the auxiliary building. This strategy credits manual actions. For the identified credited manual actions associated with the operation of AHUs please provide the following information:

- Describe the cue that alerts the operator to take action in a timely manner,
- Describe the operator feedback about whether the action is complete and effective,
- Describe training content, method, and frequency,
- Describe the location and accessibility of required displays and controls,
- List the controlled procedures that guide the operator's actions
- Describe the time available and the time associated with these manual actions
- Describe the validation methods used to justify the manual actions
- Describe the evaluation of environmental considerations including loss of lighting, harsh temperatures, ventilation, path obstruction and occupational dose received

Duke Energy Response

Describe the cue that alerts the operator to take action in a timely manner.

Manual actions are cued based on a path through a symptom-based emergency operating procedure (EOP), EP/1,2,3/A/1800/001.

After an event occurs, the EOP is entered and immediate manual actions and symptom checks are completed. If the control room crew determines through the EOP that the PSW system is required to mitigate the event, they will perform the EOP enclosure for placing the PSW system in operation. This enclosure will also provide guidance to place the Alternate Chilled Water (AWC) system in service. These manual actions will be performed by trained station personnel using approved procedures.

Describe the operator feedback about whether the action is complete and effective:

Feedback is provided to the operator through successful performance of the emergency procedures. For example, the emergency procedures have checks to verify expected response and then to take action if response is not as expected. In this case, personnel are dispatched to place the system in service and report status to the control room.

Describe training content, method, and frequency:

Station Training personnel will determine the required skills and knowledge, appropriate training setting and frequency of training using approved training development procedures utilizing a systematic approach to training. Tasks that require manual actions typically require classroom and On-The-Job (OJT) training. Therefore, training will be developed and completed prior to approval of procedures and the system being placed into service.

Describe the location and accessibility of required displays and controls:

The PSW system is designed to mitigate events in the Turbine Building such as large fires or High Energy Line Breaks (HELBs).

The AWC system, which cools the Control Complex and Auxiliary Building, is located outside the Turbine Building envelope. The AWC power supply originates from the PSW electrical system, which is located outside the Turbine Building. AWC components such as a pump, chillers, air handling units and their respective controls have been placed in locations outside the Turbine building that are accessible and can be operated locally following a HELB or fire event in the Turbine Building.

Containment cooling is provided by portions of the Low Pressure Service Water (LPSW) system, which is fed by diesel engine driven pumps located at the lake and uses piping that is outside and in the penetration rooms. In order to pump the lake water through the Reactor Building Cooling Units (RBCU), it is necessary to isolate the LPSW headers using existing manual valves located in the Turbine Building. There are no direct HELB effects in the vicinity of these manual valves, so they will be accessible in a HELB event. In a fire event, the RBCUs are not required to be placed in service immediately. Access to the Turbine Building is expected to be restored in a time frame to support isolation of the LPSW headers.

List the controlled procedures that guide the operator's actions:

The station emergency procedures will provide written documentation for manual actions. They will be written and validated by approved processes and performed by trained station personnel. For example, EOP, EP/1,2,3/A/1800/001 will be revised to direct placing the PSW system into service through an enclosure. The PSW system enclosure would direct, when needed, placing the AWC system into service for Control Complex and Auxiliary Building cooling. It would also direct placing Containment cooling into service when needed.

Describe the time available and the time associated with these manual actions:

Because the AWC modification is still in design, a definitive list of manual actions and corresponding timeframes for performance is not finalized. Preliminary analysis indicates that restoration of cooling to the Unit 1 & 2 Control Room is the most time sensitive task and will need to be completed within an estimated 4 hour timeframe following the event. A considerable amount of additional time is available to restore cooling to the other areas of the plant.

The following is an example of generalized manual actions that may be required to support placing AWC in service. Note that it is not an all-inclusive list.

- Start an AWC pump.
- Start an AWC chiller.
- Close normal supply valves to credited Air Handling Units (AHUs).
- Open AWC supply and return valves to AHU(s).
- Align AWC power to AHU and start AHU(s).

The following is an example of generalized manual actions that may be required to support placing containment cooling in service. Note that it is not an all-inclusive list.

- Stage diesel powered portable pump at lake.
- Route hose from discharge of portable pump and connect to LPSW supply line to RBCU.

- Connect hose to RBCU LPSW return line and route to yard drain.
- Close normal LPSW supply header isolation valves.
- Start diesel powered pump
- Start RBCU.

Describe the validation methods used to justify the manual actions:

Validation is the process of exercising procedures to ensure that they are usable, that the language and level of information is appropriate for the people for whom they are intended, and that the procedures will function as intended. Validation methods include simulator validation, in-field walk down of procedures, and mock-up validation. Validation includes verification that time critical actions can be performed within the allotted time.

Procedure validations are performed as part of the initial procedure development process. Continuing procedure validations can also be performed during training and scheduled drills.

The procedure writer identifies the methods of validation. Methods of validation are based on the procedure characteristics necessary to ensure the intent of the new or revised procedure is met and is based on nature of changes to the procedure. More than one validation method may be appropriate.

With the exception of Operations emergency procedures, the validation process for technical procedures is governed by nuclear system directive (NSD) 705, "Instructions for Writer's Manual Verification and Plant Validation." The Operations emergency procedures validation process is governed by operations management procedures OMP 4-2, "Verification and Validation Process for APs, EOP, and Support Procedures" and for time critical actions, NSD 514, "Control of Time Critical Tasks." These references are available on the share point.

The manual actions associated with the AWC system will be identified and the appropriate procedures will be revised or created to address them. The procedures will then be validated as described above. This will be done prior to approving the procedures and placing the system in service.

Describe the evaluation of environmental considerations including loss of lighting, harsh temperatures, ventilation, path obstruction and occupational dose received:

The lighting (fixed and/or portable) is validated to ensure sufficient lighting is available to perform the intended action.

Environmental conditions such as radiological hazards, high temperature/humidity, egress paths, and smoke/toxic gases (resulting from fire) are assessed for the event. No harsh environmental conditions are anticipated in the Auxiliary Building as the Auxiliary Building/Turbine Building wall is a three hour fire barrier. The validation process ensures that any required tools, equipment, or keys required for the action is available and accessible. This includes consideration of self-contained breathing apparatus and personal protective equipment if required. (This includes staged equipment for repairs). The environmental conditions are assessed as part of the procedure validation and is the same as described in the documents above.

RAI-176 [AHPB2]

During the presentation given to the NRC staff on October 3, 2013, the licensee described the alternate cooling methods included in the analysis for providing alternative source of power feed from PSW to the a reactor building cooling unit. It was stated that all the electrical operations are manual operations. For the identified credited manual actions associated with these electrical operations please provide the following information:

- Describe the location and accessibility of required displays and controls,
- List the controlled procedures that guide the operator's actions
- Describe the time available and the time associated with these manual actions
- Describe the validation methods used to justify the manual actions

Duke Energy Response

See the response to RAI-175.

RAI-177 [AHPB3]

Please identify any remaining credited manual actions and provide detailed information concerning the validation process used to justify these actions and please discuss what, if any, task analysis was done to assess the cognitive load on individuals and crews which will be designated with performing the credited function.

Duke Energy Response

See the response to RAI-175.

RAI-178 [EMCB1]

Confirm that the PSW building and the underground electrical duct banks have been designed and constructed in accordance with nuclear safety related (QA Condition 1) requirements of the ONS quality assurance program.

Duke Energy Response

Conduit duct banks and manholes connecting the Keowee Underground to the PSW Building, conduit duct banks, Technical Support Building (TSB) cable vault, Elevated Raceway, and Manhole 7 connecting the PSW Building with the Unit 3 Auxiliary Building, and conduit duct banks connecting Manhole 7 to the SSF cable trench and the SSF trench to the SSF have been designed and constructed to QA-1 standards.

UFSAR Section 9.7.3.5.1 previously stated that the PSW system is housed in four new structures. It will be revised to specifically state that the PSW system is housed in four new QA-1 structures as follows:

Section 9.7.3.5.1 [Building Structures]

The PSW system is housed in four new QA-1 structures, as follows:

1. PSW Building
2. Conduit duct banks and manholes connecting the Keowee Underground to the PSW Building
3. Conduit duct banks, Technical Support Building (TSB) cable vault, Elevated Raceway, and Manhole 7 connecting the PSW Building with the Unit 3 Auxiliary Building (AB)
4. Conduit duct banks connecting Manhole 7 to the SSF cable trench and the SSF trench to the SSF.

The revision to UFSAR Section 9.7.3.5.1 is included in Attachment 1.

RAI-179 [EMCB2]

Page 63 of licensee letter dated April 5, 2013, states the following:

> *"All mechanical equipment was requalified for the appropriate in-structure response spectra in OSC-10764 Revision 1. In cases where the capacity did not completely envelope the new in-structure demand response spectra, either an appropriate engineering justification was made, or the equipment was requalified using the new in-structure response spectra."*

Discuss and provide further information on seismic qualification of those mechanical components where the capacity of the component did not completely envelope the in-structure response spectra.

Duke Energy Response

Duke Energy clarifies the original statement from the letter dated April 5, 2013 as follows:

> *"All mechanical equipment was requalified for the appropriate in-structure response spectra provided in OSC-10764, Revision 1. The capacity of the QA-1 mechanical equipment in the PSW Building completely envelopes the in-structure response spectra as given in OSC-10764, Revision 1."*

RAI-180 [EMCB3]

Page 65 of licensee letter dated April 5, 2013, states the following:

> *"Seismic analysis of the attachment of electrical equipment uses a static coefficient factor of 1.5 for new designs."*

Discuss and provide further information on the methodology used for the design of the PSW mechanical equipment anchorage.

Duke Energy Response

Discussion of the methodology for the anchorage design for PSW QA-1 mechanical equipment will be separated into three topics: I) QA-1 mechanical equipment in the PSW Building; II) QA-1 ventilation equipment in the Auxiliary Building (AB); and III) QA-1 pumps in the AB. There is no PSW mechanical equipment located in the Standby Shutdown Facility (SSF).
Section 3.9.2.2 of the ONS UFSAR provides two alternative analytical methods for the seismic qualification of mechanical equipment. Dynamic analysis may be utilized to determine the principal natural frequency and the seismic demand determined for that frequency or, alternatively, the peak seismic demand may be used without evaluation of the principal natural frequency. In addition, ECV-0601.00-00-0005, "Specification for Seismic Qualification of Equipment", requires the use of a static coefficient of 1.5 when using the peak demand unless the equipment is shown to be rigid.

I) Anchorage of the QA-1 mechanical equipment in the PSW building was designed and is controlled by drawings. It was demonstrated by dynamic analysis that the principal natural frequencies of the QA-1 mechanical equipment support structures is greater than 33 Hz. The analysis used the enveloped spectra accelerations at 33 Hz from OSC-10764, Revision 1, "Generation of SSE In-Structure Seismic Response Spectra for the PSW Building" for all the equipment locations to perform structural analysis to determine the support reactions for the controlling Safe Shutdown Earthquake (SSE) load combinations. Anchorage connections were designed and qualified to resist these reactions. Designed anchorage connections include concrete expansion anchors and welds made to embedded steel plates. Anchorage connection designs conform to OSS-0235.00-00-0015, "Design Specifications for HVAC Supports and Restraints", Rev. 4; OSS-0020.00-00-0006, "Specification for the Design, Installation, and Inspection of Hilti Concrete Anchors", Rev. 5; and AWS D1.1, "Structural Welding Code", dated 2008.

II) Anchorage of the QA-1 mechanical ventilation equipment in the AB was designed and is controlled by drawings. Peak accelerations, with a static coefficient of 1.5, from the appropriate spectra were used for all the equipment locations in the AB to perform structural analysis to determine the support reactions for the controlling SSE load combinations. The spectra are from OSS-027B.00-00-0002, "Specification for the Displacements and Response Spectra for the Turbine, Auxiliary, Reactor, and Standby Shutdown Facility Buildings". Anchorage connections were designed and qualified to resist these reactions utilizing concrete expansion anchors. Anchorage designs conform to OSS-0235.00-00-0015, "Design Specifications for HVAC Supports and Restraints", Rev. 4; and OSS-0020.00-00-0006, "Specification for the Design, Installation, and Inspection of Hilti Concrete Anchors", Rev. 5.

III) Anchorage of the QA-1 PSW Primary and Booster pumps was designed and is controlled by drawings. In the design calculation for the primary and booster pump anchorage, OSC-10035 and OSC-10300 respectively, Duke Energy used peak accelerations, with a static coefficient of 1.5, from the appropriate spectra for the equipment locations to perform structural analysis to determine the anchor reactions for the controlling SSE load combinations. The spectra are from OSS-027B.00-00-0002, "Specification for the Displacements and Response Spectra for the Turbine, Auxiliary, Reactor, and Standby Shutdown Facility Buildings." The designed and qualified grouted, headed, anchor bolts conform to ACI-349-06. Regulatory Guide 1.199 endorses ACI 349-01 Appendix B, Section B.12 for the design of grouted embedments. OSC-10035 and OSC-10300 reference ACI 349-06, Appendix D, Section D.12. OSC-10035 and OSC-10300 document that the applicable code requirements of ACI 349-01 are compatible with the applicable code requirements of ACI 349-06.

RAI-181 [EMCB4]

Page 58 of licensee letter dated April 5, 2013, indicates the following:

> *"Qualification by analysis was used for some of the equipment following the methods given in IEEE 344-1975. The 1.5 multimode factor was used as appropriate and justified. Therefore, RG 1.100, Revision 1 exception #1 has been addressed."*

Page 65 and 70 of licensee letter dated April 5, 2013, indicates the following:

> *"Seismic analysis of the attachment of electrical equipment uses a static coefficient factor of 1.5 for new designs."*

Contrary to the above statements, Page 70 of licensee letter dated April 5, 2013, indicates that static coefficient of 1.0 was used in calculation OSC-9818. Confirm that static coefficient of 1.5 has been appropriately used in seismic qualification of the PSW components, including their anchorage design.

Duke Energy Response

Consistent with the response to RAI 160 contained in the Duke Energy letter dated April 5, 2013, seismic qualification of electrical equipment and equipment anchorage shall be treated separately. In regards to the qualification of electrical equipment the statement on page 58 of Duke Energy letter dated April 5, 2013:

> *"Qualification by analysis was used for some of the equipment following the methods given in IEEE 344-1975. The 1.5 multimode factor was used as appropriate and justified. Therefore, RG 1.100, Revision 1 exception #1 has been addressed."*

is correct. In regards to the anchorage of electrical equipment, the statement on pages 65 and 70 of Duke Energy letter dated April 5, 2013:

> *"Seismic analysis of the attachment of electrical equipment uses a static coefficient factor of 1.5 for new designs."*

is correct. As described in the revised response to RAI 141 (Duke Energy letter dated April 5, 2013) the In-Structure Response Spectra (ISRS) was revised for the PSW building. This revision is documented in calculation OSC-10764, Revision 1, "Generation of SSE In-Structure Seismic Response Spectra for the PSW Building." After the issuance of OSC-10764, Revision 1, all PSW Building electrical equipment anchorage design calculations were reviewed to determine whether the SSE seismic demand used in the original anchorage designs bounded the peak SSE seismic acceleration(s) from the revised ISRS multiplied by a static coefficient of 1.5. In any cases where the original anchorage design seismic demand was not bounding, the design was re-qualified to the peak SSE seismic acceleration(s) from the revised ISRS amplified by a static coefficient of 1.5.

RAI-182 [EMCB5]

The last paragraph of Section 9.7.3.5.2 (Page 9.7-11) of the UFSAR change package included in the licensee letter dated April 7, 2013 ([sic] August 7, 2013), states the following:

> The anchorage of PSW related equipment in the ONS AB was designed in accordance with ACI 318-63 (Reference 9) and the AISC Manual of Steel Construction, 13th edition, 2006 (Reference 4).

Discuss and provide further information on the manner ACI 318-63 and AISC, 13th edition, were used for the anchorage design of the PSW related equipment in the ONS Auxiliary Building.

