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June 17, 2025

ANO-1 Pressurizer Heater Capacity

Pre-submittal Presentation

Agenda

- Background
- ANO-1 Technical Specification and Bases
- Proposed Change
- Technical Justification
- Next Steps

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Background

In the third quarter of 2022, ANO-1 received the following green non-cited violation:

The inspectors identified two examples of a Green, non-cited violation of the Confirmatory Order issued to Arkansas Nuclear One, Unit 1, dated January 2, 1980, for the licensee's failure to implement requirements set forth in NUREG-0578, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations."

> First, as-measured pressurizer ambient heat losses exceeded the predetermined pressurizer heater capacity needed to establish and maintain natural circulation at hot standby conditions when offsite power was not available. The licensee determined this was acceptable based on their conclusion that 4 hours was an acceptable time duration for the pressurizer heaters requirement.
>
> Second, in the event of a loss of offsite power with failure of B-train emergency power, manual operator actions outside the main control room are required to restore power to the minimum-required pressurizer heater capacity powered by A-train emergency power. (This is being addressed in a separate license amendment request).

Background

In 1992, ANO-1 performed a Pressurizer ambient heat loss test during a refueling outage.

- Result was a calculated ambient heat loss of 183 kW.
- Historical information indicates a belief this value was not valid based on suspected Reactor Coolant System (RCS) Pressurizer Spray Valve Leakage.
- Identification of this historical test result led to the 2022 violation.

The ANO-1 Technical Specification (TS) value for required emergency-powered Pressurizer Heater capacity was 126 kW in 1992. (Same requirement exists today)

Background

Following the ambient heat loss test result in 1992, Entergy Licensing was asked to provide input on the time required to ensure adequate Pressurizer Heater capacity per the ANO-1 licensing basis and previous correspondence.

- Entergy Licensing concluded there was no specific NRC regulation governing the time for maintaining adequate Pressurizer Heater capacity in support of natural circulation at hot standby conditions.
- Recommendation 2.1.1 of NUREG-0578 (clarified in NUREG-0737 II.E.3.1) was interpreted by Entergy to be the amount of time necessary to manage the Loss of Offsite Power (LOOP) in a controlled manner.

Background

As a result, Entergy developed a position that 4 hours was an acceptable minimum time for maintaining RCS pressure using Pressurizer Heaters alone.

- An Entergy calculation determined that adequate SCM could be maintained for 4.9 hours with 1 gpm Pressurizer Code Safety leakage, 183 kW ambient heat loss, and 126 kW Pressurizer Heater capacity.
- Entergy concluded that compliance with Recommendation 2.1.1 did not require Pressurizer Heater capability to maintain hot standby indefinitely, and 4 hours was consistent with the Station Blackout Rule, where 4 hours was considered an acceptable time to restore offsite power if temporarily lost.

Background

As documented in the 2022 Resident Inspector's integrated inspection report (ML22312A527) :

> "The NRR staff confirmed that use of a 4-hour coping time for pressurizer heaters was not appropriate because a station blackout event is a beyond design basis event, while a LOOP is defined as an anticipated operational occurrence, which is expected to occur one or more times during the life of the plant."

Background: NUREG-0578

Recommendation:

Provide redundant emergency power for the minimum number of pressurizer heaters required to maintain natural circulation conditions in the event of loss of offsite power. Also provide emergency power to the control and motive power systems for the power-operated relief valves and associated block valves and to the pressurizer level indication instrument channels.

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Background

In response to the NUREG-0578 recommendations related to emergency-powered pressurizer heater capacity and associated required TS changes, Babcock and Wilcox (B&W) provided the following input to ANO-1 and this was incorporated into the Unit 1 TS:

- B&W recommends that the Arkansas Nuclear One – Unit 1 station have a procedure to allow the operators to restore power to at least 126 kW of Pressurizer Heaters from an assured power source within two (2) hours after a loss of offsite power.

- B&W notes that backup pressure control from the Makeup/High Pressure Injection (HPI) system in the form of Pressurizer level/pressure control is available in the event Pressurizer Heaters cannot be restored.

ANO-1 Technical Specification

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.9 Pressurizer

LCO 3.4.9 The pressurizer shall be OPERABLE with:

a. Pressurizer water level ≤ 320 inches; and

b. A minimum of 126 kW of Engineered Safeguards (ES) bus powered pressurizer heaters OPERABLE.

----------NOTE----------
OPERABILITY requirements on pressurizer heaters do not apply in MODE 4.

APPLICABILITY: MODES 1, 2, and 3,
MODE 4 with RCS temperature > 259 °F.

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ANO-1 Technical Specification Bases

The pressurizer heaters are used to maintain a pressure in the RCS so reactor coolant in the loops is subcooled and thus in the preferred state for heat transport to the steam generators (SGs). This function must be maintained with a loss of offsite power. Consequently, the emphasis of this LCO is to ensure that the Engineered Safeguards (ES) bus powered heaters are adequate to maintain pressure for RCS loop subcooling with an extended loss of offsite power.

