February 16, 1977

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Docket No. 50-29

Yankee Atomic Electric Company
ATTN: Mr. Robert H. Groce
Licensing Engineer
20 Turnpike Road
Westboro, Massachusetts 01581

Gentlemen:

RE: YANKEE-ROWE

In August of 1976 we sent letters to you and the licensees of other operating PWR facilities which expressed our concern over the number of reported instances of reactor vessel overpressurization. We requested that an analysis be provided of the reactor coolant system (RCS) response to pressure transients and that any design modifications be identified that were determined to be necessary to preclude exceeding the limits of Appendix G to 10 CFR Part 50.

Your October 26, 1976 letter indicated that several plant operating procedures had been reviewed and updated to reduce the potential for pressure transients while the plant is in a cold, water-solid condition. Your December 1, 1976 letter provided additional information on these procedural changes and also forwarded the transient analysis and design modifications proposed for the Yankee-Rowe facility, as requested in our August 11, 1976 letter.

We have completed our preliminary review of your December 1, 1976 submittal. This review has resulted in the staff positions and requests for additional information which are enclosed with this letter. You are requested to respond to these positions and provide the additional information requested within 45 days of receipt of this letter.

Sincerely,

/s/

A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Enclosure:
Request for Additional Information

cc w/encl: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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dupe of preceding document

cc: Mr. Donald G. Allen, President
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ENCLOSURE

STAFF POSITIONS AND ADDITIONAL INFORMATION REQUESTS FOR YANKEE-ROWE DOCKET NO. 50-29

I. STAFF POSITIONS AND INFORMATION REQUESTS ON APPENDIX A

1. The staff considers it essential that all plant operators (i.e., reactor operators, equipment operators, instrument & control personnel) be made aware of the details of the reactor coolant system (RCS) pressure transients which have taken place at PWR facilities. Position: Formal discussions should be held with these personnel to review the causes of past RCS pressure transients that have occurred at other operating PWR facilities. Your discussions should address the plant conditions at the time, the mitigating action that could have been or was taken, and the preventive measures that could have been taken to avoid the event and the steps taken to prevent similar future, occurrences. Plant similarities and distinctions should be identified in relationship to plant startup, shutdown, and testing operations. In regards to this requirement, you are requested to provide the following information:

   a. If you have not already completed the required formal discussion, when will you do so?

   b. How will the discussions be held?

   c. Identify which of the past Appendix G violations that have occurred at PWR facilities and which are described in License Event Reports, are not credible in your plant due to equipment differences. Provide a description of the distinctions.

   d. Describe, in detail, how you are reducing the likelihood of the other remaining credible events. Furnish schematics, diagrams or procedural summaries necessary to support the effectiveness and reliability of these measures.

2. The majority of the reported pressure transients have occurred while the plants were operating in a water solid condition, Position: The staff will require that operations during which the plant is maintained in a water solid condition be minimized or if possible, eliminated.

   Appendix A, to your December 1, 1976 submittal describes two procedures in which water-solid operations are used. During plant cooldowns the RCS is filled water-solid for a more rapid pressurizer cooldown. During plant heatups the pressurizer is filled after system venting.

a. Discuss the necessity for establishing a water-solid system during each of these procedures. Also provide your justification for not using a nitrogen, air or steam bubble.

b. Include any supplementary information such as system diagrams and descriptions of equipment operation to justify your need for operating the plant water-solid.

3. The inadvertent operation of safety injection system (SIS) components during cold shutdown conditions has been responsible for a major portion of the overpressure incidents. Position: Based on licensee submittals, the recent November 3-5, 1976 meetings, and discussions with NSSS vendors, the staff will require the deenergization of SIS pumps, (with the exception of those required to be operable by Tech Specs) and closure of SI header/discharge valves during cold shutdown operations.

   In Appendix A, you describe the various times when the SIS is realigned. The following requests are the result of our review of your December 1, 1976 submittal and reflect the above stated position:

   a. Furnish a schematic diagram of the SIS showing the components and the flowpaths into the RCS. Also, provide the head flow characteristics of each of the SIS pumps.

   b. Pages A-1 and 2 of your submittal indicate that two of the three ECCS trains are taken out of service at 1000 psig and the third at 200°F, 300 psig. Describe how this is done, (e.g., switches or breakers repositioned). Indicate these trains on the requested schematic diagram.

   c. You discuss the closing of selected SI header isolation valves at 1000 and 300 psig. Is the power from these valves also removed? Indicate how and from where the valves are controlled. Identify them on the requested schematic diagram.

