Entergy

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Palisades Nuclear Plant
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Palisades Nuclear Plant
Docket 50-255
License No. DPR-20

Response to Request for Additional Information Regarding License Amendment Request for Emergency Core Cooling System Surveillance Requirement (TAC No. MD5259)

On April 18, 2007, Entergy Nuclear Operations, Inc. (ENO) requested Nuclear Regulatory Commission (NRC) review and approval of a proposed license amendment for the Palisades Nuclear Plant (PNP). The proposed amendment would revise Technical Specification surveillance requirement 3.5.2.9 to reflect planned modifications to the containment sump. On July 16, 2007, ENO provided additional information.

In an electronic mail message dated September 7, 2007, the NRC requested additional information. ENO provided responses on September 7 and September 12, 2007. On September 18, 2007, ENO was requested to submit the responses on the docket.

Enclosure 1 provides ENO's responses to the NRC's request. The information does not affect the significant hazards consideration determination or environmental review consideration provided in the April 18, 2007, request, nor does it affect any other information in that submittal.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

A002
Process per C. Haney

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 20, 2007.

Christopher J. Schwarz
Site Vice President
Palisades Nuclear Plant

Enclosure (1)

CC Regional Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
NRC Resident Inspector, Palisades USNRC

ENCLOSURE 1
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
PALISADES LAR - ECCS SURVEILLANCE REQUIREMENTS

On April 18, 2007, Entergy Nuclear Operations, Inc. (ENO) requested Nuclear Regulatory Commission (NRC) review and approval of a proposed license amendment for the Palisades Nuclear Plant (PNP). The proposed amendment would revise Technical Specification surveillance requirement 3.5.2.9 to reflect planned modifications to the containment sump. In an electronic mail message dated September 7, 2007, the NRC requested additional information. ENO's responses are provided below.

NRC Request

1. *Clarify whether the reviews and evaluations were performed and documented to determine the effects of any missiles, high energy lines and associated dynamic effects due to pipe whip and jet impingement on the modified strainer assemblies Provide a summary of these evaluations to establish the structural integrity of the strainer assemblies.*

ENO Response

The strainer assemblies would be located in an area of the 590' elevation of containment where no high-energy line break (HELB) piping exists. The closest HELB location would be on the elevation above, on the 607' elevation, which is separated from the 590' elevation by a concrete floor. The strainer modules' location was planned such that a concrete wall or floor is between the HELB line and the modules. The strainer modules would be located so that there is not a "line of sight" through the 607' elevation floor openings. Therefore, the effects of any missiles, high-energy lines and the associated dynamic effects due to pipe whip and jet impingement on the modified strainer assemblies are considered to be not credible.

NRC Request

2. *Provide a simple sketch of the layout showing the arrangement for the modified containment sump strainer assembly.*

ENO Response

Refer to the attached general arrangement drawing that shows the location of the strainer assemblies on the 590' containment elevation. Note there was also a simplified drawing submitted with the April 18, 2007, request.

NRC Request

3. *Discuss the load components (such as dead weight load, debris loads, hydrodynamic mass, thermal, seismic load, Loads due to differential pressure or head loss, loads due to any other dynamic effects, etc.) and load combinations that are used in the structural design of the modified sump strainer components and the floor mounted bolted connections.*

ENO Response

General Information

The sump replacement strainer pressure retaining components have been designed and analyzed to the standards of American National Standards Institute (ANSI) (American Society of Mechanical Engineers [ASME]) B31.1, "Power Piping," 1973 Edition through summer 1973 Addenda for the specified normal and accident conditions inside containment. The strainers are classified as "other pressure-retaining components" as described in Paragraph 104.7 of the ANSI (ASME) B31.1 Code. Many of the strainer components are unique and ANSI (ASME) B31.1 does not provide specific design guidance for these types of components.

The ASME Boiler and Pressure Vessel Code, Section III, 1998 Edition, was used for the qualification of pressure retaining parts of the strainer that are not covered in B31.1, such as perforated plate and internal wire stiffeners. Some parts of the strainers (external radial stiffeners, seismic stiffeners, tension rods, edge channels, etc.) are classified as part of the support structure. Structural support members were designed and fabricated to the standards of USA Standard (USAS) (ASME) B31.1 and the American Institute of Steel Construction (AISC) Structural Steel Specification, Eighth Edition, 1980. Strainer assembly angle iron support tracks were evaluated per AISC Ninth Edition.

Additional guidance was also taken from other codes and standards where the AISC code does not provide specific rules for certain aspects of the design. For instance, the strainers are made from stainless steel materials. The AISC Code does not specifically cover stainless steel materials. Therefore, ANSI/AISC N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities," was used to supplement the AISC in any areas related specifically to the structural qualification of stainless steel. Note that only the allowable stresses were used from this N690-1994 Code and load combinations and allowable stress factors for higher service level loads are not used.

