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YANKEE ATOMIC ELECTRIC COMPANY

FYR 83-41
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YANKEE

1671 Worcester Road, Framingham, Massachusetts 01701

April 12, 1983

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

References: (a) License No. DPR-3 (Docket No. 50-29)
(b) YAEC Letter to USNRC, dated December 23, 1982 (FYR 82-120)

Subject: Additional Information on SEP Topic V-11.B, Residual Heat Removal (RHR) Interlock Requirements

Dear Sir:

In Reference (b), we presented our position on the issue of pressure interlocks on the RHR System valves. As a result of the ACRS Subcommittee presentation of March 11, 1983, and further discussions with your staff, a detailed review of plant procedures for transition from hot standby to cold shutdown has been conducted and is provided in the attachment. This review assessed the procedural steps and plant practices precluding initiation of the RHR System at too high a Main Coolant System pressure, and provides qualitative comparisons of this review and that performed by NRC's consultant, SAI.

The results of this detailed evaluation indicate that the postulated event is an insignificant contributor to both core melt frequency and public risk. The probability of the event is, at best, difficult to quantify because of the number of operators involved, the number of operations, and the length of time it takes to accomplish shutdown cooling. In any case, the probability of inadvertent operation is unquantifiably low. NRC's own very conservative assessment of public health consequences performed by Sandia Laboratories in 1981 concluded for the worst "siting source terms" (SST-1) that no acute fatalities are expected and the mean number of latent effects is very small. Given these findings, the RHR interlock should be classified as a low contributor to risk issue.

Based on our detailed procedures review presented herein, supported by the information presented in Reference (b), and the information presented at

A035

the ACRS Subcommittee meeting, we conclude that the installation of the RHR interlocks is unnecessary since the event for which these interlocks might be of value is both extremely low in probability and consequence.

If you have any questions, please contact us.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

J. A. Kay

J. A. Kay
Senior Engineer - Licensing

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REVIEW OF PLANT PROCEDURES FOR TRANSITION
FROM HOT STANDBY TO COLD SHUTDOWN

Introduction and Summary

The procedures used to bring the plant from a hot standby condition to cold shutdown were reviewed in support of YAEC's assessment of SEP Topic V-11.B, "RHR Interlock Requirements". The three relevant procedures are listed below:

- o OP-2105, "Plant Cooldown from Hot Standby";
- o OP-2653, "Removal of the Emergency Core Cooling System from Service"; and
- o OP-2162, "Operation of the Shutdown Cooling System".

The purpose of the review was to assess the procedural steps and plant practices precluding cutting in of the Shutdown Cooling System (SCS) at too high a Main Coolant System (MCS) pressure. The critical value for MCS pressure was assumed to be 600 psig. This is 300 psig above (twice) the procedural limit on allowable MCS pressure for operation of the SCS. However, this assumed failure pressure is conservative because the SCS was hydro-tested at 600 psig.

Qualitative comparisons of this review and that performed by NRC's consultant, SAI, are also provided where appropriate. This review demonstrates that the SAI evaluation is quite conservative relative to the number of Operations errors required to initiate the SCS at too high a MCS pressure. Although the SAI evaluation is comprehensive, the assessment apparently did not include a talk-through of the relevant procedures with plant personnel. A talk-through is required to properly understand the interdependencies of the procedural steps relative to the "undesired event", a nonisolable LOCA outside the vapor container.

The postulated scenario requires numerous consistent errors by the Operations staff. Also, the transition from hot standby to initiation of the SCS is dynamic, requiring about 10 hours, typically. (The attached figure provides the pressure-temperature relationship for the most recent plant cooldown. This is discussed below.) Additionally, the most probable outcome of cutting in the SCS at too high a MCS pressure is not a nonisolable LOCA outside the VC, but instead spillage of MCS fluid inside the VC via operation of the two SCS relief valves.

Finally, even if a LOCA occurred outside the VC, the rupture should be isolable by reclosure of the SCS isolation valves. Even if the event were not mitigated, there would be no acute fatalities because of the reduced radioactivity and the time that it would take for severe core damage to occur.