   d. Indicate on the schematic diagram any other pumps that are disabled and valves which are in an off-normal position during a cold, and shutdown condition.

   e. During cooldown or shutdown conditions other than fill and vent operation, for each SIS breaker opened (or "racked-out"), describe the following:

1. The SI component,

2. The breaker location.

3. The places from which the breaker's position can be controlled.

4. The places from which the breaker's position can be determined.

5. The position indication and status signals which will be lost as a result of opening or removing (rack-out) the breaker.

f. Describe the administrative controls that ensure the proper equipment alignment shown on the diagram. What supervisory personnel are responsible for maintaining control?

g. Below 1800 psig, automatic safety injection is blocked. Describe any "unblock" or "block-bypass" features you have, and how this factors into your pressure protection procedures.

h. The third ECCS train is not tagged out of service until the RCS has been cooled to around 200°F. What is the justification for not tagging out this ECCS train along with the others at 1000 psig, 360°F?

i. During system fill and vent, you state on page A-3 that all ECCS pumps are tagged inoperable. Does this include the removal of power from all high pressure SIS pumps and motor operated header isolation valves? Show the equipment status on a SIS schematic. Describe the location of the breakers that will be opened, and the places from which they can be controlled. Describe the position indication and status signals which will be lost as a result of deenergizing these components.

4. We have noted that several Appendix G violations have occurred during component or system tests while in cold and shutdown conditions. In this regard, please address the following:

a. What components or system that could cause a pressure transient are routinely tested while in a cold shutdown condition?

b. What extra measures are taken to prevent an overpressure event during these tests?

5. We believe that a high pressure alarm used during low RCS temperature operations is an effective means to attract the operator's attention to a transient in progress. Position: We will require, if it is not presently installed, that such an alarm be installed as soon as possible.

   You briefly describe a proposed alarm in Appendix B, on page B-3. With regard to this proposed alarm, furnish the following informaiton:

   a. Your method to provide the alarm, and the implementation schedule.

   b. A synopsis of the system modifications that are necessary.

   c. The alarm setpoint, mode of annunciation and sensor.

   d. How you ensure that the alarm is available and operating properly during all water-solid operations and how you minimize its down-time for all other cold shutdown conditions.

6. The shutdown cooling system (SCS) is normally connected to the RCS and operating when the plant is in a cold shutdown condition. The inadvertent isolation of the SCS while water solid has caused a number of pressure transients, and the SCS safety valve has actually terminated others. The SCS therefore plays an important part in the possible initiation and mitigation of potential PWR pressure transients.

   The use of the SCS code safety valves as overpressure protection devices is discussed in your submittal. To assist us in evaluating your proposal, supply the following information:

   a. A diagram of your SCS showing the arrangement on the code safety valves and system isolation valves.

   b. SCS design pressure.

   c. A description of the system isolation valves and their arrangement (e.g., number and configuration of valves installed, and pneumatic or motor operated).

   d. Interlocks, interlock setpoints, and alarms associated with each isolation valve.

   e. Nominal stroke time of isolation valves.

   f. All pressure alarms, setpoints and associated annunciation for the system.

7. Based on your December 1, 1977 submittal, we assume that the SIS high pressure pumps and the coolant charging pumps are not the same. Describe the methods you use to prevent inadvertent pressure transients from the latter.

8. After admitting filtered air at 80 psig to the pressurizer, the water level is increased so that RCS pressure is sufficient for the main coolant pump (MCP) jog procedure (page A-4 of your submittal). A pressure transient is considered possible while raising the pressurizer level. Describe the steps you take to ensure this does not occur.

II. STAFF POSITIONS AND INFORMATION REQUESTS ON APPENDIX B

1. On page B-1 you state that each SCS safety valve has the capacity to relieve 101 gpm of 400°F water at about 467 psig. Please address the following questions:

   a. Provide an analysis which estimates the combined relief rate assuming the fluid is at 100°F, 200°F and 300°F for a range of pressures above the setpoint.

   b. The effects of flashing and backpressure on safety valve discharge rate should be determined by your analysis. We request that the results of your analyses be provided, even if a significant reduction in discharge capacity is not found. Furnish your time schedule for completing and submitting this analysis.

2. On page B-1, you state that the discharge of the shutdown cooling system safety valves is directed to a terminal tank. Regarding this arrangement, address the following:

   a. Does the pressurizer relief valve relieve to the same place?

   b. Since the SCS safety valves and the pressurizer relief valve may be open during a pressure transient, simultaneous discharge is possible. If the terminal tank is common to both relief valves, what is the possiblity of backpressure from one discharge effecting the flow rate from the other?