A minimum nominal capacity of 126 kW for the pressurizer heaters ensures that the RCS pressure can be maintained (Reference CR-ANO-1-2009-0158-09). Unless adequate heater capacity is available, reactor coolant subcooling may not be maintained (although the pressure control provided by the high head high pressure injection pumps is an alternate method of maintaining subcooling). Inability to control the system pressure and maintain subcooling under conditions of natural circulation flow in the primary system could lead to loss of single phase natural circulation and decreased capability to remove core decay heat.

Proposed Change

- To restore compliance with NUREG-0578 and the previous Confirmatory Order requiring all "Category A" short-term recommendations from NUREG-0578 be implemented, Entergy will :
  - Request relaxation of the NUREG-0578 requirement for ANO-1 Pressurizer Heater Capacity including a good cause justification consistent with the guidance in the NRC Enforcement Manual, Section 2.7.8. This will be an exception to Item 2.1.1, "Emergency Power Supply Requirements for the Pressurizer Heaters, Power-Operated Relief and Block Valves, and Pressurizer Level indicators in PWRs ."
  - Request a license amendment to revise TS 3.4.13, “RCS Operational LEAKAGE” to add a limit for identified leakage through the Pressurizer Code Safety Valve of 1 gallon per minute (gpm).
- Revised Recommendation Item 2.1.1 (proposed):
  Provide redundant emergency power for the minimum number of pressurizer heaters required to maintain natural circulation conditions for at lease 9 hours (with 1.0 gpm Pressurizer Code Safety leakage) during a loss of offsite power. In the event Pressurizer Heaters alone are challenged to maintain Reactor Coolant System subcooling and natural circulation, High Pressure Injection can be used as an alternate method of maintaining subcooling. Also provide emergency power to the control and motive power systems for the power-operated relief valves and associated block valves and to the pressurizer level indication instrument channels.

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Proposed Change

3.4.13 RCS Operational LEAKAGE

LCO 3.4.13 RCS operational LEAKAGE shall be limited to:

a. No pressure boundary LEAKAGE;

b. 1 gpm unidentified LEAKAGE;

c. 10 gpm identified LEAKAGE*; and

d. 39 gallons per day primary to secondary LEAKAGE through any one Steam Generator (SG).

* Pressurizer Code Safety LEAKAGE is limited to 1 gpm

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Technical Justification

In 2025, Entergy performed an additional analysis to determine the time to maintain adequate Subcooling Margin (SCM) for ANO-1 using Pressurizer Heaters alone.

Assumptions:

- 126 kW of Pressurizer Heater capacity (based on only 1 Emergency Diesel Generator (EDG) available – current TS basis).
- Ambient heat loss value of 183 kW (based on 1992 data).
- Current estimated ambient heat loss value (based on Pressurizer Heater current) of 165 kW.
- Minimum SCM value (at which time HPI would be initiated) of 20F SCM.
- Pressurizer Code Safety Valve leakage values of 0, 0.5, and 1.0 gpm (consistent with 1992 Entergy calculation).
- High Pressure Injection actuation on low RCS pressure is not credited.
- Reactor Building temperature value of 70F (conservative).
- Normal RCS parameters per current ANO-1 operating data.
- Normal expected operator response per Emergency Operating Procedures.

Technical Justification

Results:

Ambient Heat Loss	Pressurizer Code Safety Leakage (gpm)	Time to 20F SCM (hours)
183 kW	0.0	20.1
183 kW	0.5	12.6
183 kW	1.0	9.0

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Technical Justification

Entergy determined the limiting value for maintaining adequate SCM using Pressurizer Heaters alone based on the 1992 measured ambient heat loss was 9.0 hours.

- This allows adequate time for ANO-1 to stabilize the RCS following a LOOP and assess the anticipated return of offsite power.
- Restoration of another power source (offsite power, 2nd Emergency Diesel Generator, Alternate AC Diesel Generator) provides additional Pressurizer Heater capacity for maintenance of RCS pressure.
- Challenges to RCS pressure control before shutdown cooling operation is achieved would be addressed using the Makeup/HPI system to maintain adequate RCS pressure control as an allowed defense in depth method per ANO-1 TS, Emergency Operating Procedures, and B&W Generic Operating Guidance.

Technical Justification

ANO-1 Emergency Operating Procedure – Degraded Power

- Consistent with the B&W Generic Operating Guidelines, one of the early steps in the Degraded Power Emergency Operating Procedure (EOP) is to restore the previously operating or standby HPI pump to service.

- The previously operating HPI pump was being used as a Makeup Pump under normal operating conditions per B&W plant design (i.e., not functioning as an HPI pump under ECCS conditions).

- This action restores RCS makeup capability and Reactor Coolant Pump (RCP) Seal Injection to restore cooling to the RCP seals. Restoration of RCP Seal Injection minimizes challenges to the RCS barrier.

- If the previously operating or standby HPI pumps are not available, EOP guidance directs use of the dedicated Engineered Safeguards (ES) HPI pump to restore these functions (i.e., the remaining third pump is utilized for RCS makeup and RCP Seal Injection).

Next Steps

- Submittal in 3rd Quarter 2025
- Request standard NRC review and approval time

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Questions?


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