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Pilgrim Nuclear Power Station
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BECo 91- 123
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U.S. Nuclear Regulatory Commission
Document Control Desk
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License DPR-35
Docket 50-293

Request for NRC Approval of an Engineering Evaluation:
Elevated Tailpipe Temperature on Safety Relief Valve SRV 203-3D

Boston Edison Company requests NRC review and approval of the attached engineering evaluation of an elevated tailpipe temperature on safety relief valve (SRV) 203-3D. NRC approval of this evaluation is required by PNPS Technical Specification 3.6.D.4 which states, in part; "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." As discussed in the evaluation, operation with SRV leakage that results in a tailpipe temperature less than 255°F will not cause setpoint drift in excess of that permitted by the Technical Specifications and will not jeopardize the ability of the valve to perform its intended safety function.

The elevated temperature was discovered on August 14, 1991. Boston Edison requests the NRC's approval prior to November 11, 1991 to preclude an unnecessary shutdown of Pilgrim Station.

G. W. Davis

GGW/cab/6233

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cc: Next page

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BOSTON EDISON COMPANY
OPERABILITY EVALUATION

1. Initiating Document F&MR 91-373

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

Target Rock Corporation Two-Stage Safety Relief Valve 203-3D

3. Specified Function 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 process high pressure. The safety relief valves limit peak vessel pressure during overpressure transients to satisfy ASME code requirements. The postulated transients where safety/relief valve actuation is required are given 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 where 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 are unable to maintain vessel water level.

4 References

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

2. General Electric Report NSE 13-0252 "Pilgrim Plant, SRV Tailpipe Steam Temperature Correlation for SRV Leakage Monitoring System", dated February 1982.

3. NRC letter to Boston-Edison Co. 1.82.072, dated March 20, 1982.

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

5. Supplemental Reload Licensing Report for PNPS Reload 8, Cycle 9, 23A7101 Rev. 0.

5. Operability Concern

Safety Relief Valve 203-3D is leaking. This condition was detected by tail pipe temperature monitoring instrumentation. Thermographic data comparisons were made between a safety relief valve that had no

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internal leakage and SRV 203-3D. The data collected, indicates that the pilot stage is not leaking, and the high tail pipe temperature is caused by leakage past the main disc/seat boundary. Installed instrumentation does not facilitate discriminating between pilot and main stage leakage. However, pilot stage leakage will discharge immediately downstream of the main disc causing similar increases in tail pipe temperature as from main stage leakage. Pilot stage leakage affects valve lift point and response time while main stage leakage does not.

Technical Specification 3.6.D.3 requires an engineering evaluation justifying continued operation if the temperature of any safety relief valve discharge pipe exceeds 212°F for a period of greater than 24 hours during normal reactor power operation. This technical specification was incorporated at the request of the NRC to require prompt corrective actions and assessments when abnormal tail pipe temperature is detected. The Technical Specification Bases states that minimal leakage exists when the tail pipe temperature is below 215°F, and therefore a conservative temperature of 212°F was chosen.

6. Operability Evaluation (Check one)

[X] Operable

[ ] Inoperable

[ ] Conditionally Operable

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

There are two potential leakage paths through the Target Rock Corporation (TRC) two-stage safety relief valve: (1) main stage, past the main disc and seat interface, or (2) pilot stage, past the disc and seat interface. The thermographic data collected at PNPS on the SRV203-3D indicates that the leakage path is across the main stage. Tail pipe temperature traces from leaking SRVs installed at PNPS during Cycle 5 indicate a gradual rise over approximately one to four weeks in the tail pipe temperature. The temperatures steadied at approximately 230°F, and then gradually rose at a slow rate over many weeks to a temperature above 25[illegible]°F. Subsequent examinations and testing of the valves showed that the pilot stage leaked and eventually the pilot was severely eroded. Conversations with GE representatives indicate, that main stage leakage is typically substantial and increases faster than pilot stage leakage. Therefore, the rapid increase in SRV203-3D tail pipe temperature which is approximately 240°F indicates main stage leakage. Based on the thermographic data, leakage rate increases, and total temperature rise, main stage leakage is considered to be the cause of the observed tail pipe temperature rise. However, the consequences of leakage across either boundary must be addressed, since leakage increases may occur at either location.