Duke Energy Response

UFSAR Section 9.7.3.5.2 did not previously include Duke Energy specification OSS-0020.00-00-0006 or state that AISC Manual of Steel Construction 13th and 14th editions were for Member Properties. UFSAR Section 9.7.3.5.2 has been revised to clarify codes and standards used in the design of anchorage of PSW equipment located in the PSW Building and in the ONS Auxiliary Building as follows:

The structural attachment of equipment within the PSW Building was designed in accordance with the following codes, standards, and specifications:

1. AISC Manual of Steel Construction for Member Properties, 13th edition, 2006 (Reference 4).
2. Regulatory Guide 1.142, Revision 2, November 2001 (Reference 6).
3. AISI North American Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition (Reference 14).
4. ANSI / AISC N690-1984 (Reference 5).
5. Regulatory Guide 1.122, Revision 1, February 1978 (Reference 15).
6. Regulatory Guide 1.199, November 2003 (Reference 16).
7. OSS-0020.00-00-0006, Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors (reference 24).

The anchorage of PSW related equipment in the ONS AB was designed in accordance with the following codes, standards, and specifications:

1. For concrete expansion anchors: OSS-0020.00-00-0006, Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors (reference 24).
2. For grouted anchor bolts: ACI 349-01 (reference 22), ACI 349-06 (reference 23), and Regulatory Guide 1.199 (reference 16).
3. For steel support frames: AISC Manual of Steel Construction, 6th edition (reference 12).
4. Member properties for steel support frames: AISC Manual of Steel Construction, 13th edition (Reference 4) and AISC Manual of Steel Construction, 14th edition (Reference 25).
5. Evaluation of anchorage loads on ONS AB structural members: ACI 318-63 (reference 9).

UFSAR Section 9.7.5 also did not previously include all of the anchorage codes and standards cited. UFSAR Section 9.7.5 has been revised to add the following:

22. American Concrete Institute (ACI) 349-01, "Code Requirements for Nuclear Safety Related Concrete Structures."

23. American Concrete Institute (ACI) 349-06, "Code Requirements for Nuclear Safety Related Concrete Structures."

24. OSS-0020.00-00-0006, "Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors."

25. American Institute of Steel Construction (AISC), Manual of Steel Construction, 14th edition, 2011.

The revised sections of the UFSAR are provided in Attachment 1.

RAI-183 [EMCB6]

The UFSAR change package included in the licensee letter dated April 7, 2013 ([sic] August 7, 2013), designates the PSW building as a Class 1 structure by adding it to Section 3.2.1.1.1 of the ONS UFSAR. As described in Section 3.2.1.1.1, Class 1 structures are those which prevent uncontrolled release of radioactivity and are designed to withstand all loadings without loss of function. Since the PSW building is not designed for the turbine missile loading, designation of the PSW building as a Class 1 structure appears to be inconsistent with the ONS UFSAR. Discuss this apparent inconsistency and provide further justification for designation of the PSW building as a Class 1 structure.

Duke Energy Response

The PSW Building was designed as a Class 1 structure. Class 1 structures are those which prevent uncontrolled release of radioactivity; however, the PSW Building does not directly prevent the uncontrolled release of radioactivity because it does not house radioactive structures, systems, or components. The PSW Building is designed to withstand all credible loadings without loss of function. Also, Class 1 structures, except those structures not exposed to wind, are designed for tornado loads.

In general, turbine missile protection for Oconee is described in UFSAR Section 3.5.1.2. Two basic categories of plant equipment failure are hypothesized and considered in the Oconee design:

1. Missiles generated inside Containment - Assumptions and design requirements for missiles generated inside containment are described in Section 3.5.1.1.

2. Missiles generated by a main turbine failure - Assumptions and design requirements for missiles generated by a main turbine failure are described in Section 3.5.1.2.

Turbine missiles can occur in two different forms: low trajectory (or direct) missiles (LTM) and high trajectory missiles (HTM).

Duke Energy calculation OSC-6849 (R0), "Turbine Missile Strike and Damage Probability," (1): provides guidance on whether a component (or structure) needs to be analyzed for a turbine

missile loading based on the trajectory path (or missile strike zone) for low trajectory path missiles and based on the square footage of the component (or structure) for the high trajectory path missiles and (2): applies additional guidance for evaluating the need to protect (by separation or shielding) components or to exclude them from the missile strike zone. Specifically, the need to protect a piece of plant equipment against missiles is based upon the probability of a piece of plant equipment being damaged by equipment failure, namely main turbine failure.

OSC-6849, Section 9.1 states:

"LOW TRAJECTORY MISSILES – STRIKE AREAS

Page 3 of Reference 8.2 states,

Evidence currently available indicates that low-trajectory turbine missile strikes will be concentrated within an area bounded by lines inclined at 25 degrees to the turbine wheel planes and passing through the end wheels of the low-pressure stages. This applies to the low-pressure stage shrunk-on wheels of the 1800-rpm turbines generally used with light-water cooled reactors. Essential systems within this area and close to the turbine axis are most vulnerable; those further removed from the turbine axis are less likely to be hit by a missile. Systems outside this area are not endangered by high-energy low-trajectory missiles."

Note: Reference 8.2 of the calculation is US Nuclear Regulatory Commission Regulatory Guide 1.115, "Protection Against Low-Trajectory Turbine Missiles," Revision 1, July 1977.

The location of the PSW Building is well outside the missile strike zone based on the figures providing a graphical representation of the strike zone in OSC-6849; therefore, the location of the PSW Building meets the criteria for low trajectory missile exclusion.

Section 9.3 of OSC-6849 states:

"HIGH TRAJECTORY MISSILES

Page 6 of Reference 8.1 states,

High trajectory turbine missiles are characterized by their nearly vertical trajectories. Missiles ejected more than a few degrees from the vertical either have sufficient speed such that they land offsite, or their speeds are low enough so that their impact on most plant structures is not a significant hazard. The probability of a high trajectory turbine missile landing within a few hundred feet from the turbine is on the order of 10^{-7} per square foot of horizontal target area. Consequently, the risk from high trajectory turbine missiles is insignificant unless the vulnerable target area is on the order of 10^{4} square feet or more."

Note: Reference 8.1 of the calculation is NUREG-0800 - US Nuclear Regulatory Commission Standard Review Plan. Section 3.5.1.3, "Turbine Missiles," Rev. 2, July 1981.

According to drawing O-398-A2-101A, rev. 0, the total square footage of the PSW Building, including the vestibules, is slightly less than 4,000 square feet which allows the building to be excluded based on the total area presenting an insignificant risk according to OSC-6849; therefore, the PSW Building, satisfies the criteria for high trajectory missile exclusion.

Calculation OSC-10775, "Turbine Missile Strike Evaluation for PSW and Keowee Underground Systems", Revision 0, evaluated the PSW Ductbank vulnerability to both high and low trajectory turbine missiles. All those portions of the PSW Ductbank that were not excluded from turbine

missile loading consideration, based on target location or size, were shown to be adequate missile barriers.

RAI-184 [EMCB7]

The last paragraph of Section 9.7.3.5.1 (Page 9.7-10) of the UFSAR change package included in the licensee letter dated April 7, 2013 ([sic] August 7, 2013), states the following:

> *"The design response spectra for the new structures correspond to the May 1990 El Centro North-South earthquake normalized to a peak ground acceleration of 0.15g for structures founded on structural fill in accordance with the Oconee Nuclear Station current licensing basis."*

In addition to a typographical error of 1990 instead of 1940, the above statement is not consistent with the response to RAI-141 in licensee letter dated April 5, 2013, where it is indicated that (1) Figure 2-55 of the ONS UFSAR was used in the design of the PSW building; and (2) for the generation of the in-structure response spectra the 1940 El Centro time history ground motion input normalized to 0.15g was used. Discuss this apparent inconsistency and provide further clarification.

Duke Energy Response

UFSAR Section 9.7.3.5.1 will be revised to correct inconsistencies and typographical errors as follows:

From Page 9.7-9, the statement, "The PSW building has a seismic classification of Category 1," will be removed from the discussion as follows:

"The PSW building houses the major electrical equipment. The building is a reinforced concrete structure consisting of a transformer room, a mezzanine, a cable spreading area, and two battery rooms. The building is seismically qualified to the Maximum Hypothetical Earthquake (MHE) and designed to withstand tornado missiles, wind and differential pressure in accordance with Regulatory Guide 1.76, Revision 1 (Reference 7). The following load conditions were considered in the analysis and design:"

From Page 9.7-10, the following paragraph:

"The design response spectra for the new structures correspond to the May 1990 El Centro North-South earthquake normalized to a peak ground acceleration of 0.15g for structures founded on structural fill in accordance with the Oconee Nuclear Station current licensing basis. The PSW Building is founded on structural fill. The building design response spectra were developed in accordance with Regulatory Guide 1.122 (Reference 15). The dynamic analysis of the PSW Building is made using the STAAD-PRO computer program with amplified response spectra generated at elevations of significant nodal mass. "

will be revised as follows:

"The PSW Building is founded on structural fill (overburden). The Maximum Hypothetical Earthquake (MHE) response spectra used for the design of the PSW Building is Figure 2-55 of the ONS UFSAR in accordance with ONS current licensing basis (UFSAR Section 3.7.1.1 "Design Response Spectra"). The design MHE in-structure response spectra for the PSW Building was generated from the time history record of the North-South, May 1940 El Centro

earthquake normalized to a peak ground acceleration of 0.15g for both the vertical and horizontal excitations in accordance with the ONS current licensing basis (UFSAR Section 3.7.1.2 "Design Time History"). The building design in-structure response spectra were developed in accordance with the intent and guidance of Regulatory Guide 1.122 (Reference 15). The dynamic analysis of the PSW Building is made using the STAAD-PRO computer program with amplified response spectra generated at elevations of significant nodal mass."

RAI-185 [EMCB8]

Licensee letter dated April 5, 2013, includes broadened in-structure response spectra (ISRS) for the PSW building. These ISRS exhibit sharp valleys and it does not appear they have been smoothed; thus, not satisfying the intent/guidance of Regulatory Guide 1.122. Discuss and provide further information relative to the effects of these non-smoothed ISRS on the design of the PSW components, subsystems and their anchorage.

Duke Energy Response

The In-Structure Response Spectra (ISRS) for the PSW building shown in Figures 141-9 through 141-16 that were submitted with the revised response to NRC Request for Additional Information (RAI) 141 [EMCB6] via Duke Energy Letter dated April 5, 2013, were developed in accordance with the guidance of Regulatory Guide 1.122. The enveloped ISRS for the operating floor, the battery room roof, the building roof, and the exterior walls from the current design basis (CDB) and the lumped soil springs (LSS) analyses were enveloped and then widened by a minimum of ±15% on the frequency scale at every frequency including the structural modal frequencies to generate the enveloping spectra shown in these figures. These widened ISRS were not smoothed. In addition, the horizontal ISRS in these figures are the envelope of the X- and Z- direction ISRS.

Figure 1 provides a comparison of the widened response spectrum based on ±15% widening at every frequency for the example provided in Figure 1 of Regulatory Guide 1.122. As seen from this comparison, the widened response spectrum based on ±15% widening at every frequency bounds the smoothed response spectrum recommended for use by the RG 1.122 at almost all frequencies.

Figure 2 provides an example of a comparison of the widened and un-widened response spectra with multiple sharp valleys based on ±15% widening at every frequency. As seen from this figure the resulting accelerations for the sharp valleys of the widened response spectrum are higher than the corresponding valley accelerations of the un-widened response spectrum.

The ±15% widening at every frequency that was used for generation of PSW building response spectra is in accordance with the accepted industry practice and the resulting sharp valleys require no further adjustment. It is considered that widening the response spectra at every frequency, not just the peaks, eliminates the need for smoothing and is acceptable. This is evident from the NRC acceptance of similar response spectra with sharp valleys which are used for certified designs of Westinghouse AP1000 and GE ABWR. Figures 3 through 5 provide examples of the Westinghouse AP1000 response spectra [Reference ADAMS ML11171A440]. Figures 6 through 8 provide examples of the GE ABWR response spectra [Reference ADAMS ML11126A103]. Both examples exhibit response spectra with sharp valleys, that indicate the response curves were not smoothed.

Based on the above, the generation of the PSW building ISRS, as described in the revised response to RAI 141, meets the intent/guidance of Regulatory Guide 1.122. However, as

requested, the following provides a discussion relative to the effects of these non-smoothed ISRS on the design of the PSW components, subsystems and their anchorage.

Smoothing of the ISRS of OSC-10764, Revision 1, "Generation of SSE In-Structure Seismic Response Spectra for the PSW Building", could potentially affect two analyses: the Neutral Grounding Resistor (NGR) frames in transformers CT6 and CT7, OM 302.A –0072.003, Revision D02, "PSW Seismic Evaluation of 10 MVA Transformers CT6 & CT7"; and the QA-1 mechanical equipment structural supports, OSC-10581, Revision 12, "Structural / System Analysis on Fan Assembly Mounting and Ductwork for the Oconee PSW Building". All other QA-1 equipment qualification and anchorage relies on testing and/or peak accelerations to determine seismic capacity or demand and will, therefore, not be affected by smoothing the ISRS.

OSC-10764, Revision 1, generates ISRS at nineteen distinct locations within the PSW Building designated as points one through nineteen. The qualification of the NGR frames uses the envelope of the five percent damping spectra at points one and three to determine the seismic demand. Accelerations at various frequencies between 12 Hz and 33 Hz are utilized to calculate a conservative seismic demand. Smoothing of these two sets of response spectra may result in a small, less than two percent, increase in the acceleration values for point one in the vertical direction (Y) and E-W direction (Z) between 18 Hz and 23 Hz. In both cases the acceleration values are bounded by those at point three. Smoothing will have no impact on the point three response spectra near the frequencies of interest. The Required Response Spectra (RRS) developed in OM 302.A –0072.003, Revision D02 (See Figure 9), based on the response spectra in OSC-10764, Revision 1, to qualify the NGR frames would bound the smoothed five percent damping response spectra for points one and three as well. Therefore, smoothing the ISRS will have no impact on the qualification of the NGR frames, OM 302.A –0072.003, Revision D02.

The qualification of the QA-1 mechanical equipment structural supports uses the envelope of the five percent damping response spectra at points eight, nine, ten, eleven, and thirteen at 33 Hz to determine the seismic demand. Smoothing of these five response spectra will have no effect in the region of the response spectra near 33 Hz. Therefore, smoothing the ISRS has no impact on the qualification of the QA-1 mechanical equipment structural supports, OSC-10581, Revision 12.

The use of the non-smoothed ISRS in lieu of smoothed ISRS has no effect on the design or qualification of the PSW components, subsystems and their anchorage.