Conclusions

Yankee concludes that the postulated event is an insignificant contributor to both core melt frequency and public risk. (The probability of the event is, at best, difficult to quantify because of the number of people involved and the time it takes to accomplish shutdown cooling and, in any case, is unquantifiably low.) NRC's own very conservative assessment of public health consequences performed by Sandia Laboratories in 1981 concluded for the worst "Siting Source Terms" (SST-1) that no acute fatalities are expected and the mean latent effects number 685. Given these findings, the RHR interlock should be classified as a low contributor to risk event.

Relevant Highlights from Plant Procedures

1) Maximum cooldown rate 30°F/hr [Precaution Step 1 of OP-2105].

2) Half-hourly readings on OPF-2105.1 [Procedure Step 1 of OP-2105].

   - Includes MCS temperature and pressure (requires sign-off).

   - Hourly readings also required on station logs, including MCS temperature and pressure.

- o Thus, plant temperatures and pressures are continuously monitored during plant cooldown to ensure all limits are being met.

- o Safety Parameter Display System (SPDS) provides continuous display at shift supervisor's station.

- o Overlay of P-T relationship to P-T limits is used.

3) Procedure OP-2105 requires maintenance of the main coolant P-T relationship by intermittent pressurizer spray and/or heater operation [Procedure Step 7].

   - o This requires operators to examine MCS temperature and pressure.

   - o Pressurizer spray operation is manually performed about every 30 to 60 minutes.

   - o SPDS provides overlay of P-T relationship to allowable P-T.

4) Procedure OP-2105 requires adjustment of pressurizer level density compensation during pressure decrease [Procedure Step 8].

   - o This occurs at MCS pressures of about 2000, 1326, 621, 118 and 0 psig.

   - o This is an additional prerequisite (621 psig point) before SCS is cut in.

It would appear that the NRC evaluation did not consider these elements of plant MCS pressure and temperature control. This is understandable because a review of normal plant operation and the dependencies of the plant operation and procedures would be required to ensure their consideration.

Since each of the steps discussed above is a continuous operational requirement - e.g., half-hour readings - this implies the need for a dynamic, time dependent if you will, logic model. For example, on the most recent plant cooldown, MCS pressure was less than 600 psig <u>three</u> to four hours before the SCS was cut in. Additionally, MCS pressure was less than 600 psig three to four hours before the MCS temperature was less than 330°F, the maximum allowable MCS temperature for SCS operation. This indicates that at least 6 to 8 readings of MCS temperature and pressure were recorded in the interval between MCS pressure reduction below the SCS failure pressure and cut in of the SCS; and, similarly, 6 to 8 readings of MCS temperature and pressure were recorded in the interval between MCS pressure reduction below the SCS failure pressure and the point at which MCS temperature met the SCS cut in criteria.

This information clearly shows that many more errors need to occur than assessed in the NRC evaluation before the SCS could be cut in at a pressure high enough to fail the pressure boundary. Even excluding the dynamics of the situation, errors in both reading pressure and temperature instrumentation would need to occur.

5) The NRC evaluation basically starts at Step 9 of OP-2105, which requires the operator to initiate "Removal of the ECCS from Service, OP-2653". This action is required to ensure that an inadvertent SIAS and ECCS injection does not occur as MCS pressure is reduced during the transition from hot standby to hot and/or cold shutdown.

This is an appropriate point to discuss the NRC consultant's understanding of the interfacing of procedures at the plant. For example, on Page 36 of the NRC evaluation, the possibility of human error due to procedures was reviewed and an apparent assumption concerning use of one procedure at a time was made. Let us clarify this situation.

OP-2105, "Plant Cooldown from Hot Standby," is the major cooldown procedure. This procedure would be maintained on the main control board. The actual performance of the cooldown would go as follows:

- o Operator draws a copy of OP-2105 from a file in the Main Control Room and reads the precautions and starts completing the prerequisites. [This procedure requires both Control Room operator and shift supervisor sign-off, as well as Plant Operations Manager review.]

- o After meeting all prerequisites, the operator starts the cooldown at Step 1. The relevant precautions and procedure steps up to Procedure Step 9 were discussed above.