3. Provide prints of the existing and proposed circuitry used to operate the solenoid on the pressurizer relief valve. These diagrams should enable us to trace signals from the detector to the solenoid.

4. It is the staff's position that the probability of a LOCA not be allowed to increase significantly because of design modifications made to protect against overpressurization at low temperatures. You propose to replace your existing pressurizer relief valve with one of higher capacity. Further, the proposed dual pressure setpoint potentially introduces additional failure modes that could cause the valve to open while the RCS is at normal operating pressure. Describe the features of our proposed design (such as single failure proof circuitry and interlocks) that would minimize the probability of inadvertent opening of the relief valve.

5. Discuss the feasibility of including an alarm that would warn the operator to actuate the low pressure setpoint on the pressurizer relief valve, to assure its availability during RCS low temperature operations.

6. The use of an extra dedicated operator for RCS pressure monitoring during water-solid operations is discussed on pages A-2 and B-3. Describe the indications, alarms and warning devices available to this operator that guarantee his awareness of a pressure transient in progress, and indicate those analyses in which you take credit for his action.

7. It is not clear from your discussion of design criteria, (page B-3 to B-5) whether the criteria are being applied to your present or future pressure protection system. To clarify this, address the following:

   a. In discussing the operator action criteria, using an operator to take corrective action within ten (10) minutes is described. Will this be needed when your dual setpoint feature is installed? What operator action design criteria will be applied for your final design modification?

   b. The single failure criterion discussed on page B-4 states that below 300°F, three relief valves are available. For RCS temperatures between 300°F and 360°F, operator action after a response delay of ten minutes provides pressure protection. The RCS can be fully pressurized above 360°F. Will operator action still be required in the 300°F to 360°F range when the dual setpoint, higher capacity pressurizer relief is installed? What single failure criteria will you use then?

c. Do the Testability, Seismic Considerations and IEEE 279 sections of Appendix B pertain to the system as it now exists or as it will exist once the proposed features are installed (e.g., dual setpoint, high capacity relief)?

8. We do not understand your statements at the bottom of page B-3 and the top of page B-4. In these statements you are describing how you take credit for operator action within ten (10) minutes, and that this action is fully redundant to the SCS reliefs or operator action at ten (10) minutes. To clarify our understanding of these statements, address the following:

   a. If action at ten (10) minutes prevents overpressurizations, then why is action required before this, (i.e., why is it necessary to deviate from the staff's operator action criterion?)

   b. With regard to Appendix C in which you evaluate potential overpressure causing events, several of these require operator action to prevent RCS overpressurizations. However, in each of these cases, the operator action took place ten (10) minutes after the event despite your stated need for action in less time (page B-3). Clarify this apparent descrepancy.

9. On page B-4, in Section B you state that two of the three relief valves that are available below 300°F are sufficient to keep transient RCS pressures in the worst-case event to less than vessel limits. You further state that the new high capacity pressurizer relief valve will be fully redundant to both of the SCS safety valves. You also stated, previously, that each SCS safety valve can relieve 101 gpm at 467 psig (Appendix B, page B-1). From Figure A-1 on page C-23, the replacement pressurizer relief valve capacity does not reach 202 gpm until system pressure is about 500 psig. Explain this inconsistency. Consider future operation with more restrictive Appendix G limits as vessel irradiation increases.

10. The single failure criteria we specified at our November 3 meeting, and as summarized in the meeting summary (copy attached) require that following the initiating event (failure) the pressure protection system be designed to protect the RCS with a single (additional) failure (either equipment or operator) once the pressure transient is in progress. It is not evident from your submittal whether your system is designed in accordance with this criteria. Provide additional discussion on your system's single failure criteria, and what modifications in your final design would be needed to meet the acceptance criteria described above.

11. Paragraph C, page B-4 discusses the testability of your pressure protection components. Provide further explanation as to why the "total operability" of the dual setpoint pressurizer relief valve cannot be determined.

12. As we stated in our November 3 meeting, the electrical components of the pressure relief system should be designed to meet the requirements of IEEE 279, or you should provide the basis for any deviations. Paragraph E page B-5 discusses IEEE 279 requirements but lacks sufficient justification for the deviations. Provide your basis for not meeting the requirement specified in IEEE 279. Include any prints or diagrams necessary to your explanation. Will the additional insturmentation and electrical equipment you have proposed meet IEEE 279 requirements as well as Class IE criteria?