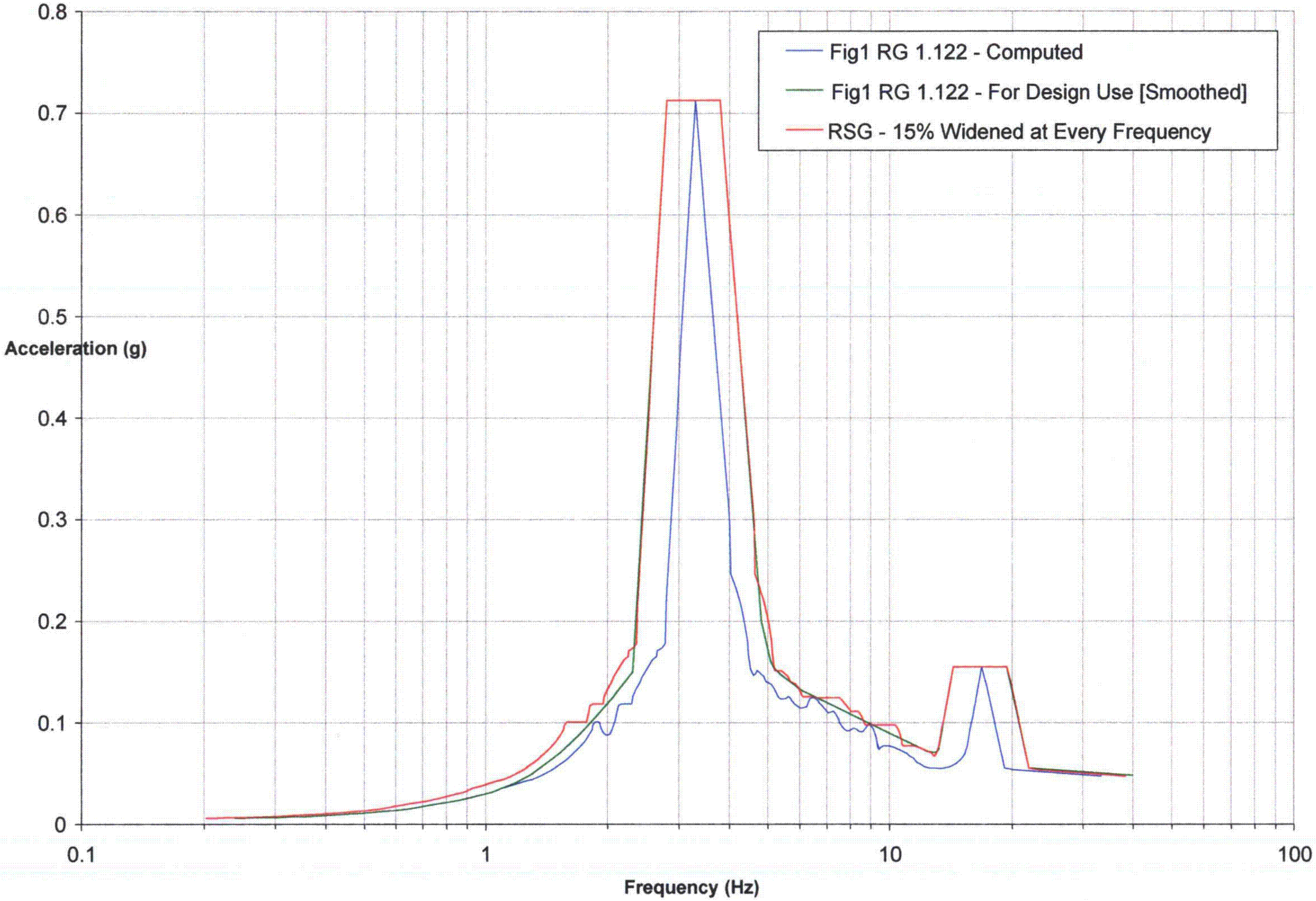

0.8
0.7
0.6
0.5
Acceleration (g)
0.4
0.3
0.2
0.1
0
0.1
1
10
100
Frequency (Hz)
Fig1 RG 1.122 - Computed
Fig1 RG 1.122 - For Design Use [Smoothed]
RSG - 15% Widened at Every Frequency

Figure 1

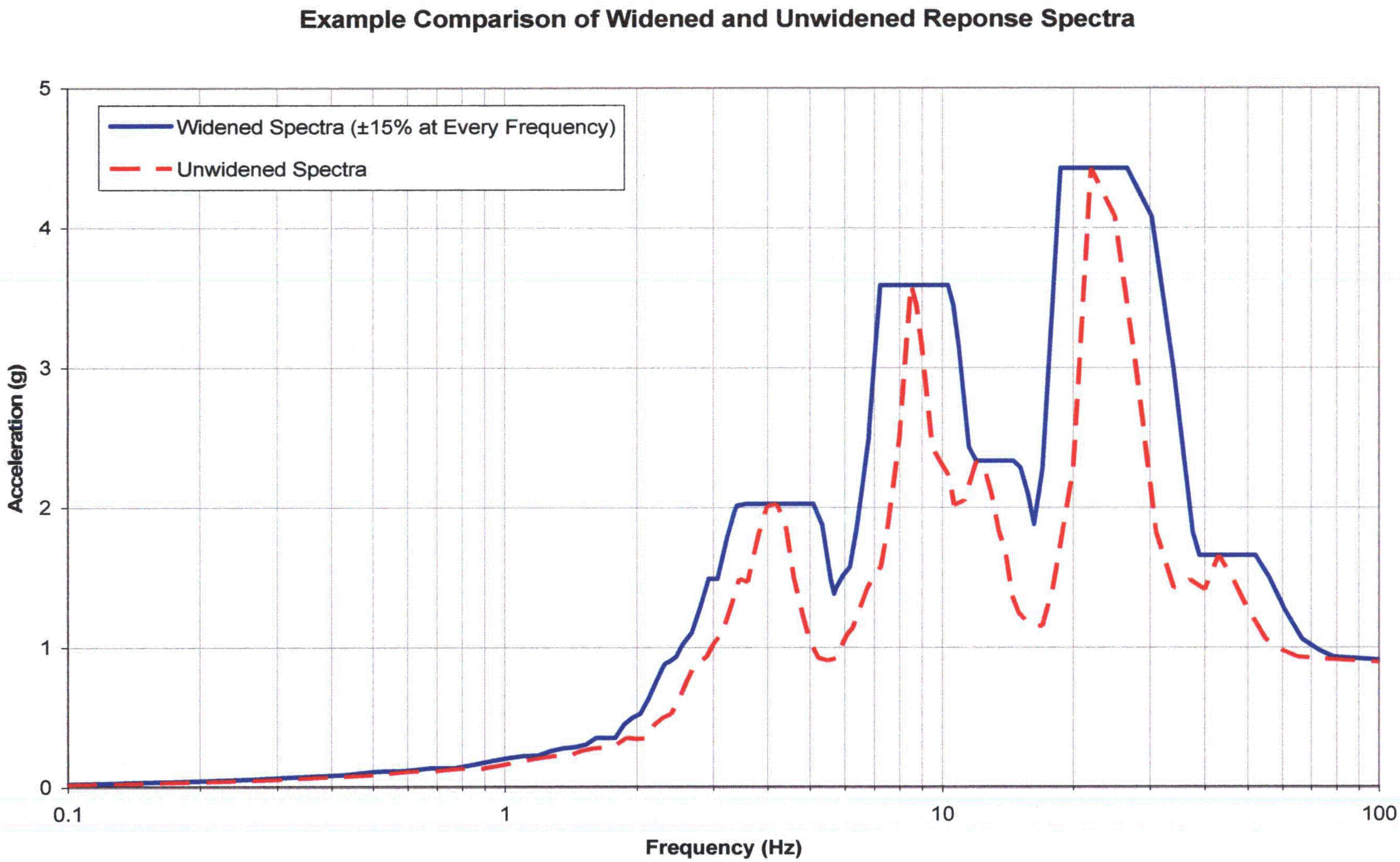
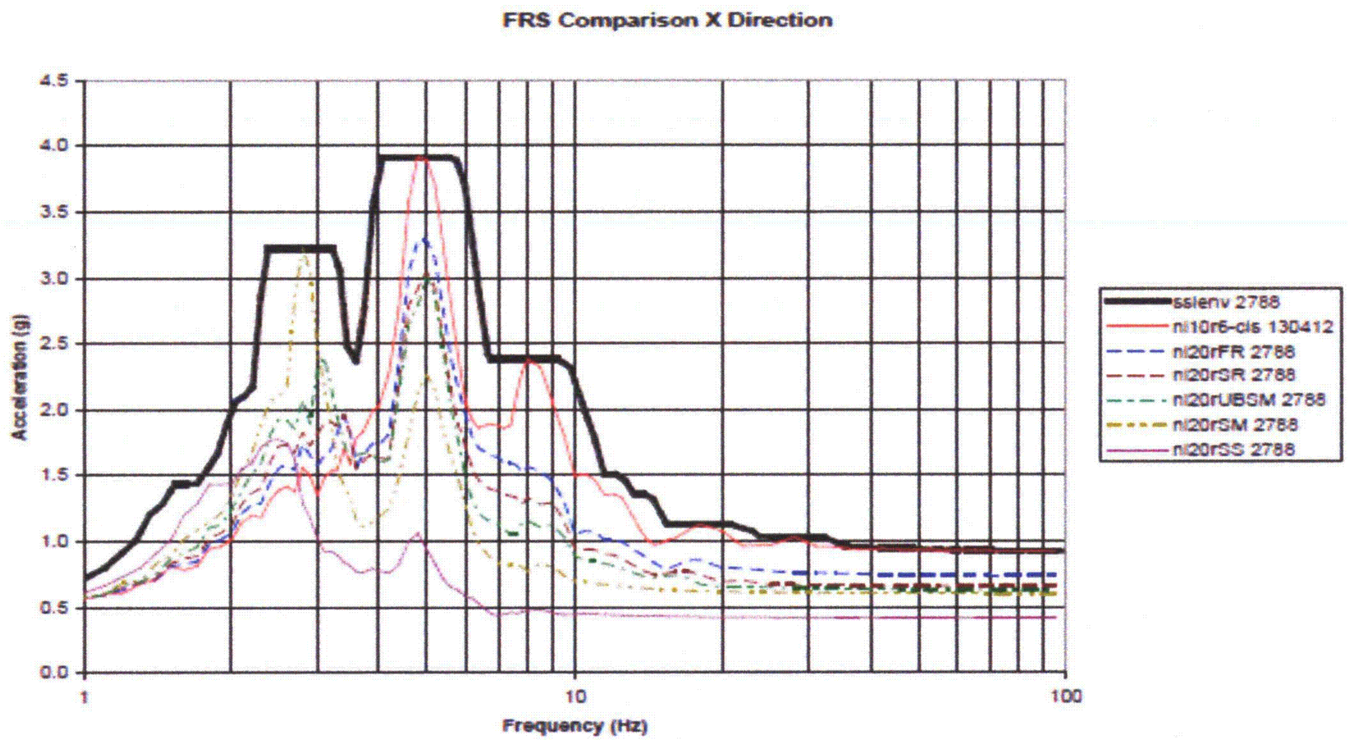

Example Comparison of Widened and Unwidened Reponse Spectra
Widened Spectra (±15% at Every Frequency)
Unwidened Spectra
Acceleration (g)
0
1
2
3
4
5
0.1
1
10
100
Frequency (Hz)

Figure 2

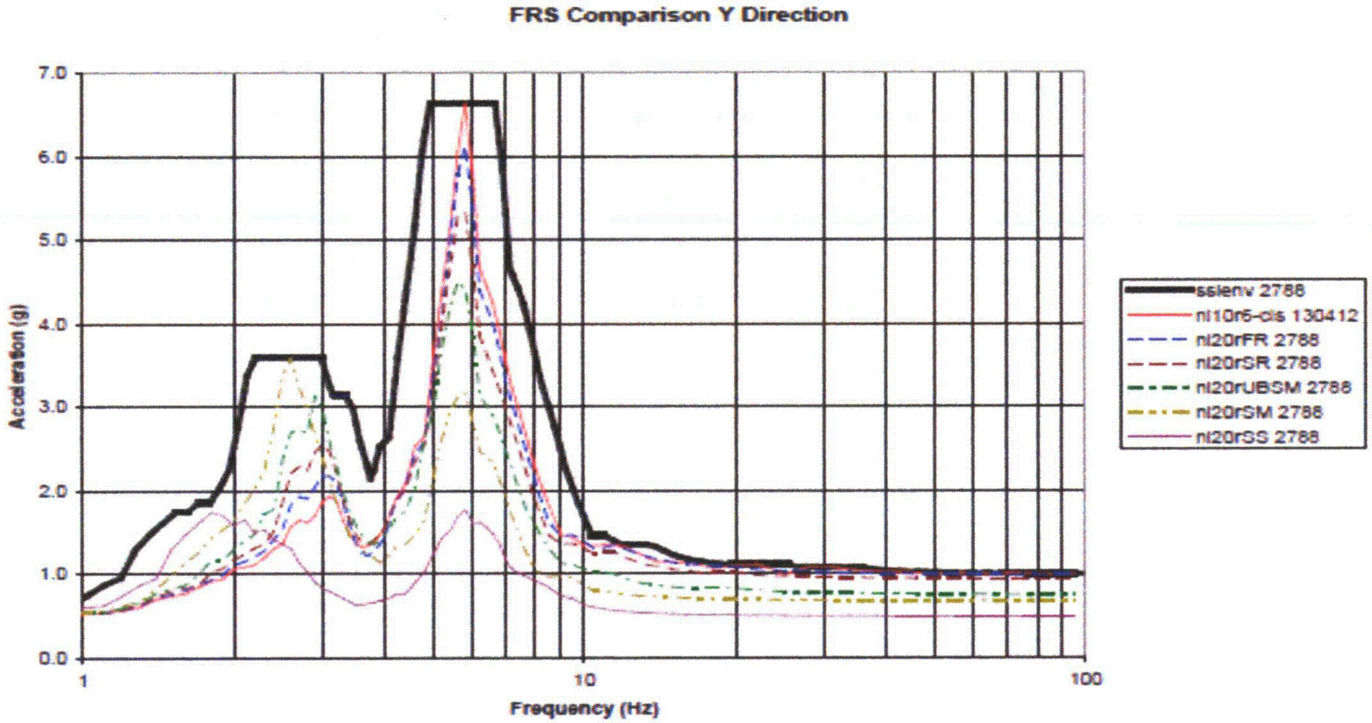


[Figure 3G.4-10X

X Direction FRS for Node 130412 (NI10) or 2788 (NI20) SCV Near Polar Crane Elevation 224.00']*

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

Figure 3

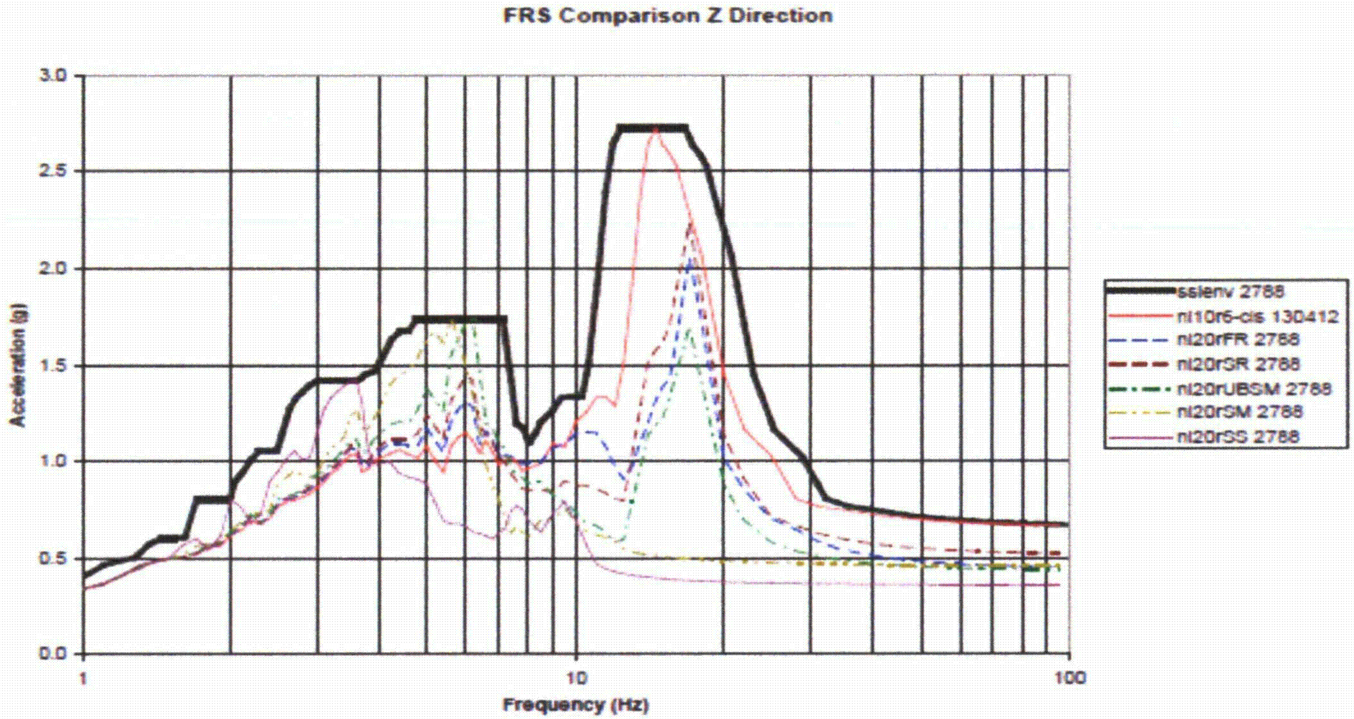


[Figure 3G.4-10Y

Y Direction FRS for Node 130412 (NI10) or 2788 (NI20)
SCV Near Polar Crane Elevation 224.00']*

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

Figure 4



[*Figure 3G.4-10Z*

Z Direction FRS for Node 130412 (NI10) or 2788 (NI20)
SCV Near Polar Crane Elevation 224.00']*

*NRC Staff approval is required prior to implementing a change in this information; see DCD Introduction Section 3.5.

