Boston Edison
Pilgrim Nuclear Power Station
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January 30 ,1998
BECo Ltr. 2.98.012

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

Docket No. 50-293
License No. DPR-35

Request for NRC approval of an Engineering Evaluation:
Elevated Tailpipe Temperature on Safety Relief Valve 203-3B

In accordance with Pilgrim Nuclear Power Station (PNPS) Technical Specification 3.6.D.4, Boston Edison requests NRC review and approval of the attached engineering evaluation of elevated tailpipe temperatures associated with safety-relief valve (SRV) 203-3B. This evaluation was reviewed by the Operational Review Committee on January 15, 1998.

The PNPS Technical Specification 3.6.D.4 states:

> Any safety relief valve whose discharge pipe temperature exceeds 212°F for 24 hours or more shall be removed at the next shutdown of 72 hours or more, tested in the as found condition and recalibrated as necessary prior to reinstallation. Power operation shall not continue beyond 90 days from the initial discovery of discharge pipe temperatures in excess of 212°F for more than 24 hours without prior NRC approval of the engineering evaluation delineated in 3.6.D.3.
>
> Technical Specification 3.6.D.3 states, in part, that an engineering evaluation shall be performed justifying continued operation for the corresponding temperature increases.

An elevated tailpipe temperature associated with safety/relief valve 203-3B (i.e., 132°F) was first observed on December 11, 1997. The temperature slowly increased, and on December 24, 1997, the temperature reached and remained in excess of 212°F for more than 24 hours. The tailpipe temperature is currently approximately 217°F where it has remained relatively stable. SRV 203-3B is operable in its present condition. The leakage is minor in nature and it has tentatively been attributed to pilot stage leakage.

If SRV203-3B tailpipe temperature exceeds 235°F for a period greater than 24 hours or exceeds 250°F at any time, then an orderly shutdown of the reactor shall commence, as recommended in the attached engineering evaluation.

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Your review and approval is requested prior to March 24, 1998 to preclude a shutdown of Pilgrim Station. If additional information is required, please contact Mr. Bob Cannon at (508) 830-8321.

for L. J. Olivier

RLC/dcg
id: reqest/radmisc
Attachment: Engineering Evaluation

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ATTACHMENT

BOSTON EDISON COMPANY
ENGINEERING EVALUATION

1. Initiating Document: PR97.3565

2. Affected (System, Subsystem, Train, Component, or Device)

Target Rock Corp on Two-Stage Safety Relief Valve 203-3B

3. Specified Functions of the Affected Item

The safety relief valves are part of the reactor coolant pressure boundary and operate by power actuation (i.e., automatic depressurization system) or self-actuation by high process pressure. The safety relief valves limit peak vessel pressure during overpressure transients to satisfy ASME code requirements. The postulated transients for which safety/relief valve actuation is required are given in Chapter 14 and in Appendices R and Q of the FSAR. The automatic depressurization system provides a means to rapidly depressurize the primary system down to a pressure at which low pressure cooling systems can provide makeup. In the event of a small or medium break LOCA, this function would be required if high pressure ECCS was unable to maintain vessel water level.

4. References

1. Technical Specifications and associated bases 3.6.D.1, 3.6.D.2, 3.6.D.3, 3.6.D.4 and 3.6.D.5.

2. General Electric Report NSE 13-0282, "Pilgrim Plant, SRV Tailpipe Steam Temperature Correlation for SRV Leakage Monitoring System," dated February 1982.

3. General Electric Report NEDE-30476, "Setpoint Drift Investigation of Target Rock Two-Stage Safety/Relief Valve (Final Report)," dated February 1984.

4. Operability Evaluation for Target Rock Corporation Two-Stage Safety Relief Valve 203-3D, dated 8/17/91.

5. NRC approval of operability evaluation for 203-3D, incoming NRC letter 1.91.288 dated 10/24/91.

6. TCH92-133, "Root Cause/Corrective Action Response for 203-3D" (PR92.0338/F&MR 91-373).

7. Operability Evaluation for Target Rock Corporation Two-Stage Safety Relief Valve 203-3A dated 11/2/93.

8. Wyle Lab, Test Report No. 41211-0 dated, 4/25/91.

9. Supplemental Reload Licensing Report for PNPS Reload 11, Cycle 11, PDC 96-17, "Reload 11/Cycle 12 Core Design".

10. MR #19703052

11. Operability Evaluation for Target Rock Corporation Two-Stage Safety Relief Valve 203-3B, pilot serial number 1025, dated 2/9/96.

12. Operability Evaluation for Target Rock Corporation Two Stage Safety Relief Valve 203-3D pilot serial number 1054, dated 11/4/97.