- o [Procedure Step 9] directs the operator to perform OP-2653, "Removal of the ECCS from Service", as discussed above. The operator again draws a copy from the Control Room file cabinet and proceeds to review the procedure to refamiliarize himself with the precautions and ensure that the prerequisite criteria are met. OP-2653 and OP-2105 are performed concurrently as plant conditions are appropriate.

- o It would appear that the NRC evaluation team did not realize that OP-2105 is maintained by the operator independently of the performance of OP-2653. OP-2653 is performed concurrent with OP-2105. The steps of OP-2653 are completed as required with the operator constantly reverting back to OP-2105 as other steps of the cooldown are completed. The actual hands-on performance of steps in OP-2653 are primarily completed by an auxiliary operator under the direction of the Control Room operator.

- o Procedure Step 1 of OP-2653 would be performed. Step 2 would not be performed because the criteria on MCS pressure would not be met at this point in the cooldown. Therefore, the operator reverts back to OP-2105 at the last step he completed and signs off Step 9.2.

6) Step 11 of OP-2105 requires the operator to perform many activities related to both the secondary plant and primary plant when SG temperature is about 385°F.

- o Based on the last plant cooldown, this would occur at about a MCS pressure of 550 psig, below the SCS failure pressure. Thus, even though Steps 11.a through 11.k are primarily activities related to the secondary plant, they impact primary plant parameters including MCS temperature and pressure as follows.

At low core decay heat levels with MC pumps operational, MCS temperature is essentially equal to secondary temperature. The P-T relationship for MCS pressure and temperature is restricted as discussed above. The MCS pressure during the last cooldown was about 550 psig when MCS temperature was 385°F. Thus, these steps - 11.a through 11.k - provide an additional implicit check of MCS pressure.

These steps would not be necessary if plant cooldown occurred without using the condenser, as in Step 12 - but this would not be typical.

- Step 11.l or Step 12.a directs the operator to continue with OP-2653 when MCS pressure is less than 1000 psig. The operator would direct an auxiliary operator to complete Step 2 of OP-2653.

- Step 11.m or Step 12.b informs the operator that he should receive an alarm at about 450 psig, indicating that the LTOP System should be activated. The plant should not be put on the SCS until well after this alarm has actuated and appropriate actions taken as discussed below.

- Step 11.n directs the operator on allowable MC pump operation when MCS temperature is about 370°F. [Again, a MCS temperature of 370°F occurred at a MCS pressure of about 400 psig during the last cooldown. This is well below the SCS failure pressure.]

- Step 11.o directs the operator to place all NRV platform steam traps on bypass at about 340°F. [Again, a MCS temperature of 340°F occurred at a MCS pressure of about 400 psig during the last cooldown, well below the SCS failure pressure.]

- Step 11.p directs the operator to use OPF-2105.4. [OPF-2105.4 requires logging of pressurizer level. Pressurizer level instrumentation is next to MCS pressure instrumentation.]

- o Finally, Step 11.q directs the operator to initiate SCS operation when MCS temperature is between 300°F and 330°F and pressure is less than 300 psig.

  - The operator is directed to OP-2162.

  - The operator is directed to ensure proper operation of the SCS relief valves.

7) The operator draws a copy of OP-2162 from the Control Room file cabinet and proceeds to review the procedure to refamiliarize himself with the precautions and ensure that the prerequisite criteria are met.

- o Precaution 2 states, "The Shutdown Cooling System safety valves shall be operable whenever the MC System temperature is ≤300°F in Modes 4 and 5". [This ensures overpressure protection per LTOP requirements. These valves should be operable at temperatures greater than 300°F.]

- o Precaution 4 states, "The Shutdown Cooling System must not be placed in operation unless the Main Coolant System pressure is less than 300 psig". [This precaution provides an additional check on MCS pressure.]

- o Precaution 5 states, "Maintain the heatup and cooldown rates in accordance with Reference 8, Section B, Figures B-6 and B-7, and the Data Reference Manual". [This precaution reaffirms the requirement to monitor and maintain P-T relationships within allowable bounds.]