Figure 5

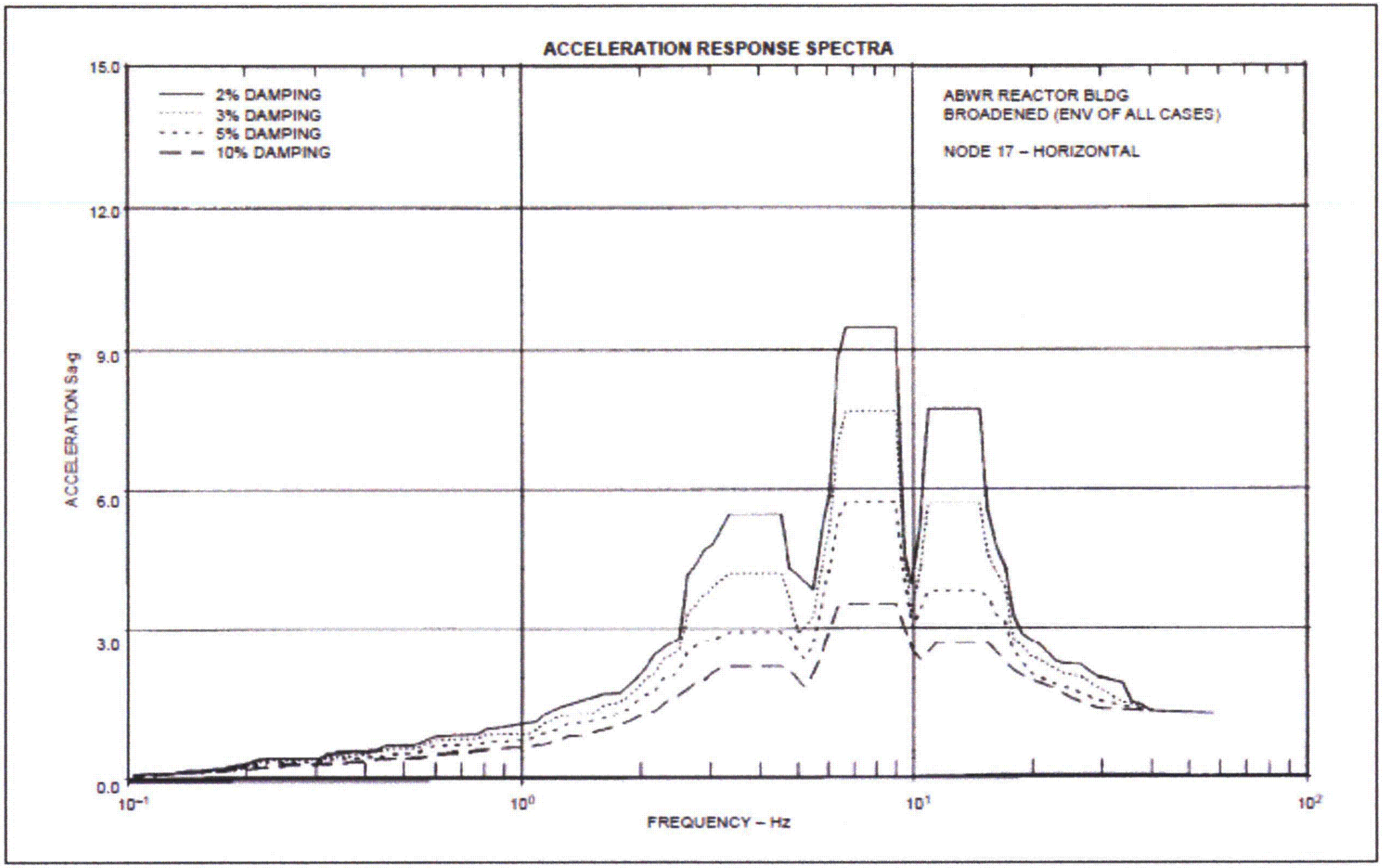


Figure 3A-128 ABWR Reactor Bldg. Broadened (Env of all Cases) Node 17–Horizontal

Figure 6

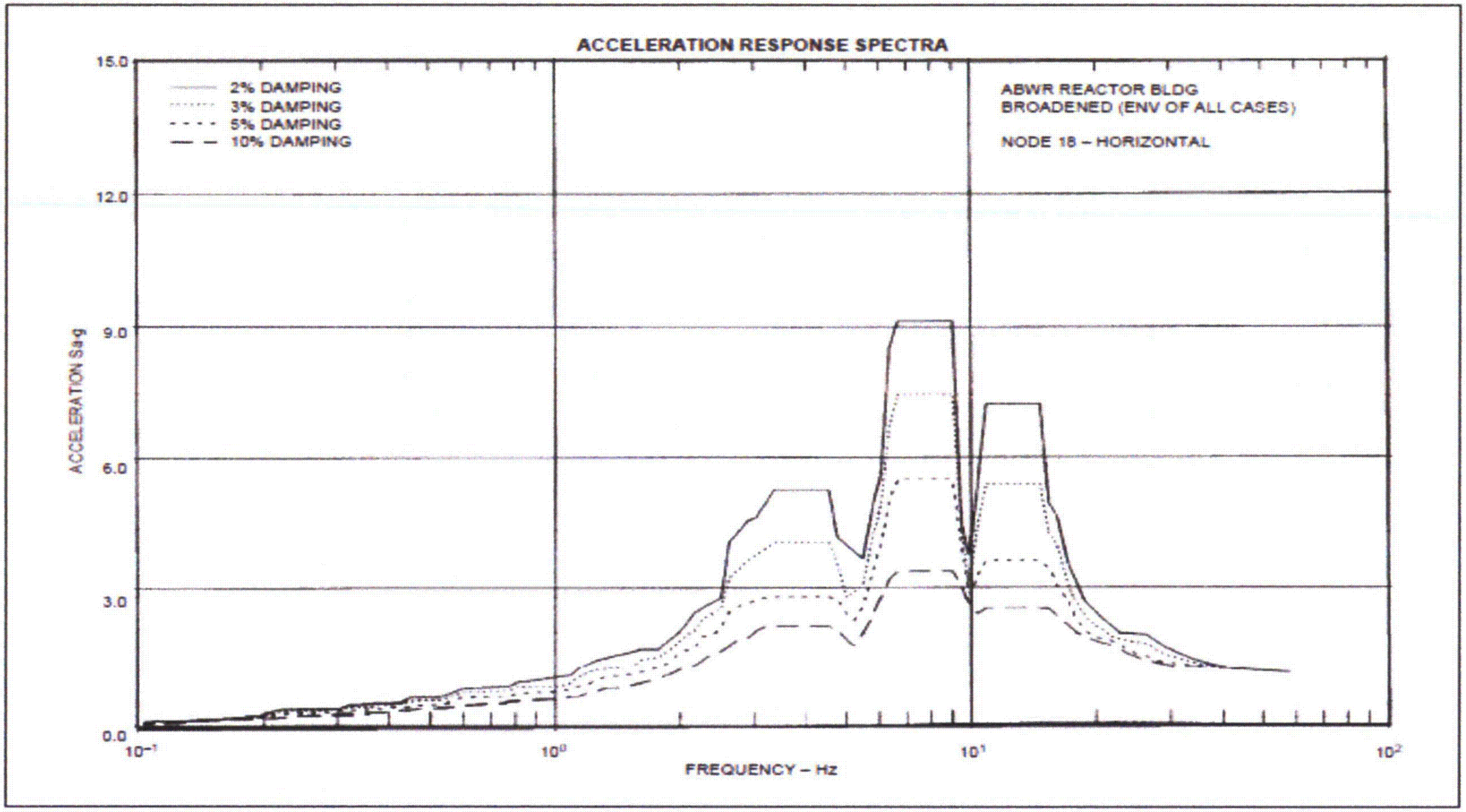


Figure 3A-129 ABWR Reactor Bldg. Broadened (Env of all Cases) Node 18–Horizontal

Figure 7

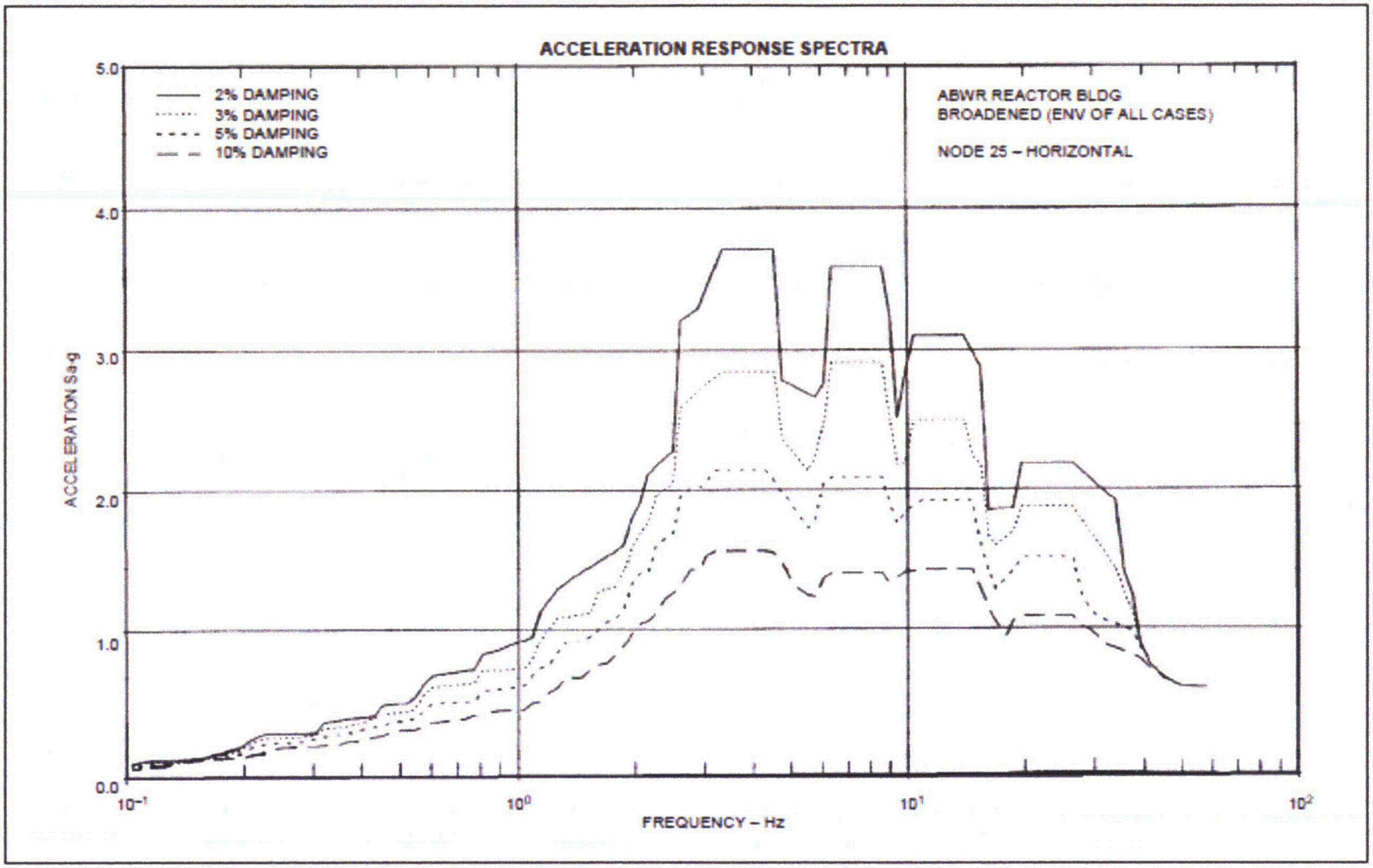


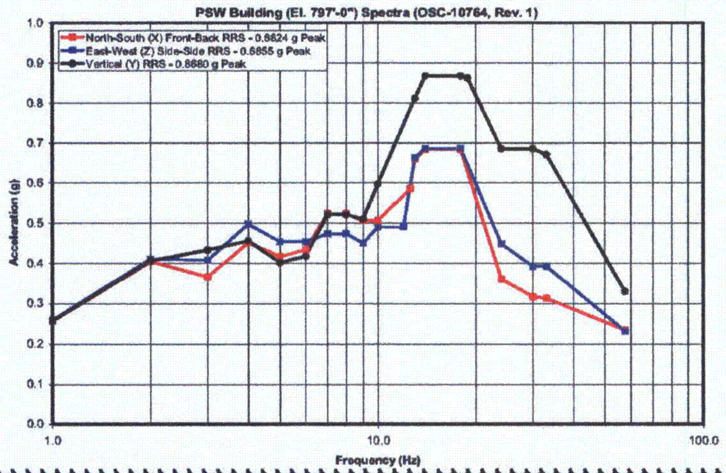
Figure 3A-130 ABWR Reactor Bldg. Broadened (Env of all Cases) Node 25–Horizontal

Figure 8

Table 6
Digitized Spectra Based on Curves in [2.4.2]
5% RRS, PSW Building (797'-0") - Concrete Floor (Nodes 1 & 3), OSC-10764, Rev. 1

Plant: North/South (X) Test: Front-Back RRS		Plant: East/West (Z) Test: Side-Side		Plant: Vertical (Y) Test: Vertical	
Frequency	Acceleration	Frequency	Acceleration	Frequency	Acceleration
1.0 Hz	0.2565 g	1.0 Hz	0.2582 g	1.0 Hz	0.2569 g
2.0 Hz	0.4033 g	2.0 Hz	0.4098 g	2.0 Hz	0.4057 g
3.0 Hz	0.3656 g	3.0 Hz	0.4070 g	3.0 Hz	0.4331 g
4.0 Hz	0.4504 g	4.0 Hz	0.4966 g	4.0 Hz	0.4555 g
5.0 Hz	0.4161 g	5.0 Hz	0.4527 g	5.0 Hz	0.4018 g
6.0 Hz	0.4330 g	6.0 Hz	0.4527 g	6.0 Hz	0.4174 g
7.0 Hz	0.5225 g	7.0 Hz	0.4729 g	7.0 Hz	0.5207 g
8.0 Hz	0.5225 g	8.0 Hz	0.4729 g	8.0 Hz	0.5207 g
9.0 Hz	0.5055 g	9.0 Hz	0.4485 g	9.0 Hz	0.5093 g
10.0 Hz	0.5055 g	10.0 Hz	0.4888 g	10.0 Hz	0.5970 g
12.6 Hz	0.5844 g	12.0 Hz	0.4888 g	13.0 Hz	0.8113 g
13.0 Hz	0.6586 g	13.0 Hz	0.6622 g	14.0 Hz	0.8680 g
14.0 Hz	0.6824 g	14.0 Hz	0.6855 g	18.0 Hz	0.8680 g
18.0 Hz	0.6824 g	18.0 Hz	0.6855 g	18.9 Hz	0.8626 g
24.0 Hz	0.3595 g	24.0 Hz	0.4475 g	24.0 Hz	0.6850 g
30.0 Hz	0.3160 g	30.0 Hz	0.3917 g	30.0 Hz	0.6850 g
33.0 Hz	0.3120 g	33.0 Hz	0.3917 g	33.0 Hz	0.6706 g
57.5 Hz	0.2334 g	57.5 Hz	0.2309 g	57.5 Hz	0.3291 g

Note: The frequencies and corresponding accelerations above in Table 6 provide better defined spectral curves shown in Figure 9 below than the original values presented on Page 36. The accelerations were paired with conservative approximations of corresponding frequency values.



D2

Note: See Rev.1 for previous data.

Figure 9
Enveloping RRS (5%) Based on Curves in [2.4.2]

Figure 9

RAI-186 [EMCB9]

Calculation OSC-10824 has been referenced in the licensee letter dated April 5, 2013, for evaluation of the impact of the new ISRS on seismic qualification of the PSW components.

a. As noted in the conclusion section of calculation OSC-10824, the NGR frame and the battery chargers required further analysis to demonstrate their seismic qualification. Discuss and provide further information regarding seismic qualification of these components.

b. On Page 8 of calculation OSC-10824, it is noted that a fuse block was qualified separately. Discuss the method used for seismic qualification of the fuse block and provide further information on consideration of the in-cabinet amplification in the seismic qualification of the fuse block.

c. On Page 18 of calculation OSC-10824, for evaluation of 13.8kV and 4160V Switchgear, on Page 28 for evaluation of manual disconnect switch, on Page 44 for evaluation of 600V load center, and on Page 49 for evaluation of 5MVA transformer, it is noted that related qualification calculations leverage the peak acceleration level and for all locations at Elevation 797', the peak accelerations have decreased. Discuss and provide further clarification on how the peak acceleration level was leveraged to demonstrate seismic qualification of these components.