13. NEDO-22159 General Electric Boiling Water Reactor Increased SRV Simmer Margin Analysis for PNPS Unit1-June 1982.

5. Operability Concern

Safety Relief Valve (SRV) 203-3B is leaking. This condition was detected by tailpipe temperature monitoring instrumentation on 12/11/97 and documented in Problem Report 97-3565. The SRV 203-3B tailpipe temperature trended to 132 °F on 12/11/97, 145 °F on 12/16/97, 212 °F on 2/24/97 and stabilized at 217 °F on 1/2/98. This temperature profile supports a condition indicative of pilot stage leakage.

Technical Specification 3.6.D.3 requires an engineering evaluation to support continued operation if the temperature of any safety relief valve discharge pipe exceeds 212°F for a period greater than 24 hours during normal reactor power operation (Ref. 1). The Technical Specification Bases states that minimal leakage exists when the tailpipe temperature is 215°F, and therefore, a conservative temperature of 212°F was chosen.

6. Operability Recommendation (Check one)

☒ Operable

☐ Inoperable

7. Basis for Recommendation (Use additional sheets as necessary)

The most likely leakage paths through the Target Rock Corporation (TRC) two-stage safety relief valve are: (1) through the main stage, past the main disc and seat interface, or (2) through the pilot stage, past the disc and seat interface. General Electric (GE) and TRC (the valve's manufacturer) representatives have in the past indicated main stage leakage is typically substantial and increases faster than pilot stage leakage and pilot stage leakage is more [illegible] on than main disc leakage.

SRV 203-3B pilot 1025 had high tailpipe temperatures between 1/24/96 and 2/6/96. The operability evaluation determined the elevated temperature which eventually settled out at 217 °F was the result of minor pilot leakage. This was later confirmed at Wyle Labs where diagnostic "as-found" setpoint and leakage tests were performed.

SRV 203-3D pilot 1054 and main stage 008 were replaced on 12/3/97 due to high tailpipe temperature. Although diagnostic testing is incomplete, a leaking pilot valve is suspected.

Due to the similarity of the increase in tailpipe temperatures to SRV-3B pilot 1025 leakage, the most probable cause for the leakage presently experienced by SRV-3B is pilot leakage. This condition may clear with a lowering of reactor pressure; however, it will more likely remain at some low level (218-220 °F), for a period of months.

The consequences of leakage across either the pilot or main stage boundary for SRV 203-3B must be addressed, since leakage increases may occur later and may occur at either location. Pilot stage leakage affects valve lift set point and response time while main stage leakage does not.

Pilot Stage Leakage

Pilot stage leakage can affect the performance of the two stage Target Rock SRV in the pressure actuated mode (i.e., safety mode). The effects of leakage on valve performance have been extensively studied and basically consist of the following: (1) setpoint drift, (2) response time changes (Ref. 3).

The leakage rates studied by GE and TRC range from 200 lbs/hr to 1000 lbs/hr. Test results indicate that set point pressure increased to approximately 1% at 225 lbs/hr and to 2% at a leakage rate of approximately 400 lbs/hr. The setpoint then decreased 2% per 100 lbs/hr of additional leakage. The effect of leakage rate on setpoint is illustrated in Reference 3. Based on TRC test results, pilot stage leakage up to 1000 lbs/hr did not significantly affect the SRV setpoint (Ref. 3).

Response time is the interval from pilot actuation to main disc lift. The normal response time for a two stage TRC SRV is approximately 0.4 seconds. Response time varies with leakage rate A slower response time results in a higher peak reactor vessel pressure during the safety mode, and a faster response time results in a lower peak reactor pressure. A slower response time also

results from a higher tailpipe temperature (i.e., higher steam leakage). The impact of leakage on response time is presented in the plant analysis section of this report.

Main Stage Leakage

Main stage leakage is an uncommon problem in the industry according to TRC. This view is substantiated by the volumes of information available on relief valve leakage, all of which is a result of pilot stage leakage. Leakage across the main stage boundary is an economic concern because of the potential for seat and/or disc damage. TRC and GE advise that leakage across the main disc will not affect the ability of the SRV to operate in either the pressure actuated or power actuated modes. Leakage across the main stage should not cause the SRV to inadvertently open and cause a rapid depressurization or fail to reclose after operating.

Plant Analysis

General Electric has performed sensitivity analyses on PNPS showing that even if drift results in an opening pressure 10% above the nominal setpoint for all Pilgrim's installed SRVs, the peak pressure for the MSIV closure-flux scram event is less than the upset limit of 1375 psig. Based on these results, GE concludes that BWRs with TRC two-stage SRVs can tolerate drifts significantly above the 1% technical specification setpoint tolerance.

Also, the peak vessel pressure would increase by 5 psig if one SRV experienced the leakage induced maximum response time delay of 0.9 second (Ref. 3). This is much less than the 77 psig margin between reactor vessel pressure for cycle 12 and the upset limit of 1375 psig (Ref. 9).