8) The actual prerequisite steps of OP-2162 now begin by initiating steps outlined in Attachment A of OP-2162.

- o Prerequisite 2 of Attachment A requires the Shift Supervisor's (SS) clearance as denoted by his signature. [Because the transition from hot standby to cut in of the SCS takes many hours, the SS would have cognizance of plant conditions and would verify appropriateness of plant conditions again. Additionally, the SPDS provides a visual indication and trending of MCS P-T relationships to allowable limits at the SS's station and would be used in confirming plant conditions.]

- o Prerequisite 3 allows for Electrical Maintenance to reconnect power to the SCS MOVs when MCS pressure is less than or equal to 300 psig.

- o Prerequisite 4 requires the operator to confirm that the MCS temperature is less than or equal to 330°F and that the MCS pressure is $\leq$ 300 psig.

- o Prerequisite 5 controls issuance of the keys from the SS for operation of the SCS isolation valves.

- o The remaining seven prerequisite steps involve system alignments and assurance that charging pumps are available to provide system makeup.

    - [Charging pump operation could be used to provide core cooling if the SCS were cut in at too high a MCS pressure and failed.]

    - [Also, although two of the three trains of ECCS would be racked out and flow paths isolated, at least one train - HPSI plus LPSI - would be available manually and the valves could be reopened if ECCS flow were required.]

9) Now, Procedure Steps 1 through 18 of OP-2162 would be performed.

- o Procedure Step 1 requires the operator to confirm that all four SCS isolation valves are closed.

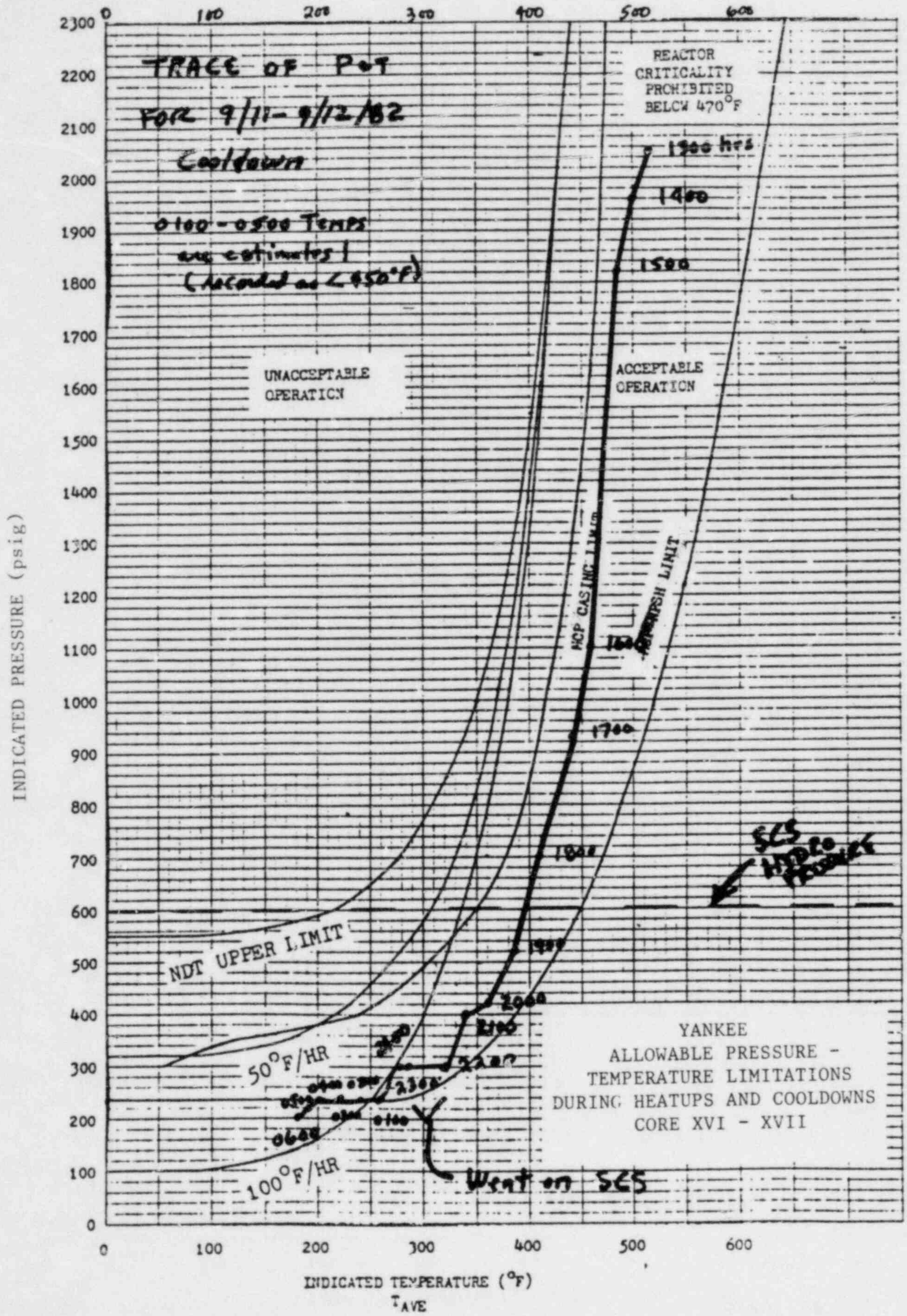
- o Procedure Steps 2 and 3 involve establishment of appropriate conditions in the SCS such as ensuring the system is full and system cooling is operational.