Duke Energy Response

a. BATTERY CHARGER

The Battery Charger was originally qualified as a complete assembly by shake table testing and therefore included a seismic capacity based on the shake table Test Response Spectrum (TRS). The new In-Structure Response Spectrum (ISRS) in OSC-10764 Revision 1 exceeded this originally supplied seismic capacity below approximately 7Hz in the vertical direction and below 2Hz in the Horizontal direction. Since the lowest natural frequency of the enclosure was 10Hz, the seismic qualification of the enclosure was not affected by the new ISRS and the seismic qualification of the enclosure remained acceptable. Therefore only the electrical components within the enclosure required further analysis. The original equipment vendor (Ametek) provided an addendum to the seismic qualification report which included previously obtained seismic test data incorporating all of the safety related switches, power supplies and relays contained within the battery charger enclosure. This previous test was performed by placing multiple relays, power supplies and terminal blocks on a test panel and this panel was mounted directly to the shake table. The panel was then subjected to multiple OBE and SSE tests while being monitored for contact chatter and if appropriate, proper operation. The resultant seismic capacity from this test was then compared to the incabinet demand at the appropriate location and axis from the PSW Battery Charger and the capacity was shown to far exceed the in-cabinet demand.

NGR FRAME

The NGR frame was originally qualified via a static analysis. The previous acceleration used was based on the acceleration at the structural natural frequencies of the NGR

Frame. The new ISRS in OSC-10764 Revision 1 resulted in a minor shift in the frequency peaks, which resulted in an increase in the acceleration values at these specific structural natural frequencies. The Vendor Seismic Report was therefore revised by Duke Energy to account for the increased acceleration. All impacted calculations within this Vendor Seismic Report were repeated using this increased acceleration value and the final margin was recalculated. The equipment was shown to have sufficient margin to address this increase in acceleration without further analysis.

b. Subsequent to the original seismic qualification of the Control Panel, it was determined that a Fuse and Fuse Block was required. A supplemental seismic test was performed by mounting the Fuse and Fuse Block directly to the shake table and subjecting it to an amplified Required Response Spectra (RRS). This amplified RRS was based on and bounds the In-Cabinet TRS measured at the Fuse and Fuse Block location during Test #15. This accounts for the effects of In-Cabinet amplification and allows the Fuse and Fuse Block to be tested separately without having to install them in a test enclosure and test the entire assembly. This additional seismic test was performed while electrically loaded and monitored for continuity. The results were an additional set of TRS data for the Fuse and Fuse Block. However, since the amplified RRS for the Fuse and Fuse Block is based on and bounds the In-Cabinet TRS from Test #15, the Test #15 shake table TRS can be used for the capacity and directly compared to the new ISRS demand from OSC-10764 Revision 1. The new ISRS from OSC-10764 was fully enveloped by the shake table TRS from Test #15, therefore the amplified in-cabinet response from Test #15 is bounding. Calculation OSC-10824 Revision 1 is used to show that this capacity vs. demand comparison was performed and the results are in Figures 3 and 4.

c. In all of the cases cited in this NRC question, the original seismic reports contained auxiliary components that were qualified separately via a static analysis. The acceleration used was the peak of the In-Structure Response Spectrum (ISRS) that was supplied with the procurement specification, multiplied by an appropriate amplification factor. For example, in the 5MVA Transformer, non-safety related thermostats were added to the enclosure that required a mounting qualification. As part of the original mounting qualification, an in-cabinet amplification factor was used along with the peak ISRS acceleration to determine the loading on the mounting screws. Calculation OSC-10824 Revision 1 is therefore being used to document that since the peak ISRS accelerations at this location under OSC-10764 Revision 1 are lower than the ISRS used to perform the original qualification, the previously determined inertial loading is bounding and does not need to be recalculated.

RAI-187 [EMCB10]

The licensee indicated that the use of response spectrum anchored at 0.15g (Maximum Hypothetical Earthquake for soil) for the design of the PSW Building is consistent with what was used for the design of the CT4 Block Houses, the only other ONS seismic Category 1 structures founded on the overburden. Discuss and provide further information regarding the variation of the subsurface soil condition at the CT4 Block Houses and the PSW building.

Duke Energy Response

The Protected Service Water (PSW) system is not classified as a "safety system" in that it is not required to mitigate design basis events (such as a Loss of Coolant Accident). The PSW system was designed to mitigate events that could occur in the ONS Turbine Building (TB) that could result in the loss of all 4160V power. Seismic design criteria at the Oconee Nuclear Station (ONS) is applied to those structures, systems, and components which are essential to

the prevention or mitigation of design basis events. Duke Energy has designed and is implementing the PSW system in accordance with Duke Energy quality standards that are applied to safety-related systems (QA-1). While the PSW system has been designed to withstand seismic loading there was no requirement to do so since the system is not required to mitigate a design basis event. However, the safety related Keowee Emergency Start cables, although not related to PSW system, are routed through the lower portion of the PSW Building.

The PSW Building is classified as a Class 1 structure (as opposed to Category 1) since it houses portions of the PSW electrical system. The PSW system provides defense in depth for the functions provided by the Standby Shutdown Facility (SSF). Since the SSF building is a Class 1 structure, the PSW Building was similarly classified. Class 1 structures are defined in UFSAR section 3.2.1.1.1 as those structures which prevent the uncontrolled release of radioactivity. The PSW Building itself does not directly prevent the release of radioactivity. The building houses no radioactive systems or components. However, Duke Energy designed the PSW system and building to QA-1 standards. The PSW building was designed as a Class 1 structure because it houses electrical systems and components that, together with other PSW systems and components, provides defense in depth for the functions provided by the SSF. In addition, the PSW building was designed as a Class 1 structure because it houses the Keowee Emergency Start Cables. Finally, the building was designed as a Class 1 structure in order to enhance the quality attributes of the system and the building.

To meet the design requirements of a Class 1 structure, the building was designed for the 0.15g Maximum Hypothetical Earthquake (MHE) ground acceleration for Class 1 structures founded on fill or overburden. The Class 1 design requirement was incorporated into the ONS Preliminary Safety Analysis Report (PSAR) at the recommendation of the Atomic Energy Commission (AEC) and its consultants (Reference response to question 2.7, Dockets 50-269 & 270, Supplement No. 1 – dated April 1, 1967). This was supported by the Safety Evaluations by the AEC, Docket Nos. 50-269, -270, and -287 dated August, 1967 (App. E) and Docket No. 50-269 dated December 29, 1970 (pgs. 8-9). These references are available on the share point. It was understood that the 0.15g MHE ground acceleration value was representative of overburden at the site as a whole, and thus considered and incorporated the variability of overburden parameters found throughout the site.

Prior to the construction of the ONS site, soil boring(s) were made to determine the subsurface properties of the natural ground at the site (Reference UFSAR Figure 2-65). In addition, significant site work was required to excavate material for setting the foundation of the various buildings and leveling of the powerhouse yard, including the area where the PSW building is presently located. During the original construction of the TB, the natural ground was excavated down to bedrock, as noted in UFSAR Figure 2-57 (note the line of the TB basement at EL. 771-0" on the figure). The TB basement and walls were constructed and subsequently backfilled with engineered fill to the yard elevation of 796'-0". The CT-4 slab and building were then constructed on the fill.

In the RAI-141 submittal of April 5, 2013, Duke Energy described the CT-4 Blockhouse as being similar to the PSW building insofar as both were designed as Class 1 structures founded on fill. In consideration of the NRC request provided by this RAI to compare the subsurface properties under CT-4 with those under the PSW building, a direct comparison is not possible because the available subsurface properties at CT-4 reflect those made to determine the subsurface properties of the natural ground, prior to any site work or construction at the ONS site.

RAI-188 [SBPB1]

As stated in the LAR, the PSW system is designed as a backup system with capability to achieve and maintain a safe shutdown condition. In order to accomplish this, all components necessary to achieve and maintain safe shutdown via the PSW system must be capable of performing their intended function in the environment associated with their location. This capability should be ensured for the duration of the PSW system mission time.

The response to RAI 170 stated that the proposed Alternate Chilled Water system will provide cooling water and power to existing ventilation equipment, ensuring the auxiliary building environment supports extended operation of the PSW system.

Provide the following additional information regarding the Alternate Chilled Water system:

- Describe the water source for Alternate Chilled Water and the need for makeup during operation;
- Describe the power supply for Alternate Chilled Water;
- Will availability of the Alternate Chilled Water system be monitored under existing plant procedures;
- Describe the major inputs and assumptions for the analyses used to determine the auxiliary building temperature response with PSW and Alternate Chilled Water in service;
- Describe the process used to determine that PSW components are qualified for the expected auxiliary building environment.

Duke Energy Response

Each request of this RAI is divided into a separate response. These responses apply for PSW in support of NFPA-805 and High Energy Line Break (HELB).

1. Describe the water source for Alternate Chilled Water and the need for makeup during operation:

   Auxiliary Building and Control Complex Alternate Cooling will be provided by a closed loop chilled water system. This modification is still under development with Plant Drinking Water (PDW) used as the primary source of makeup water. PDW is supplied by the local municipality and requires no station support. Planned alternate sources are High Pressure Service Water, Demineralized Water and make up from the diesel driven pump supplying water to Reactor Building Cooling Units.

2. Describe the power supply for the Alternate Chilled Water:

   Refer to RAI 172 for description of the PSW Alternate Cooling electrical system.

3. Will availability of the Alternate Chilled Water system be monitored under existing plant procedures:

PSW System Alternate Cooling is being designed to utilize existing equipment and new equipment. Modifications to install the additional equipment required for PSW Alternate Cooling have not been completed.

Development of inspection, testing and availability/reliability requirements for PSW Alternate Cooling including the Alternate Chilled Water system will be directed by Duke Energy processes and procedures. These processes include:

- NSD 301, Engineering Change Program
- NSD 408, Testing
- NSD 411, Preventive Maintenance Program
- NSD 310, Requirements for the Maintenance Rule

4. Describe the major inputs and assumptions for the analyses used to determine the auxiliary building temperature response with PSW and Alternate Chilled Water in service;

Maximum temperature in the Auxiliary Building and Control Complexes is determined through GOTHIC modeling. Specific temperatures for areas depend on many factors including the operator recovery times and specific ventilation equipment that is assumed to be operating. The GOTHIC model has been developed as described below and various cases have been developed beginning with no forced ventilation equipment operating. While final temperature conditions have not been determined, work to date indicates some forced ventilation equipment is required.

Assumptions and major inputs are found within the calculations developed or under development that provide the basis for the GOTHIC model. The inputs, assumptions and methodology of the temperature evaluation continue to be refined. The results of cases evaluated in the GOTHIC model are used when comparing expected room ambient temperatures with equipment temperature ratings. Inputs to the model were developed as described in the proceeding sections.

1) Geometric information was collected for analyzed areas. This information was collected through review of drawings and/or walkdown of the areas. This included information such as room/area dimensions, materials of construction and openings through boundaries of the rooms. Information for this step will be documented in the following calculations:

Geometric data 12-101 (OSC-7931, approved, Auxiliary Building Data Collection for Gothic Model)

2) Heat load information was collected for the analyzed areas. This included information such as passive heat loads (residual heat from equipment in-service prior to the event but not active during the event) and active heat loads (heat from equipment in-service during the event). Examples of passive heat loads include electric motors at rest and stagnant pipe with hot fluid that cools over time. Examples of active heat loads include operating electric motors, inservice piping systems with hot fluid and cable heat loads. The scope of passive equipment includes equipment operating in analyzed areas prior to the event. The scope of active loads include new and existing equipment operating to mitigate the PSW event. Information for this step will be documented in the following calculations:

AB Heat Load 12-071 (OSC-7932, Rev. 1 unapproved but will be completed in support of Milestone 5, Auxiliary Building Heat Load Development for GOTHIC Analysis of Protected Service Water Pump PSW Scenarios)

Supporting Calculations:

- OSC-10493, approved, Protected Service Water (PSW) System Suction Supply Availability and Temperature Evaluation
- OSC-10648, approved, Auxiliary Building Heat Up Analysis For Protected Service Water Events- Pre-Event Operating Mechanical Systems/Equipment
- OSC-10653, approved, Auxiliary Building Heat Up Analysis For Protected Service Water Events- Pre-Event Operating Electrical Systems/Equipment Unit 1
- OSC-10654, approved, Auxiliary Building Heat Up Analysis For Protected Service Water Events- Pre-Event Operating Electrical Systems/Equipment Unit 2
- OSC-10655, approved, Auxiliary Building Heat Up Analysis For Protected Service Water Events- Pre-Event Operating Electrical Systems/Equipment Unit 3
- OSC-10657, approved, Heat Load input Calculation for PSW Equipment in the Auxiliary Building
- OSC-11069, approved, 13-170 Ventilation Room 600/208V MCCs and Transformer Heat Load Analysis For a PSW Event
- OSC-11068, approved, 13-270 Additional Heat Load for Critical Room Cooling During Protected Service Water (PSW) Events

Control Complex Heat Load 12-336 (OSC-7935, unapproved but will be completed in support of Milestone 5)

3) Ductwork models were developed for the analyzed areas. This included documenting ductwork physical length, size and fan head curves of credited duct systems. Flow distribution through the duct systems was modeled to match either test data, design flows or estimated flow based on the information available.

AB QA Duct Work Model NAI-1727-002 (OSC-10973, unapproved but will be completed in support of Milestone 5)

Control Complex Duct Work Model NAI-1727-001 (OSC-10972, approved)

Supporting Calculations:

- OSC-1579, approved, Oconee Nuclear Station Atmospheric Pressure For Design Calculations

4) A base case GOTHIC model was developed with inputs from above. A base GOTHIC case was created with details for each room including the volumes, external and internal thermal conductors, and natural circulation flow paths. Heat loads and other scenario specific information are not included in this base model.

Base Case Gothic Model NAI-1652-001 (OSC-7933, unapproved but will be completed in support of Milestone 5) Auxiliary Building GOTHIC Heat Up Analysis Based Model

Supporting Calculations:

- OSC-10347, approved, Temperature Evaluation for West Penetration Room and Cask Decontamination Room
- OSC-5501, approved, Containment Response Following a Loss of All A.C. Power
- OSC-2790, approved, HVAC Calculations for Chillers A&B
- OSC-9936, approved, Auxiliary Building PSW Pump Room Exhaust Fan Sizing

5) A final GOTHIC model was developed from the GOTHIC base case and used to evaluate different scenarios or cases. Case specific heat sources, boundary conditions, initial conditions and other scenario specific parameters are included in the cases evaluated with the model. Cases were created to investigate the effect of reduced heat loads and additional manual actions to enhance flow. Within Case 6, forced cooling was restored to the Control Complexes. Case 7 analyzes area temperatures with the use of forced cooling in the Auxiliary Building and Control Complexes.

Case 6 Model NAI-1652-002 Rev. 1 (OSC-7934, approved) Auxiliary Building GOTHIC Heat Up Analysis - PSW Event Cases (Auxiliary Building analyzed only)

Case 7 Model NAI-1652-002 Rev. 2 (OSC-7934, approved) Auxiliary Building GOTHIC Heat Up Analysis - PSW Event Cases (Auxiliary Building and Control Complex)

Supporting Calculations:

- OSC-10767, approved, HPI Pump Cycling Frequency
- OSC-10785, approved, GOTHIC Containment Analysis Utilizing the Protected Service Water (PSW) System
- OSC-10651, approved, Event Mitigation with Protected Service Water (PSW)

5. Describe the process used to determine that PSW components are qualified for the expected auxiliary building environment:

Through the Engineering Change process, Auxiliary Building and Control Complex PSW System Alternate Cooling will be sized to maintain temperatures in areas containing equipment required for PSW System operation below temperatures needed to ensure equipment operation as outlined below.