III. STAFF POSITIONS AND INFORMATION REQUESTS ON APPENDIX C

1. Appendix C discusses your evaluation of postulated events which could cause reactor vessel overpressurization. Respond to the following:

   a. In all postulated events, except the Main coolant pump (MCP) start, you assume that the presenlty installed equipment is available for pressure protection. (e.g., SCS safety valves and operator control of pressurizer relief valve). In the analysis of the MCP start transient, you assume the availability of only the existing pressurizer relief valve with the dual setpoint feature, taking no credit for the two (2) SCS safety valves (425 psig, 101 gpm each) which are assumed operable for all other transients. We do not understand why an analysis was not performed assuming the higher capacity SCS safety valves were available for pressure protection. Please explain this assumption.

   b. You have not considered the inadvertent ECCS operation or the loss of shutdown cooling heat capacity transients as plausible events due to your procedural restrictions. However, the reactor coolant flow initiation transient is analyzed in detail, even though procedural restrictions do not allow MCP starts unless an air or steam bubble exists in the pressurizer (page C-11) and at all other times, the MCP breakers are withdrawn (page A-2). Explain in detail why you have selected the MCP start transient as the event requiring the most detailed study, and not the inadvertent ECCS operation or the loss of SCS. Explain the difference in your procedural restrictions that allow the MCP start to be more likely than the other two transients.

c. On page C-13 you state that further reviews of your pressure protection system will be performed as vessel irradiation alters the Appendix G pressure-temperature limitations. Furnish an estimated schedule for you future reviews and associated submittals to the staff. Indicate if your high capacity pressurizer relief valve has been sized on the basis of anticipated vessel irradiation effects on Appendix G limits and the applicable irradiation levels assumed.

2. On page C-4, you state that the maximum allowable pressure at 300°F is about 1300 psig, and on page C-2 you indicate that the RCS may be fully pressurized when above 360°F. Furnish a plot of your allowable pressure-temperature curves showing the Appendix G limits, as a function of irradiation.

3. On page C-2, you conclude that further protection against an inadvertent ECCS actuation is not required due to your procedural controls. We have reviewed your procedural measures described in Appendix A and on page C-2.

   Since you close SI header isolation valves and disable SI pumps, inadvertent injection is definitely less likely. However, we will require that you demonstrate adequate overpressure protection considering all potential initiating events. Accordingly, address the following:

   a. Perform a RCS transient pressure analysis assuming a non water-solid pressurizer and an inadvertent injection from a single ECCS train. State your initial conditions.

   b. Since the RCS is made water solid at around 180°F on a system cooldown (Appendix A), and the third ECCS train is tagged out when the RCS temperature is $\leq$200°F, perform the same analysis as above assuming a water-solid system. (Assume a RCS temperature of about 180°F).

   c. How sensitive is the predicted RCS pressure response in the above analyses to the initial RCS temperature and pressure (assuming accumulation effects on relief value performance)?

4. Describe the procedural or equipment limitations that ensure a minimum pressurizer steam volume of $\geq$200 cubic feet, as you describe on page C-3.

5. Two cases are discussed in the charging without bleed flow transient. In Case B, you indicate that an analysis of this event was performed. Provide the details of this analysis. As a minimum, furnish the following information:

   a. Description of system model

   b. Initial conditions and assumptions

   c. Plot of RCS pressure vs. time.

   d. Sensitivity of predicted response to initial conditions.

6. On page C-4, you briefly describe an "operational pressure limit" (OPL) that precludes vessel overpressurization in Case B of the charging without bleed flow transient. Please furnish additional information on this OPL, indicating when it is used, and how it precludes vessel overpressurization for this event.

7. In your discussion of the pressurizer heater operation without bleed flow, on page C-5, you state:

   > "It is assumed throughout the discussion that the single equipment failure or operator error is that which causes isolation of the bleed path. No further failures or errors occur."

   This assumption is not consistent with single failure criteria specified in our November 3, 1977 meeting and as repeated in the meeting summary:

   > "<u>Single Failure Criteria</u> - The pressure protection system should be designed to protect the vessel given a single failure in addition to a failure that initiates the pressure transient."

   If this criteria cannot be met, provide sufficient justification for not doing so.

8. In your discussion of Cases A, B, C, and D of pressurizer heater operation without bleed flow, you have omitted the details of the analysis. Provide, as a minimum, the information we reuqested in item 5 above.

9. You have also omitted the details of your analysis of the loss of shutdown cooling heat removal capacity transient. Provide, as a minimum, the information we requested in item 5 above.