The impact of either a delay in SRV response time or an increase in SRV opening pressure on critical power thermal margin is minimal. This is due to the rapid insertion of large negative control reactivity during transients before the higher pressure can contribute to any significant additional core power production due to core void collapse. This was demonstrated in NEDO-22159 (Ref. 13), where a 30 psig increase in SRV opening setpoint resulted in only 0.1% increase in peak fuel rod heat flux following a limiting pressurization event. This was specifically evaluated for PNPS for cycle 6. However, it would also apply to cycles 7-12 due to the insignificant contribution of SRV pressure relief to the mitigation of the core power excursion associated with limiting pressurization events. Reactivity shutdown via reactor scram renders the core essentially subcritical before SRV pressure relief can be effective in moderating the void collapse due to the pressurization event.

SRV Leakage Versus Tailpipe Temperature and SRV Setpoint

The maximum allowable SRV 203-3B tailpipe temperature of approximately 255°F can be correlated to a steam leakage flow rate of approximately 225 lbs/hr, while steam leakage of 1000 lbs/hr corresponds to a tail pipe temperature of approximately 275°F. It is acceptable to continue operation with a tailpipe temperature of less than or equal to 255°F since test data has demonstrated that the possible relief valve setpoint drift at this temperature is equivalent to +1% (Ref. 3).

Plant Parameter Effects on Tailpipe Temperature

Drywell temperature: Sensitivity analysis predicts that the tailpipe temperature is relatively insensitive to drywell temperature variations over the entire range of steam leakage (Ref. 2).

Reactor pressure: The temperature of the steam at the exit of the relief valve decreases as reactor pressure increases. Any effect on downstream tailpipe temperature may be offset by increased leakage rates at higher reactor pressure. The temperature limit of 255°F was based on normal reactor operating pressure for the exit steam (Ref. 2).

Containment pressure: The safety relief valve tail pipe is equipped with vacuum breakers that prevent drawing a column of torus water into the tailpipe. The tailpipe will be at atmospheric pressure prior to inerting and slightly above atmospheric pressure after inerting the containment. The effects of containment pressure on tailpipe temperature are negligible because the difference in tailpipe pressure due to inerting is only a few psig. Also the maximum leakage flow rate of up to 1000 lbs/hr will not be sufficient to pressurize the tailpipe, thereby affecting temperature (Ref. 2). Therefore, containment pressure effects are judged to be negligible.

Equipment Qualification

Each safety relief valve has one solenoid valve which is attached to a manifold mounted on the air operator for the valve. The leakage flow through the safety relief valve will raise the temperature of the main valve body, base, pilot assembly and associated tailpipe. The solenoid valve is environmentally qualified, considering in-part the normal ambient temperature to which it is exposed. The solenoid valve is not in direct contact with any part of the safety relief valve which will experience appreciable elevated temperature because of the leakage through the valve.

Therefore, the solenoid valve will not be exposed to any significant amount of conducted heat but could be exposed to a slightly higher ambient temperature. The solenoid valve is mounted as an appendage off the safety relief valve in a configuration that maximizes air circulation around it and minimizes the ambient temperature to which the solenoid valve is exposed. Therefore, the effects of minor leakage through the SRV 203-3B safety relief valve are judged to have no appreciable affect on the environmental qualification of the safety relief valve solenoid.

Conclusion

SRV 203-3B is operable in its present condition. The leakage that has occurred is of a minor nature attributed to pilot stage leakage and is acceptable as discussed previously. Either intermittent or continuous leakage within the limits described below is acceptable for continued operation. Tests and analyses have shown that leakage rates of approximately 225 lbs/hr (equivalent to 255°F) should not impact the SRV setpoint by more than +1%.
Based on past experience with leaking pilot valves, a slightly lower action limit has been selected for this SRV in order to assure reliable SRV operation and reduce damage to the pilot seat and

disc. If the tailpipe temperature exceeds 235°F for a period greater than 24 hours or exceeds 250°F at any time, an orderly shutdown of the reactor shall commence.

8. Compensatory Measures/Conditions Required Justification for Continued Operation

Technical specification surveillance 4.6.D.3 requires that SRV tailpipe temperature be logged daily. This surveillance shall be performed at an increased frequency of once per hour, to compensate for the reduced margin between the normal maximum tailpipe temperature of 212°F and 235°F.

Temporary Modification 97-66 has been installed to reconfigure the alarm circuitry on safety relief valve temperature recorder TR260-20. The alarm point of RV-203-3B which normally annunciates at 200°F has been reset to annunciate at 230°F.

If SRV 203-3B tailpipe temperature exceeds 235°F for a period greater than 24 hours or exceeds 250°F at any time, then an orderly shutdown of the reactor shall commence.

This relatively small leakage is not expected to cause torus water temperature or drywell temperature to change significantly; therefore, an increased surveillance interval for these parameters is not warranted.