For the Auxiliary Building and Control Complexes, equipment temperature limits have been determined for new equipment added as part of the PSW System modification and also for existing equipment in the Auxiliary Building and Control Complexes that will support the PSW System. Based on the rate of temperature rise for the equipment areas, operator manual action times to start the PSW Alternate Cooling systems are being determined to ensure the equipment design temperatures are maintained. Verification that equipment temperature limits are not exceeded for equipment supporting PSW and located within the Auxiliary Building and Control Complexes is being performed by comparison of predicted area temperatures to equipment design temperature limits. This verification is being documented in the following Duke Energy calculation:

PSW Auxiliary Building Equipment Temperature Verification (OSC-11083, to be developed, but will be completed in support of Milestone 5)

Supporting Calculations:

- OSC-10651, approved, Event Mitigation with Protected Service Water (PSW)
- OSC-10682, approved, Non-PSW Installed Auxiliary Building Electrical Equipment That Supports PSW System
- OSC-7917, approved, PSW Equipment Temperature Ratings Installed in the Auxiliary Building
- Case 7 Model NAI-1652-002 Rev. 2 (OSC-7934, approved) Auxiliary Building GOTHIC Heat Up Analysis - PSW Event Cases (Auxiliary Building and Control Complex)

RAI-189 [SBPB2]

The Alternate Chilled Water system is credited to ensure extended operation of the PSW system. Therefore, Alternate Chilled Water should remain functional during any event where the PSW system is credited for mitigation.

Describe how components of the Alternate Chilled Water system are routed or protected such that events crediting PSW for mitigation will not result in unavailability.

Duke Energy Response

The PSW system is designed to mitigate events in the Turbine Building such as fires or high-energy line breaks (HELBs). The Alternate Chilled Water (AWC) system, which cools the Control Complex and Auxiliary Building, is being designed in accordance with the requirements of NFPA 805. The AWC piping, power and control cables, and equipment will be located outside the Turbine Building envelope. The power supply for the chillers and air handling units will originate from the PSW electrical system which is located outside the Turbine Building.

Containment cooling is being designed in accordance with the requirements of NFPA 805 and will be provided by utilizing portions of the Low Pressure Service Water (LPSW) system. Cooling water is supplied by diesel engine driven pumps taking suction from the lake. The pumps, piping, and power and control cables, are located outside the Turbine Building. The power supply for the Reactor Building Cooling Units (RBCU) will originate from the PSW electrical system which is located outside the Turbine Building.

In order to align lake water through the RBCUs, it is necessary to isolate the LPSW headers in the Turbine Building using the existing manual valves. There are no direct HELB effects in the vicinity of these manual valves, and, based on preliminary analysis, there is adequate time available to clear the Turbine Building for entry, operate the LPSW manual valves and place containment cooling in operation before the qualification temperature limits of the credited components inside containment are approached.

In conclusion, these systems are inherently protected from the effects of an event inside the Turbine Building due to their location outside the Turbine Building envelope.

ATTACHMENT 1

Revised PSW UFSAR

9.7 Protected Service Water System

9.7.1 General Description

The Protected Service Water (PSW) system is designed as a standby system for use under emergency conditions. The PSW system provides added "defense in-depth" protection by serving as a backup to existing safety systems and as such, the system is not required to comply with single failure criteria. The PSW system is provided as an alternate means to achieve and maintain safe shutdown conditions for one, two or three units following certain postulated scenarios. The PSW system reduces fire risk by providing a diverse power supply to power safe shutdown equipment in accordance with the National Fire Protection Association (NFPA) 805 safe shutdown analyses. The PSW system requires manual activation and can be activated if normal emergency systems are unavailable.

The function of the PSW system is to provide a diverse means to achieve and maintain safe shutdown by providing secondary side decay heat removal, RCS pump seal cooling, RCS primary inventory control, and RCS boration for reactivity management following plant scenarios that disable the 4160V essential electrical power distribution system. Following achieving safe shutdown, a plant cooldown is initiated within 72 hours of event initiation. The PSW system is not an Engineered Safety Feature Actuation System (ESFAS) and is not credited to mitigate design basis events as analyzed in UFSAR Chapters 6 and 15. No credit is taken in the safety analyses for PSW system operation following design basis events. Based on its contribution to the reduction of overall plant risk, the PSW system satisfies Criterion 4 of 10 CFR 50.36 (c)(2)(ii) and is therefore included in the Station Technical Specifications.

Core decay heat removal is provided by feeding the steam generators from the PSW pumps (booster and high head pumps) via PSW flow control valves. Core reactivity is controlled in a safe manner by injecting borated water from the borated water storage tank (BWST) into the RCS to maintain adequate shutdown margin. RCS inventory control is provided by existing plant equipment that can be selectively powered from the PSW Electrical Distribution System. Specifically, one High Pressure Injection (HPI) pump (either "A" or "B"), the associated suction valve from the BWST (HP-24), the RCP seal injection flow control valves (HP-139 and HP-140), and the "A" HPI injection valve (HP-26) can be powered from PSW to provide RCS makeup. RCS letdown can be provided by repowering the Reactor Vessel (RV) Head Vents (RC-159 and RC-160) and the RCS Loop High Point Vent Valves (RC-155, -156, -157, -158) and repositioning the valves as needed to control RCS inventory. These valves are capable of being supplied with electrical power from the PSW switchgear. Manual power transfer control switches for these components are located in each respective unit's control room.

The PSW Electrical Distribution System can be used to repower a number of pressurizer heaters to establish and maintain a steam bubble in the pressurizer to aid in RCS pressure control. Selected pressurizer heaters with a nominal combined capacity of ≥400 KW are capable of being supplied with electrical power from the PSW switchgear. Manual power transfer switches for these components are located in each respective unit's East Penetration Room.

The PSW Electrical Distribution System also supplies power to the Vital Instrumentation and Control (I&C) Battery Chargers to maintain electrical power on the vital I&C buses. The PSW Electrical Distribution System can also be aligned to supply power to the Standby Shutdown Facility (SSF) Electrical Distribution System should the normal and emergency power sources to the SSF be lost.

The PSW system does not provide the primary success path for core decay heat removal following design basis events and transients. The Emergency Feedwater (EFW) System serves as the primary success path for design basis events and transients in which the normally operating main feedwater system is lost and the steam generators are relied upon for core decay heat removal. The PSW system serves as a backup to the EFW system and adds a layer of defense-in-depth to the SSF Auxiliary Service Water (ASW) System, which also serves as a backup to the EFW system.

The PSW system reduces fire risk by providing a diverse QA-1 power supply to power safe shutdown equipment thus enabling the use of plant equipment for mitigation of certain fires as defined by the ONS Fire Protection Program. For certain scenarios inside the Turbine Building (TB) resulting in loss of 4160V essential power, either the SSF or PSW system is used for reaching safe shutdown. The PSW system can achieve and maintain safe shutdown conditions for all three units for an extended period of operation during which time other plant systems required to cool down to MODE 5 conditions will be restored and brought into service as required. Similar to the SSF, the PSW system is equipped with a portable pumping system that may be utilized as necessary to replenish water to the Unit 2 embedded Condenser Circulating Water (CCW) piping. The water in the Unit 2 embedded CCW piping is used as a suction source for the PSW system. Electrical power is supplied from the PSW electrical system. The PSW portable pump is located in an onsite storage location. The portable pumping system is not expected to be necessary unless there is a prolonged use of the PSW system to feed the steam generators. Should there be a prolonged use of the PSW system, the portable pumping system would be used to replenish the water in the CCW piping since the PSW system takes suction off the CCW pipe at its low point in the Unit 2 Auxiliary Building.

The PSW system consists of the following:

1. PSW building and associated support systems.
2. Conduit duct bank from the Keowee Hydroelectric Station underground cable trench to the PSW building.
3. Conduit duct bank and raceway from PSW Building to Unit 3 Auxiliary Building (AB).
4. Conduit duct bank from PSW Building to SSF trench and from SSF trench to SSF.
5. Electrical power distribution system from breakers at Keowee Hydro Units (KHUs) and from breakers connecting the PSW building to the Central Tie Switchyard, and from there to the AB and SSF.
6. PSW booster pump, PSW primary pump, and mechanical piping taking suction from Unit 2 embedded CCW System to the EFW headers supplying cooling water to the respective unit's SGs and HPI pump motor bearing coolers.
7. PSW portable pumping system.
8. PSW pump room exhaust fan (in AB).

Portions of the PSW System are credited to meet the Extensive Damage Mitigation Strategies (B.5.b) commitments, which have been incorporated into the Oconee Nuclear Station operating license Section H - Mitigation Strategy License Condition.

The PSW mechanical system is shown on Figure 9.44. The interface of the PSW system and the EFW system is shown on Figure 10.8. The PSW AC electrical distribution system is shown on Figure 9.45. The PSW DC electrical distribution system is shown on Figure 9.46.

In order to ensure PSW/HPI mitigating component design temperature limits will not be exceeded during PSW/HPI System operation, alternate cooling water and power to the existing ventilation systems is provided to recover from the potential loss of ventilation to the AB and RB (refer to Section 9.7.3.4.5).

9.7.2 Design Bases

The design criteria for the PSW System are as follows:

- Major PSW components are Duke Energy Quality Assurance Condition 1 (QA-1). Components that receive backup power from PSW or systems that connect to PSW retain their existing seismic and quality classifications.
- Maintain a minimum water level above the reactor core and maintain Reactor Coolant Pump Seal cooling. In addition, maintains Reactor Coolant System subcooling for fire scenarios.
- Provide steam generator secondary side cooling water from Lake Keowee to promote natural circulation core cooling.
- Transfer decay heat from the RCS by steaming the steam generator(s) (SGs) to atmosphere.
- Maintain $K_{eff} < 0.99$ after all normal sources of RCS makeup have become unavailable, by providing makeup via the HPI system which supplies makeup of a sufficient boron concentration from the BWSTs.
- Control of PSW primary and booster pumps, motor operated valves and solenoid valves, required to bring the system into service are controlled from the Main Control Rooms (MCRs).

9.7.3 System Description

9.7.3.1 Mechanical

The mechanical portion of the PSW system is designed to provide decay heat removal by feeding Keowee Lake water to the secondary side of the steam generators. The system, consisting of one booster pump and one primary (high-head) pump, is designed to provide 375 gpm per unit at 1082 psig with SG pressure at the lowest relief valve lift set point. In addition, the system is designed to supply Lake Keowee water at 10 gpm per unit to the HPI pump motor bearing coolers. Refer to Figures 9-44, and 10-8 for more information.

The PSW system utilizes the inventory of lake water contained in the plant Unit 2 CCW embedded piping. The PSW pumps are located in the AB at Elevation 771'. The PSW booster pump takes suction from the Unit 2 CCW embedded piping and with the aid of the PSW primary pump, discharges into the SG(s) of each unit via separate lines into the emergency feedwater headers. The raw water is vaporized in the SG(s) removing residual heat and discharged to the atmosphere. For extended operation, a portable pump can be utilized via recovery actions to pump water directly from Lake Keowee to the Unit 2 CCW embedded piping.

During periods of very low decay heat the PSW system will be used to establish conditions that support the formation of subcooled natural circulation between the core and the SGs; however, natural circulation may not occur if the amount of decay heat available is less than or equal to the amount of heat removed by ambient losses to containment and/or by other means, e.g., letdown of required minimum HPI flow through the RCS vent valves. When these heat removal mechanisms are sufficient to remove core decay heat, they are considered adequate to meet the core cooling function and systems supporting SG decay heat removal, although available, are not necessary for core cooling.

The piping system has pump minimum flow lines that discharge back into the Unit 2 CCW embedded piping. For flow testing to the steam generators, the system is connected to a condensate water source located in the TB that is normally isolated using valves in the AB.

The PSW pumps are controlled from the Unit 2 main control room. Electrically operated valves, used to control flow to the SGs, are controlled from each unit's control rooms. PSW transfer switches for the HPI motor and motor operated valves, required to operate the system, are located in each unit's respective control room. Check valves and manual handwheel operated valves are used to prevent back-flow, accommodate testing, or are used for system isolation during system maintenance. Pumps and valves in the system are ASME Section III Class 3. Piping is designed to the 1967 Edition of USAS B31.1 (Reference 11). The PSW System piping is classified as Oconee Class F.

In service testing of pumps and valves are accomplished in accordance with the provisions of ASME Section XI and ONS's In-Service Test (IST) program, except for the portable pump. The portable pump is tested periodically to verify flow capability. A recirculation flow path and instrumentation is available for testing of the PSW Booster and PSW Primary Pumps. Active motor operated valves are included in the ONS Generic Letter (GL) 89-10 monitoring program.

9.7.3.2 Electrical

The PSW electrical system is designed to provide power to PSW mechanical and electrical components as well as other system components needed to establish and maintain a safe shutdown condition. The system is designed with adequate capacity and capability to supply the necessary loads and is electrically independent from the station electrical distribution system.

A separate PSW electrical equipment structure (PSW building) is provided for major PSW electrical equipment. Normal power is provided from the Central Tie Switchyard via a 100 kV transmission line to a 100/13.8 kV substation located adjacent to Oconee Nuclear Station (ONS) and then via a 13.8 kV feeder that enters an underground ductbank leading to the PSW building. This power path from the Central Tie Switchyard to the PSW Switchgear is non QA-1. Alternate QA-1 power is provided from the KHUs via a tornado protected underground path. These external power sources provide power to transformers, switchgear, breakers, load centers, batteries, and battery chargers located in the PSW electrical equipment structure (PSW building). The PSW DC system consists of two (2) batteries, two (2) battery chargers, a distribution center and panelboards. Either battery can be aligned to either battery charger. Refer to Figures 9-45 and 9-46 for additional information.

The power system provides primary or backup power to the following:

- PSW booster pump
- PSW primary pump
- Required 125 VDC Vital I&C Normal Battery Chargers (CA & CB)
- One HPI pump (either "A" or "B") motor per unit
- HPI valves needed to align the HPI pumps to the BWSTs
- HPI valves and instruments that support RCP seal injection and RCS makeup
- RCS and Reactor Vessel Head high point vent valves
- Portable pump (if not self-powered)
- Select groups of pressurizer heaters (nominal capacity in excess of 400 KW)
- Standby Shutdown Facility (SSF)

The PSW Electrical Distribution System does not provide the primary success path for supplying electrical power to systems and components used to mitigate design basis events and transients. The two main feeder buses and the three Engineered Safeguards (ES) power strings are designed to provide sufficient capacity, capability, redundancy, and reliability to ensure the availability of necessary power to ES systems so that the fuel, RCS, and containment design limits are not exceeded. The main feeder buses and the ES power strings are the primary success path, consistent with the initial assumptions of the accident analyses, and are credited to meet the design basis of the unit. The PSW Electrical Distribution System serves as a backup source of power for certain components normally powered from the three ES power strings.

9.7.3.2.1 Electrical Separation Criteria

The PSW electrical power distribution system has only one train; however, the PSW Primary and Booster Pump circuits, and the associated valve circuits in the PSW system are separate to the SSF ASW pump and valve circuits with one exception. The PSW 4.16 kV switchgear has a circuit that can repower the SSF 4.16 kV switchgear in the event the SSF normal and emergency power sources are not available. This circuit is normally electrically isolated from the SSF switchgear. Whenever the PSW 4.16 kV

switchgear is providing power to the SSF, there will no longer be electrical separation between the PSW and SSF electrical systems.

The KHU generator output breakers to the PSW circuits (KPF-9 and KPF-10) are electrically interlocked such that both breakers cannot be closed simultaneously. This feature prevents inadvertent connection of the outputs of KHU-1 and KHU-2, maintaining train separation and preventing potential damage to the generators.

9.7.3.2.2 Electrical Testing Requirements

The electrical power system components are tested consistent with ONS' testing philosophy as described in the fleet nuclear station directives.

9.7.3.3 Instrumentation and Control (I&C)

The PSW system has dedicated instrumentation and controls located in each main control room (MCR) as follows:

- Two (2) high flow controllers (one per SG)
- Two (2) low flow controllers (one per SG)
- Two (2) flow indicators (one per SG)
- One (1) SG header isolation valve
- Two (2) HPI pump power transfer switches
- Power transfer control switches to HPI valves needed to align the HPI System.
- Power transfer control switches for the Reactor Vessel Head and RCS High Point vent valves.