The strainer also has several components made from thin-gage sheet steel and cold-formed stainless sheet steel. Therefore, Structural Engineering Institute / American Society of Civil Engineers (SEI/ASCE) 8-02, "Specification for the Design of Cold-Formed Stainless Steel Structural Members," was used for certain components where rules specific to thin-gage and cold-formed stainless steel are applicable. The rules for allowable stress design (ASD), as specified in Appendix D of this code, were used. This was further supplemented by the American Iron and Steel Institute (AISI) Code, “Specification for the Design of Cold-Formed Steel Structural Members," 1996, where the ASCE Code is lacking specific guidance. Finally, guidance was also taken from American Welding Society (AWS) D1.6, "Structural Welding Code - Stainless Steel,” as it relates to the qualification of stainless steel welds.

Dead Weight Loads

Dead weight load due to debris on the strainer was determined by calculating the quantity of debris that would be deposited onto each Performance Contracting Incorporated (PCI) strainer module by the most limiting break. In addition to the analysis, PCI performed hydraulic testing that simulated the actual debris loading conditions specific to Prairie Island nuclear plant, whose post loss-of-coolant accident (LOCA) debris concentrations envelope Palisades' debris concentrations. The analysis and testing demonstrate that the full strainer installation design ensures that the strainers are capable of withstanding the force of full debris loading in conjunction with design basis conditions, including seismic activity.

Debris Load

The strainers were designed to ensure that they are capable of withstanding the force of full debris loading, in conjunction with design basis conditions. The effect of the debris load was reflected in the dead weight and suction pressure terms of the analysis. The strainers are capable of withstanding the force of full debris loading for the design basis load combinations discussed below.

Live Load

In addition to the dead weight loads, live loads, which would occur only during the refueling outage and strainer installation, were considered in the design analyses.

Hydrodynamic Mass

Hydrodynamic forces were considered in the seismic analysis of the strainer assemblies and associated discharge piping. Specifically, the dynamic effects of surrounding water on the submerged strainer structure during an earthquake, i.e., added water mass, inertia coupling, impulse, sloshing, wave actions, damping, and participation of added water mass in the forcing term were considered.

A generic seismic sloshing analysis performed by the strainer vendor (PCI) concluded that the sloshing loads on the strainers are negligible. The analysis was based on a close form solution where the containment was modeled as an annular tank. An equivalent mechanical model of the slosh caused by a horizontal excitation of the tank was composed of a series of oscillating slosh masses supported by mechanical springs. The water mass was broken into two parts, a rigid mass that behaves like a mass that is rigidly attached to the tank, and a sloshing mass that oscillates between the tank walls. The model was used to determine the sloshing velocity, which in turn was used to calculate the drag forces in the strainer modules. Although the values of the parameters used in the generic analysis are different than the values associated with Palisades, the differences would not result in a different conclusion (i.e. sloshing loads are insignificant compared to the other seismic loads). The conservatism in the hydrodynamic mass determination outweighs any load resulting from sloshing of the water inside containment. Therefore, seismic slosh loads are neglected from the stress analysis.

Thermal Loads

Strainer assembly thermal expansion loads would be zero because the strainers are essentially freestanding structures and, for the most part, are free to expand without restraint. Therefore, thermal loads were considered negligible and were taken equal to zero.

The thermal expansion of the strainer assembly discharge piping was taken at a temperature equal to the maximum sump water temperature. Small gaps were modeled for certain supports in the thermal analysis to account for the gaps in the pipe supports. A 1/16" gap was modeled on top of the pipe for all supports, and a 1/16" gap was modeled on either side of the shear lugs for the three-way supports. The gaps are designed to minimize unrealistic thermal loads on the sump piping.

To allow for relative thermal expansion between adjacent strainer assembly modules, as well as the strainer discharge piping and the reactor building, adjacent modules are installed with a gap between them. The gap would be sealed with a load compliant metallic sleeve.

Seismic Loads

The seismic loading considered both the reactions of seismic inertia and seismic sloshing. The hydrodynamic mass of the strainer, which would be subject to seismic accelerations, was calculated based on the mass of water enclosed by the strainer plus the added mass from the water surrounding the strainer.

The strainer purchase specification included the amplified response spectra used in the seismic analysis, which are the safe shutdown earthquake (SSE) and operating basis earthquake (OBE) seismic response spectra for all three directions at two-percent damping. The strainer modeling was excited in each of the three mutually perpendicular directions, two horizontal and one vertical. The modal combination was performed by the ten percent method combination per the Palisades Final Safety Analysis Report (FSAR), which refers to Section 1.2 of Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," for closely spaced modes. Seismic response from the vertical and two horizontal directions were combined by the use of the square-root-sum-of-the-squares (SRSS) method. The cutoff frequency was taken at 33 Hertz. Zero period acceleration (ZPA) residual mass effects were considered. The ZPA response was conservatively added to the response spectra loads by SRSS.

The seismic analysis report for the replacement sump strainers states that the strainers have been analyzed, as required, for the specified normal and accident conditions inside containment, and the strainer meets all the acceptance criteria for all applicable loadings. The seismic analysis report for the strainer discharge piping and supports demonstrates that the pipe stresses and support loads are acceptable. The piping stresses, flanges, and support component stresses are within their respective applicable limits and are, therefore, acceptable.