- o Procedure Step 4 instructs the operator to open the two outboard SCS isolation valves - SC-MOV-553 and SC-MOV-554. The two inboard valves - SC-MOV-551 and SC-MOV-552 - remain closed thus maintaining a boundary between the MCS and the low pressure portion of the SCS.

- Procedure Step 5 instructs the operator to "Crack open the shutdown cooling system isolation valve, SC-MOV-552, ...". [This step allows communication of MCS fluid with the low pressure portion of the SCS.]

  The operator is required to "Monitor the pressurizer level at this time for indication of leakage from the system". [If leakage occurs as evidenced by pressurizer level decrease, the operator would reclose SC-MOV-552, thus isolating the leak path.] This operation requires two operators - one to open SC-MOV-552 and the second operator to monitor MCS pressure and pressurizer water level. The location of the SCS valve controls is about 10 feet from the MCS pressure and pressurizer level instrumentation but not within a direct line of sight. Further backup is provided by closure of valves SC-MOV-553 and SC-MOV-554. These valves are inside the VC in full pressure - 2500 psig class-piping. Power to these valves would not be affected even if the SCS failed in the low pressure piping or components in the Primary Auxiliary Building (PAB). The maximum total flow through SC-MOV-552 before MCS pressure would decrease well below the failure pressure of the SCS is basically the fluid contained in the pressurizer. Once the pressurizer emptied, the MCS pressure would equilibrate at a pressure consistent with the saturation pressure of the MCS fluid temperature. At a MCS fluid temperature of 330°F, this pressure would be about 85 psig, significantly below the SCS failure pressure. Even if the MCS fluid temperature were as high as 486°F, the equilibrium MCS pressure would be less than 600 psig. The pressurizer level is typically maintained at about 1/3 full which is equivalent to about 750 gallons.

  The operation to cut in the SCS by cracking open SC-MOV-522 is an important recovery step. SC-MOV-522 is unseated, thus allowing the SCS pressure to increase to the MCS pressure. The valve is cracked to preclude any water hammer effects and the process monitored, as discussed above, by examining MCS pressure and pressurizer water level. The two SCS relief valves (about 250 gpm total at 600 psig) provide overpressure protection. These valves discharge to the Vapor Container (VC). Their operation could result in a LOCA inside the VC if they failed to reclose. But, ECCS would be available, and long-term recirculation of spilled fluid from the VC sump could be initiated if required.


TRACE OF PvT
FOR 9/11 - 9/12/82
Cooldown
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are estimates!
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ALLOWABLE PRESSURE -
TEMPERATURE LIMITATIONS
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CORE XVI - XVII
INDICATED PRESSURE (psig)
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