SG parameters and critical reactor coolant system parameters are monitored in the MCRs. The critical reactor parameters needed to support PSW operation are:

- Two (2) Hot Leg Temperature
- Two (2) Cold Leg Temperature
- Twelve (12) Core Exit Thermocouples
- RCS Pressure (Trains A & B)
- RCP Seal Injection Flow
- HPI Injection Flow (Train A)
- Pressurizer Level (Train A & B)
- PSW Flow

9.7.3.4 Support Systems

The PSW Building support systems are designed to provide:

1. Emergency Lighting
2. Fire Protection and Detection
3. Heating, Ventilation, and Air Conditioning
4. Duct Bank and Building Drainage
5. Battery power backup.

9.7.3.4.1 PSW Building Lighting System

The PSW Building lighting system consists of exit/emergency signs, security lighting fixtures, indoor and exterior building lighting.

Emergency DC lighting for the PSW Building is provided by self-contained 12VDC battery pack lighting units. These units are located to provide adequate levels of lighting for control panel operation and for entering and leaving the structure.

9.7.3.4.2 PSW Building Fire Protection and Detection System

Fire protection for the PSW Building is provided by two hose reel stations inside the building and adjacent fire hydrants outside of the building. The hose reels are located such that hose spray can reach any interior portion of the building. The High Pressure Service Water (HPSW) System at the north and south ends of the PSW building supplies the fire protection water. The HPSW system is maintained filled to meet NFPA 805 requirements.

The PSW Building fire detection system consists of a local fire alarm control panel (FACP), a remote fire alarm annunciator panel, photoelectric smoke detectors, heat detectors, an outdoor horn/strobe, indoor horn/strobes and multiple manual pull stations. The system is connected to the Unit 3 FACP via two monitor modules, alarm and trouble. The Unit 3 FACP will alert operators when either module actuates.

9.7.3.4.3 PSW Building Heating Ventilation and Air Conditioning System

The PSW building Heating, Ventilation, and Air Conditioning (HVAC) system consists of two subsystems, a ventilation system and an air conditioning system. The PSW HVAC System supports operation of systems and equipment located in the PSW building by maintaining temperature within design limits. The air conditioning system is normally operating while the ventilation system is in standby. The ventilation system will actuate in the event the air conditioning is lost. Both systems are shut down in event of fire in the building.

The PSW Building HVAC is designed to maintain transformer and battery rooms within their design temperature range. The HVAC System consists of two (2) systems; a non QA-1/non credited system designed to maintain the PSW Transformer and Battery Room's environmental profile and a QA-1/credited system designed to actuate whenever the non QA-1 system is not able to meet its design function.

VENTILATION SYSTEM

The PSW Building Transformer Room and Battery Rooms have independent ventilation systems. These two systems contain exhaust fans, duct heaters, tornado dampers, backdraft dampers, motor-operated dampers, air inlet dampers, and associated ductwork. Ventilation for the Battery Rooms is designed to provide adequate air flow to prevent buildup of hydrogen emitted from charging batteries in accordance with IEEE-484 (Reference 21). Both ventilation systems are located within the PSW Building and protected from tornado loads. The purpose of the ventilation systems is to maintain the PSW Building at temperatures between 60°F and 120°F.

AIR CONDITIONING SYSTEM

The PSW Building Transformer Room and Battery Rooms have independent air conditioning systems. Both systems are similar in that the condensing units are located on concrete pads outside the PSW Building. The transformer space air handling units are mounted on platforms inside the PSW Building east wall. Cooling coils and fans for the Battery Rooms are integral with the Battery Room ventilation system. The purpose of the air conditioning systems is to maintain the PSW Building at approximately 75°F. The air conditioning systems are designed in accordance with ASME AG-1-2003 (Reference 17).

9.7.3.4.4 PSW Building Underground Duct Bank Drainage System

The underground duct banks and manholes associated with the PSW Building are designed and installed to preclude water entry. In the event of water entry, duct bank conduits are sloped to manholes to prevent standing water accumulation. Manholes and duct banks are provided with gravity drains that exit the ductbank or lead to existing yard drains, or in the case of Manhole 7 and the Technical Support Building (TSB) cable vault, to the Radwaste and Interim Radwaste Trenches.

Manhole inspection ports are provided to ensure that the manholes drains are working properly and there is no standing water in the manholes. The inspection ports are located such that the bottom of the manhole is visible and inspection of the manhole interior may be accomplished by video camera without removing the manhole cover. Manhole drain exit points are provided with animal screens. Underground drain fields or dry wells are not used.

9.7.3.4.5 Alternate Cooling for the Reactor and Auxiliary Buildings

Alternate cooling water and power to the existing ventilation systems is provided to recover from the potential loss of normal AB and RB ventilation and to support extended PSW System operation to meet NFPA 805 requirements.

The alternate cooling equipment is included in the QA-5 program in accordance with the Duke Quality Assurance Topical Report as discussed in UFSAR Chapter 17. Existing repowered equipment retains its current quality classification. Cooling water to the RB equipment is supplied from Lake Keowee. Cooling water to the AB is supplied by portable chillers. The equipment is not protected from tornado or external flood damage and is not single failure proof. The equipment is not seismically designed; however, it is designed to preclude interactions with other seismically-designed SSCs during a seismic event.

9.7.3.5 Civil/Structural

9.7.3.5.1 Building Structures

The PSW system is housed in four new QA-1 structures, as follows:

1. PSW Building.
2. Conduit duct banks and manholes connecting the Keowee Underground to the PSW Building.
3. Conduit duct banks, Technical Support Building (TSB) cable vault, Elevated Raceway, and Manhole 7 connecting the PSW Building with the Unit 3 Auxiliary Building (AB).
4. Conduit duct banks connecting Manhole 7 to the SSF cable trench and the SSF trench to the SSF.

The PSW building houses the major electrical equipment. The building is a reinforced concrete structure consisting of a transformer room, a mezzanine, a cable spreading area, and two battery rooms. The building is seismically qualified to the Maximum Hypothetical Earthquake (MHE) and designed to withstand tornado missiles, wind and differential pressure in accordance with Regulatory Guide 1.76, Revision 1 (Reference 7). The following load conditions were considered in the analysis and design:

- Structure Dead Load
- Equipment Loads
- Live Loads
- Normal Wind Loads
- Seismic Loads
- Tornado Wind Loads
- Tornado Missile Loads
- Tornado Differential Pressure Loads

A reinforced concrete conduit duct bank connects the Keowee Underground power path to the PSW building. From the PSW building, a second reinforced concrete conduit duct bank/elevated raceway connects to the Unit 3 AB. A third conduit duct bank connects the PSW Building to the existing SSF cable trench. These structures were seismically qualified to the Maximum Hypothetical Earthquake (MHE) and designed to withstand tornado missiles, wind and differential pressure in accordance with Regulatory Guide 1.76, Revision 1 (Reference 7).

The PSW Building and the three duct banks were designed in accordance with the following codes and standards:

1. ACI 349-97 (Reference 3).
2. AISC Manual of Steel Construction, 13th edition, 2006 (Reference 4).
3. ANSI / AISC, N690-1984 (Reference 5).
4. ASCE 4-98 (Reference 19)
5. NUREG-0800, Chapter 3, Revision 3, March 2007 (Reference 20).
6. Regulatory Guide 1.122, Revision 1, February 1978 (Reference 15).
7. Regulatory Guide 1.142, Revision 2, November 2001 (Reference 6).
8. Regulatory Guide 1.76, Revision 1, March 2007 (Reference 7).
9. Topical Report BC-TP-9A, Revision 2, Bechtel Power Corporation, 1974 (Reference 8).

The existing sections of the Interim Radwaste Trench, which the conduit duct bank/elevated raceway from the PSW Building to the Unit 3 AB connects to, were designed in accordance with ACI 318-63 (Reference 9). The existing sections of the SSF trench, which the conduit duct bank from the PSW Building to the SSF connects to, were designed in accordance with ACI 318-71, "Building Code Requirements for Reinforced Concrete" (Reference 10).

The PSW Building is founded on structural fill (overburden). The Maximum Hypothetical Earthquake (MHE) response spectra used for the design of the PSW Building was Figure 2-55 of the ONS UFSAR in accordance with ONS current licensing basis (UFSAR Section 3.7.1.1 "Design Response Spectra"). The design MHE in-structure response spectra for the PSW Building was generated from the time history record of the North-South, May 1940 El Centro earthquake normalized to a peak ground acceleration of 0.15g for both the vertical and horizontal excitations in accordance with the ONS current licensing basis (UFSAR Section 3.7.1.2 "Design Time History"). The building design in-structure response spectra were developed in accordance with the intent and guidance of Regulatory Guide 1.122 (Reference 15). The dynamic analysis of the PSW Building is made using the STAAD-PRO computer program with amplified response spectra generated at elevations of significant nodal mass.

9.7.3.5.2 Subsystem Seismic Analysis

The PSW mechanical piping system was seismically designed using dynamic modal analysis techniques. The system was modeled using the lumped mass piping analysis program SUPERPIPE. An adequate

number of lumped masses or degrees of freedom are included in the model to determine the response of significant modes. Rigid range acceleration effects are included in the modal analysis. The Oconee Nuclear Station (ONS) earthquake motion is two directional in accordance with UFSAR Section 3.7.2.5. Therefore, the PSW structures, systems and components (SSCs) have been analyzed for maximum horizontal component (either X or Z) and the vertical component (Y) for seismic loads applied simultaneously. Pipe supported from multiple levels or structure is designed for an envelope of the response spectra for all supporting structures. Resulting analysis stresses were evaluated using the ASME USAS B31.1.0, 1967 edition (Reference 11).

The PSW mechanical piping was evaluated for potential effects from non-seismic piping and components that may be proximate to the system.

The PSW HVAC system was designed in accordance with ASME AG-1, 2003 (Reference 17).

PSW piping supports were designed in accordance with the AISC Manual of Steel Construction, 6th edition, 1963 (Reference 12) per UFSAR Section 3.9.3.4.2. Tube steel shapes were designed using AISC 7th Edition (Reference 18) with the equations used reconciled with the 6th Edition.

Cable trays located in the PSW Building, the ONS AB, and the Keowee Hydro Station, installed to support the PSW electrical distribution system, were evaluated by the Seismic Qualification Utility Group Generic Implementation Procedure (SQUG GIP) for Seismic Verification of Nuclear Plant Equipment, Revision 3A (Reference 13).

The structural attachment of equipment within the PSW Building was designed in accordance with the following codes and standards:

1. AISC Manual of Steel Construction for Member Properties, 13th edition, 2006 (Reference 4).
2. Regulatory Guide 1.142, Revision 2, November 2001 (Reference 6).
3. AISI North American Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition (Reference 14).
4. ANSI / AISC N690-1984 (Reference 5).
5. Regulatory Guide 1.122, Revision 1, February 1978 (Reference 15).
6. Regulatory Guide 1.199, November 2003 (Reference 16).
7. OSS-0020.00-00-0006, Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors (Reference 24).

The anchorage of PSW related equipment in the ONS AB was designed in accordance with the following codes, standards, and specifications:

1. For concrete expansion anchors: OSS-0020.00-00-0006, Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors (Reference 24).

2. For grouted anchor bolts: ACI 349-01 (reference 22), ACI 349-06 (reference 23), and Regulatory Guide 1.199 (Reference 16).
3. For steel support frames: AISC Manual of Steel Construction, 6th edition (Reference 12).
4. Member properties for steel support frames: AISC Manual of Steel Construction, 13th edition, 2006 (Reference 4) and AISC Manual of Steel Construction, 14th edition (Reference 25).
5. Evaluation of anchorage loads on ONS AB structural members: ACI 318-63 (Reference 9).

9.7.3.5.3 Dynamic Testing and Analysis of Mechanical Components

As part of the PSW System implementation process, procedures were established for the startup testing of the PSW mechanical system to verify the following information:

1. An "as-built" verification process is used to verify that the piping, components, and piping support/restraints have been erected within the design tolerance.
2. Vibration monitoring was completed to verify that vibration levels for system components during PSW Booster and PSW Primary Pump operations are within acceptable limits.

9.7.4 Safety Evaluation

To verify PSW system performance criteria, thermal-hydraulic (T/H) analysis was performed to demonstrate that the PSW system could achieve and maintain safe shutdown following postulated fires that disable the 4160 V essential power distribution system, without reliance on equipment located in the turbine building. The analysis evaluates RCS subcooling margin using inputs that are representative of plant conditions as defined by Oconee's NFPA 805 fire protection program. The analysis uses an initial core thermal power of 2619 MWth (102% of 2568 MWth) and accounts for 24 month fuel cycles. The consequences of the postulated loss of main and emergency feedwater and 4160 VAC power were analyzed as a RCS overheating scenario. For the examined overheating scenario, an important core input is decay heat. High decay heat conditions were modeled that were reflective of maximum, end of cycle conditions. The high decay heat assumption was confirmed to be bounding with respect to the RCS subcooling response. The results of the analysis demonstrate that the PSW system is capable of meeting the relevant NFPA 805 nuclear safety performance criteria.

During periods of very low decay heat the PSW system will be used to establish conditions that support the formation of subcooled natural circulation between the core and the SGs; however, natural circulation may not occur if the amount of decay heat available is less than or equal to the amount of heat removed by ambient losses to containment and/or by other means, e.g., letdown of required minimum HPI flow through the Reactor Coolant (RC) vent valves. When these heat removal mechanisms are sufficient to remove core decay heat, they are considered adequate to meet the core cooling function and systems supporting SG decay heat removal, although available, are not necessary for core cooling.

Regarding operation in MODES 1 and 2 other than operation at nominal full power, the duration of operation in these conditions is insufficient to result in an appreciable contribution to overall plant risk. As a result, T/H analysis was performed assuming full power initial conditions, as described above and in the Oconee Fire Protection Program, Nuclear Safety Capability Assessment (Reference 2). The plant configuration examined in the T/H analysis is representative of risk significant operating conditions and provides reasonable assurance that a fire mitigated by PSW during these MODES will not prevent the plant from achieving and maintaining fuel in a safe and stable condition.

9.7.5 References

1. Not used (reserved for Nuclear Station Report ONDS-351, "Analysis of Postulated High Energy Line Breaks (HELBs) Outside of Containment," (Rev. 2)).
2. NFPA 805 SER for the Oconee Nuclear Station dated December 29, 2010.
3. American Concrete Institute (ACI) 349-97, "Code Requirements for Nuclear Safety Related Concrete Structures" (and its supplements, except Appendix B).
4. American Institute of Steel Construction (AISC), Manual of Steel Construction, 13th edition, 2006.
5. American National Standards Institute (ANSI) / AISC, N690-1984, "Specification for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities."
6. Regulatory Guide 1.142, "Safety Related Concrete Structures for Nuclear Power Plants," Revision 2, November 2001.
7. Regulatory Guide 1.76, "Design Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, March 2007.
8. Topical Report BC-TP-9A, "Design of Structures for Missile Impact," Revision 2, Bechtel Power Corporation, 1974.
9. American Concrete Institute (ACI) 318-63, "Building Code Requirements for Reinforced Concrete."
10. American Concrete Institute (ACI) 318-71, "Building Code Requirements for Reinforced Concrete."
11. American Society of Mechanical Engineers (ASME), United States of America Standard (USAS) B31.1.0-1967, "Power Piping."
12. American Institute of Steel Construction (AISC) Manual of Steel Construction, 6th edition, 1963.
13. Seismic Qualification Utility Group (SQUG), Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment, Revision 3A.
14. American Iron and Steel Institute (AISI), North American Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition.
15. Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor Supported Equipment or Components," Revision 1, February 1978.
16. Regulatory Guide 1.199, "Anchoring Components and Structural Supports in Concrete," November 2003.
17. American Society of Mechanical Engineers (ASME) AG-1-2003, "Code on Nuclear Air and Gas Treatment."
18. American Institute of Steel Construction (AISC) Manual of Steel Construction, 7th Edition.