Differential Pressure Loads

A conservative pressure loading of 3.14 pounds per square inch (psi), which is equivalent to a pressure head of 7.25 feet of water, was applied to the structural analyses. The allowable maximum differential pressure load is limited by the ECCS pump net positive suction head requirement, which is less than the 7.25 feet.

Other Dynamic Effects

The potential of jet impingement and pipe whip were also evaluated and found to be not creditable. The primary coolant system loop pipes, including the pressurizer surge line, and the strainer assemblies are separated by a concrete floor. There are no direct pathways between the strainer locations and any HELB-associated piping locations.

Load Combinations

The replacement strainer assemblies and the discharge piping segments are designed to the following service loadings:

Sump Strainers

Loading Conditions		Loading Combinations
(1a)	Normal Operating	DW +DEB + DP
(1b)	Normal Operating (outage/Lift Load)	DW + LL
(2)	Upset	DW + DEB + DP + OBE
(3)	Faulted	DW + DEB + DP + SSE

Where:

DW = Dead Weight
LL = Live Load (Additional Live loads acting on strainer assembly during outage and installation)
DP = Differential Pressure
DEB = Weight of Debris
OBE = Operating Basis Earthquake (2% damping seismic response spectra)
SSE = Design Basis Earthquake (DBE) = Safe Shutdown Earthquake = 2 x OBE

<u>Strainer Discharge Piping</u>

Loading Conditions		Loading Combinations
(1a)	Hoop Stresses	DP
(1b)	Normal (pressure + Sustained)	P + DW
(2)	Upset	P + DW + OBE
(3)	Faulted	P + DW + SSE
(4)	Secondary	T1

Where:

DP = Design Pressure Hoop Stress
P = Differential Pressure
OBE = Operating Basis Earthquake
ASME Code Case N-411 method is employed.
SSE = Safe Shutdown Earthquake = 2 x OBE
T1 = Thermal Expansion (maximum sump water temperature of 264°F)

<u>Strainer Discharge Pipe Support Structural Components</u>

Loading Conditions	Loading Combinations
Normal	DW + T1
Upset	DW + OBE + T1
Faulted	DW + SSE + T1

Where:

DW = Dead Weight Load
OBE = Operating Basis Earthquake
SSE = Safe Shutdown Earthquake
T1 = Thermal Expansion (maximum sump water temperature of 264°F)

NRC Request

4. *Provide a summary of the structural adequacy evaluation of the modified sump strainer highlighting the design margins. Also, identify the design codes that were utilized in the structural design.*

ENO Response

Structural Evaluation Summary

The design conditions for the strainer modules, as defined in the strainer procurement specification, include the live load, differential pressure loads, thermal loading, and seismic events (OBE and SSE).

The limiting condition considered is a SSE that occurs while the strainer is in a submerged condition after a LOCA. The ability of the strainers to perform their safety functions during and/or after an OBE and SSE has been demonstrated in the seismic analysis report for Palisades, which concludes that:

- The strainer assemblies are designed to the loadings of dead weight, pressure, thermal, seismic and seismic sloshing, without loss of structural integrity.
- A maximum analytical differential pressure load of 3.14 psi, which amounts to 7.25 ft water column, was applied in the structural analyses.
- The load combinations for the strainer discharge piping and piping supports are defined in the preceding section and are in conformance with FSAR Section 5.10.1.1 and 5.10.1.2 requirements.

Design Margins

Detailed stress analyses have been performed on strainer parts, strainer assembly connecting piping, piping flanges and supports. All the component stresses analyzed meet the design allowables set forth in the design codes and standards described in the discussion of NRC question 3 above. The most limiting interaction ratio of the computed stress and the stress allowable for the strainer assembly is 0.95. This interaction ratio occurs at the sleeve banding which connects the strainer modules. The most limiting interaction ratio for pipe and pipe supports was calculated as 0.92, which occurs at a base plate of one of the pipe supports.

Codes

Codes utilized, and their application, are discussed in response to NRC question 3 under the "general information" heading. Codes used in the structural design of the strainer include the following:

- ANSI (ASME) B31.1 Power Piping 1973 Edition through summer 1973 Addenda
- AISC Structural Steel Specification, Eighth Edition

- AISC Structural Steel Specification, Ninth Edition
- ANSI/AISC N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities"
- SEI/ASCE 8-02, "Specification for the Design of Cold-Formed Stainless Steel Structural Members"
- AWS D1.6, "American Welding Society Structural Welding Code - Stainless Steel," 1999
- AISI Code, "Specification for the Design of Cold-Formed Steel Structural Members," 1996
- ASME Section III, Appendix A, 1998 Edition through 1999 Addenda
- ASME Section II, Part D, 1998 Edition through 1999 Addenda

General Arrangement Drawing Showing Location of Strainer Assemblies