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Main Stage Leakage

Main stage leakage is an uncommon problem in the industry according Target Rock, a view that 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 General Electric advise that leakage across the main stage 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.

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. 4)

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 set point then decreased 2% per 100 lbs/hr of additional leakage. The effect of leakage rate on setpoint is illustrated in Reference 4. Based on conversations with representatives from General Electric, prolonged operation with gross leakage (i.e., greater than 1000 lbs/hr) through the pilot stage is outside their experience base with leaking SRVs, and may cause pilot damage and subsequent valve misoperation. Based on TRC test results, pilot stage leakage up to 1000 lbs/hr did not significantly affect the SRV setpoint. (Ref. 4)

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 has the opposite effect.

Plant Analysis

General Electric has performed sensitivity analyses on PNPS and the results show that even if drift results in an opening pressure 10% above the nominal setpoint for all 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% Tech. Spec. setpoint tolerance.

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Also, the peak vessel pressure would increase by 5 psig if one SRV experienced the leakage induced maximum response time delay of 0.9 seconds (Ref. 4). This is much less than the 70 psig margin between reactor vessel pressure for Cycle 9 and the upset limit of 1375 psig (Ref. 5).

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 pressures can contribute to any significant additional core power production due to core void collapse. This was demonstrated in NEDO-22159 where a 30 psig increase in SRV opening setpoint resulting in only 0.19° increase in fuel rod heat flux following a limiting pressurization event. This sensitivity would also hold for conditions and fuel currently at PNPS

SRV Leakage Versus Tail Pipe Temperature and SRV Set Point

The current tail pipe temperature of approximately 240°F can be correlated to a steam leakage flow rate of approximately 100 lbs/hr based on Figure 4-4 contained in reference 2. A tail pipe temperature of 255°F corresponds to approximately 225 lbs/hr of steam leakage, 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 tail pipe temperature of less than or equal of 255°F since test data has demonstrated that the possible relief valve set point drift at this temperature is equivalent to +1% . (Ref. 4)

Plant Parameter Effects on Tail Pipe Temperature

Drywell Temperature: Sensitivity analysis predicts the tail pipe 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 tail pipe 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 tail pipe will be at atmospheric pressure prior to inerting, and slightly above atmospheric pressure after inerting the containment. The effects of containment pressure on tail pipe temperature are negligible because the difference in tail pipe 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 tail pipe, thereby effecting

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temperature (Ref. 2). Therefore, containment pressure effects are judged negligible.

Conclusion

Tests and analyses have shown that leakage rates of approximately 225 lbs/hr (equivalent to 255°F) should not impact the SRV set point by more than +1%. Therefore, an SRV tail pipe temperature up to 255°F is acceptable for continued operation. (Ref. 2 and 4)

This evaluation satisfies the Technical Specification 3.6.D.3 requirement that an engineering evaluation be performed for the subject condition. Because tail pipe temperature for SRV203-3D has exceeded 212°F for greater than 24 hrs., TS3.6.D.4 requires that it be removed for testing and recalibration at the next cold shutdown greater than 72 hours in duration. Furthermore, for continued operation beyond 90 days with the subject condition TS3.6.D.4 requires NRC approval of this evaluation.

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 a increased frequency of once per shift, to compensate for the reduced margin between the normal maximum tail pipe temperature of 212°F and 255°F.

This relatively small leakage is not expected to cause torus water temperature or drywell temperature to change significantly where an increased surveillance interval is warranted.

9. Performed By [signature] Date

Reviewed By [signature] for W.J. Ricks Date 8/17/91

Recommends Approval [signature] for J.W. Connell Date 8/17/91
(S&SA Division Manager)

Recommends Approval [signature] for R.V. Fairbank Date 8/17/91
(NED Manager)

Recommends Approval [signature] Date 8-20-91
(ORC Chairman)

ORC Meeting Number 91-127

Approved By [signature] Date 8/21/91
(Station Manager)

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