19. American Society of Civil Engineers (ASCE) 4-98, "Seismic Analysis of Safety-Related Nuclear Structures and Commentary."
20. NUREG-0800, Chapter 3, USNRC Standard Review Plan 3.7.2, Seismic System Analysis, Revision 3, March 2007.
21. IEEE-484-2002, ""IEEE Recommended Practice for Installation design and installation of large lead storage batteries for generating stations and substations."
22. American Concrete Institute (ACI) 349-01, "Code Requirements for Nuclear Safety Related Concrete Structures."
23. American Concrete Institute (ACI) 349-06, "Code Requirements for Nuclear Safety Related Concrete Structures."
24. OSS-0020.00-00-0006, Specification for the Design, Installation and Inspection of Hilti Concrete Expansion Anchors.
25. American Institute of Steel Construction (AISC), Manual of Steel Construction, 14th edition, 2011.

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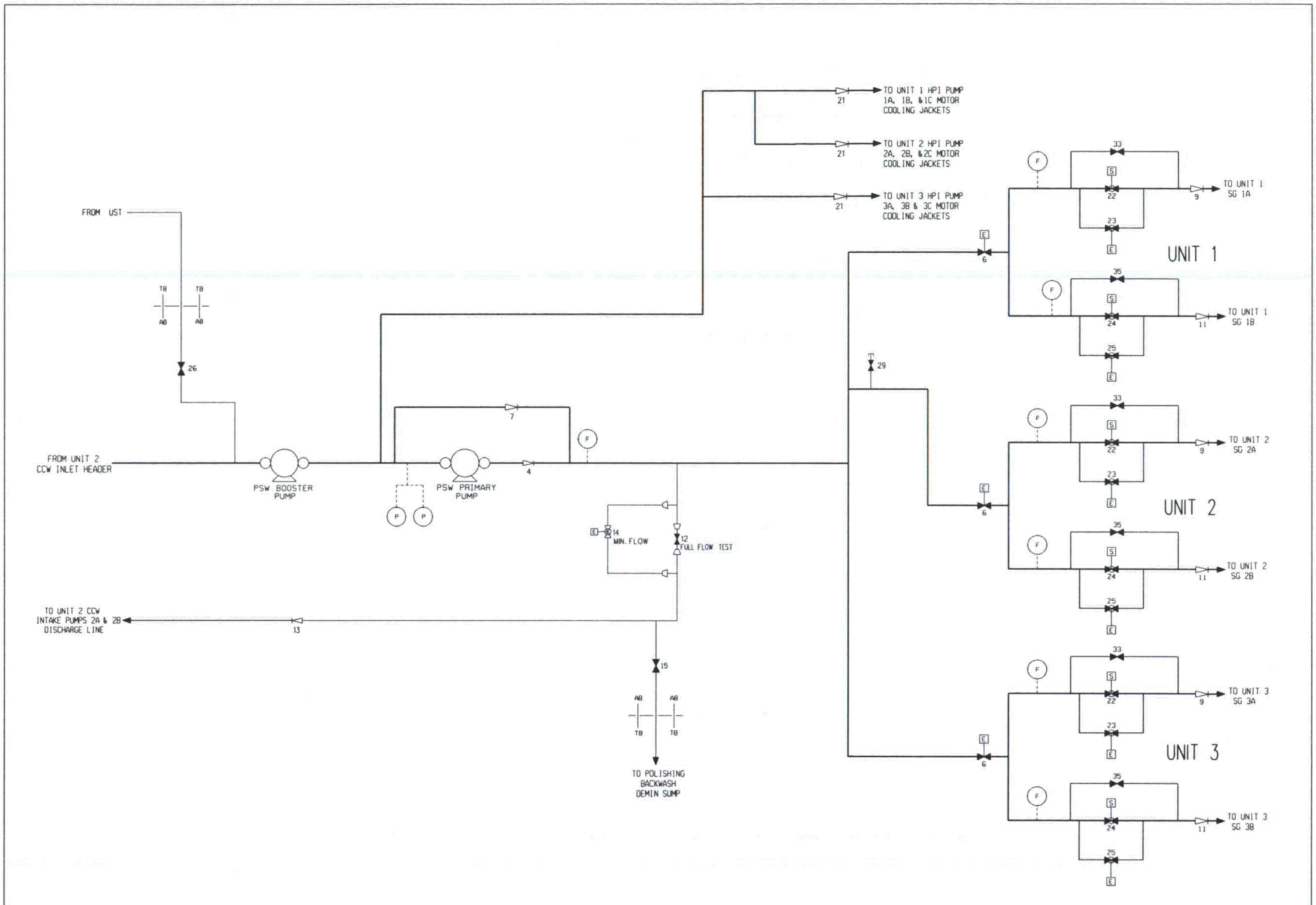
ATTACHMENT 2

New and Revised UFSAR Figures

9-44 Protected Service Water System
9-45 PSW AC Electrical Distribution
9-46 PSW DC Electrical Distribution
10-8 Emergency Feedwater System



LEGEND

- SHUTOFF VALVE
- FLOW CONTROL VALVE
- CHECK VALVE (ALL TYPES)
- RELIEF VALVE
- NORMALLY OPEN
- NORMALLY CLOSED
- NORMALLY THROTTLED
- F-FLOW
- L-LEVEL
- P-PRESSURE
- T-TEMPERATURE
- R-RADIATION MONITOR
- E-ELECTRIC
- H-HYDRAULIC
- P-PISTON (PNEUMATIC)
- S-SOLENOID
- DIAPHRAGM (PNEUMATIC)
- (ES)-RECEIVES ENGINEERED SAFEGUARD SIGNAL

THIS FSAR FIGURE WAS CREATED FROM SUMMARY FLOW DIAGRAM OSFD-131A-1. FOR COMPLETE SYSTEM DESIGN INFORMATION, REFER TO THE FOLLOWING FLOW DIAGRAMS.

OFD-131A -1.1, 1.2, 2.2, 3.2 PROTECTED SERVICE WATER

ALL VALVES "PSW" EXCEPT AS NOTED

Figure 9.44
Protected Sevice Water System

FIGURE 9-45 PSW AC ELECTRICAL DISTRIBUTION

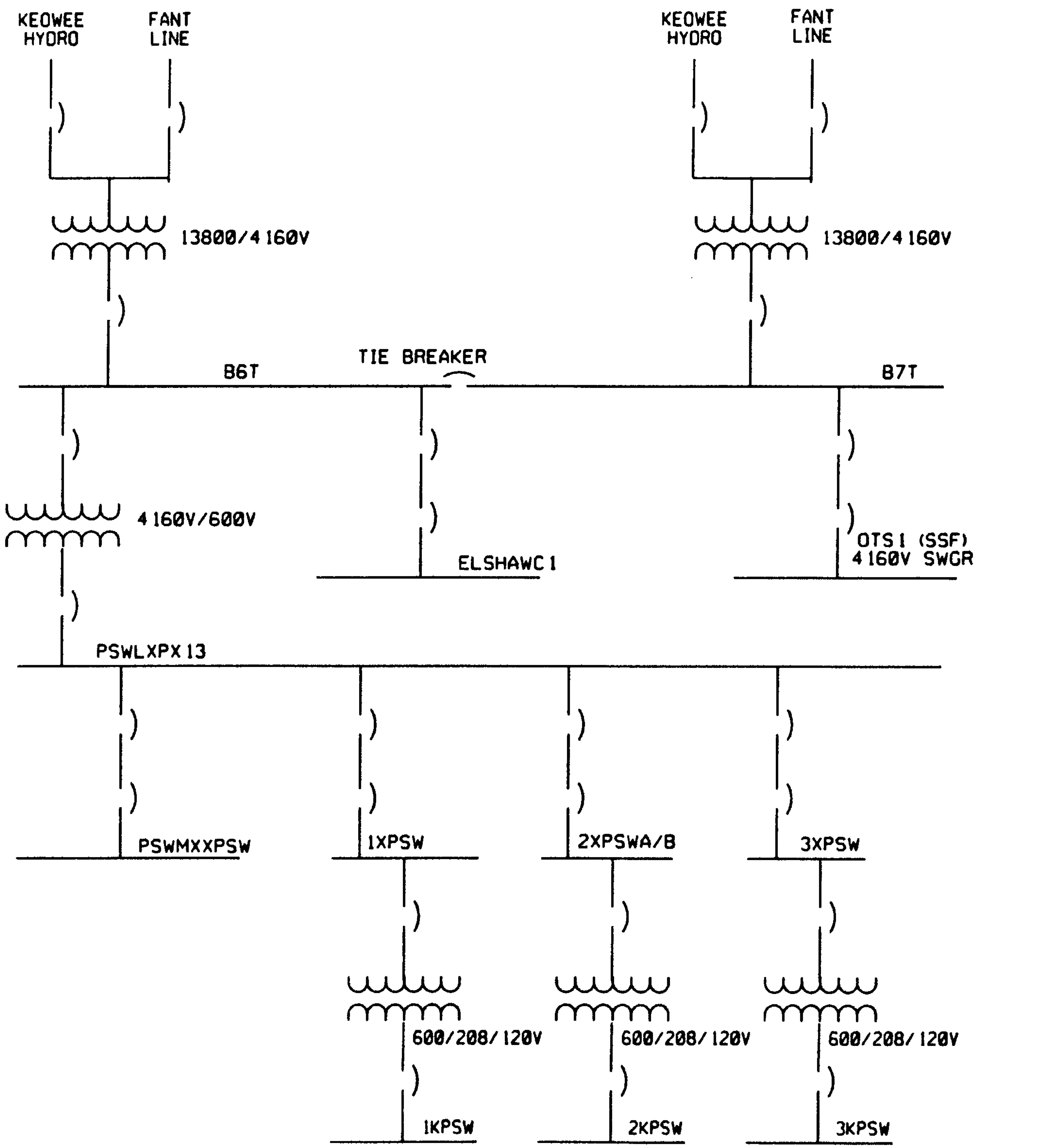
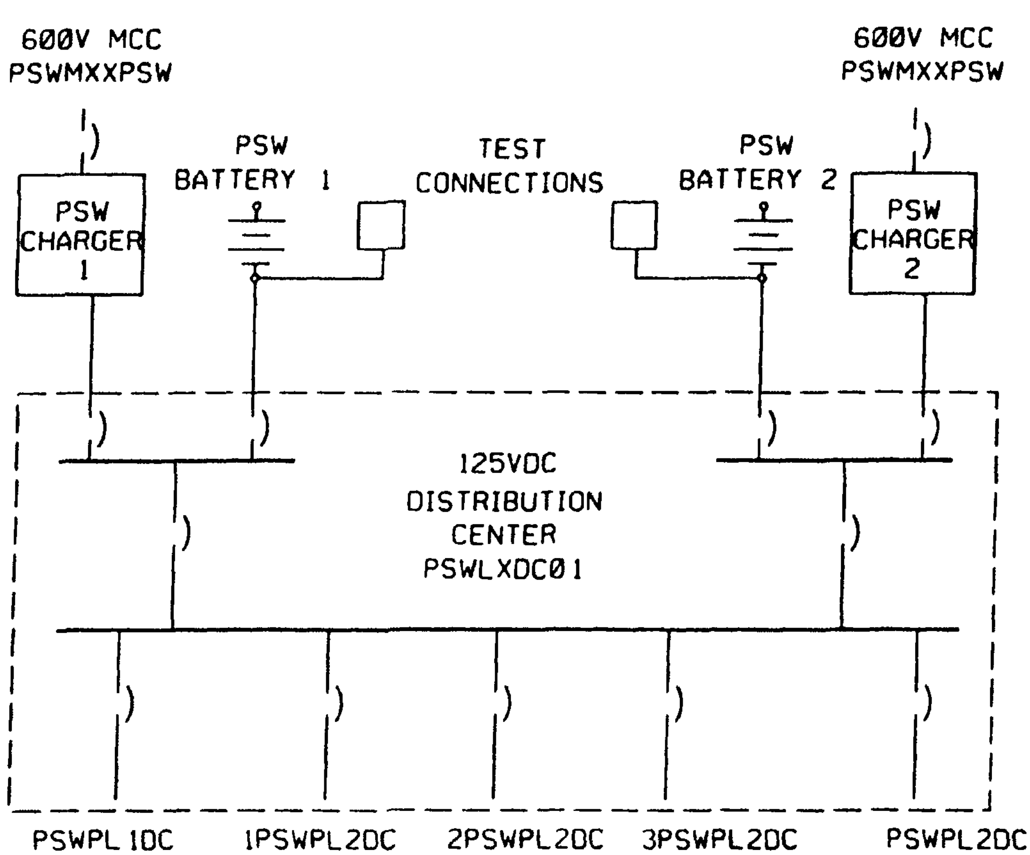


FIGURE 9-46 PSW DC ELECTRICAL DISTRIBUTION



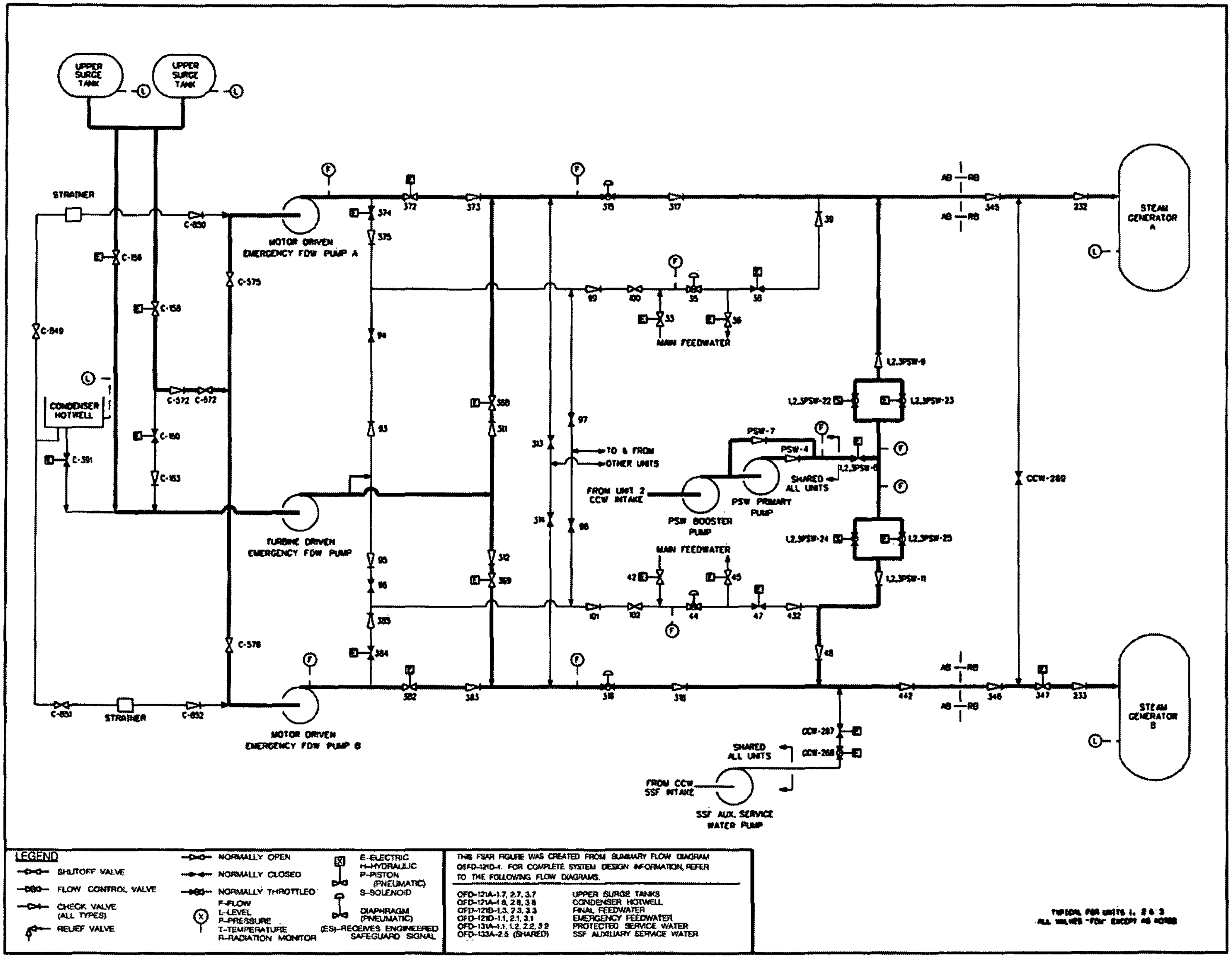


Figure 10-8 Emergency Feedwater System