10. In the discussion of the loss of shutdown cooling heat removal capacity transient, you state that the expected contribution to system expansion rate is below 33 gpm, and the total expansion rate would not exceed 202 gpm.

    a. Explain the differences between these rates. Is it due to an assumed letdown flow?

    b. Provide a discusssion of the model and assumptions used in this transient analysis which explain how the 33 and 202 gpm expansion rates were calculated.

    c. At the end of the description of the transient you state that inadvertent closure of the SCS inlet isolation valves was not analyzed because of the administrative controls you use. We consider this insufficient justification, and require an analysis of this event.

11. On page C-11 in the discussion of the MCP startup transient, you state that assuming a 100°F ΔT is conservative and is "significantly greater" than the normal temperature differential. Give further justification for this assumption. Since the RCS is cooled to 220°F by using the steam generators, and the RCS can be further cooled to <100°F, why could not a larger ΔT be experienced?

12. On page C-16, in section A.I.1 the following formula is presented:

$$h_{CL}(i)\Big|_{t+\Delta t} = h_{CL}(i)\Big|_{t} + \frac{\Delta t * \dot{m}(t + \Delta t/2)}{M_{CL}(i)} * (h_{CL}(i-1) - h_{CL}(i))\Big|_{t}$$

Is the argument of the $\dot{m}$ term:

$t + (\Delta t/2)$ or $(t + \Delta t)/2$?

13. On page C-18, in section A.II you discuss the basic assumptions of the primary system mass. One of the assumptions is:

$$M_{PRES}\Big|_t = M_{PRES}\Big|_{t=0} - \sum_{K=1}^{K} \dot{m}_v(k) * \Delta t$$

This states that the mass in the pressurizer can only remain constant or decrease, (e.g., no pressurizer insurge is allowed). Please discuss further the validity of this assumption after the relief valves lift. Even though the total quantity of the liquid released may be small, is not the system peak pressure dependent on the mass and pressure in the pressurizer as well as the relief valve discharge rate?

14. On page C-18, section A.III, in the formula describing steam generator tube temperatures in the nodes j=2 to j=J-1, is the parameter k in the second term the node's thermal conductivity, or the time index, (used in section A.II)?

15. Section A.IV describes how the time dependent steam generator secondary water temperature is calculated. Address the following:

    a. Discuss why the only source of energy to the primary fluid is the steam generator tubes and secondary fluid. Why is not the stored energy of the steam generator internals (e.g., separators, shrouds) considered as energy sources?

    b. What mass do you use for the parameter M_{SGS} (i)? Is it the liquid in the riser, in the downcomer, or a mixture of both?

    c. In the nodal representation of the SG tubes, describe the method used for establishing the mass of each node and the value used.

16. The pressurizer relief valve discharge rate calculation is described in section A.V. The quantity FRAC sets the fractional flow rate, given the theoretical full open flow at pressure $\underline{P}$. Three fractions are shown, one being time dependent. Explain the use of the time dependent term for determining your relief valve discharge rate. How do you determine the quantity DT? Is the time it takes to reach full open dependent on the system pressure?

17. The determination of the pressurizer relief valve discharge rate is discussed in section A.VII. We will require further information as listed below.

a. What K_D are you using?

b. Appendix XI to ASME Section VIII gives capacity conversions for safety valves. Do your relief valves qualify for using the Figure UA-231 to determine liquid flow rate? How does the value from this figure compare with your computed values? Discuss any differences.

c. You state that assuming a saturated condition in the pressurizer yields a conservative relief valve flow rate. Justify this statement by providing a table of flow rates with corresponding critical pressures, for a number of subcooled and saturated inlet conditions.

d. Describe how you go from the critical flow rate calculated in the formula, to the flow rate vs. system pressure shown in Figure A-1. What back pressure is assumed?

e. Please note that the units for the terms g_c and J are incorrect.

18. The results of your analysis on the MCP flow initiation transient is discussed in section B, on page C-24. We have reviewed these results and request the following additional information:

 a. Please discuss the sensitivity of your analyses to the following:

  1. Number of nodes in the model,

  2. Initial RCS pressure and temperature,

  3. Initial pressurizer temperature,

  4. Initial steam generator temperature.

 b. Perform an analysis of the RCS pressure response assuming:

  1. Both SCS code safety valves and no pressurizer relief valves open.

  2. No relief or safety valves open. (For sensitivity study purposes)

19. Note 2 on page C-27 states that the time dependent fraction used in section A.V is intended to adjust the throat area available for flow. Is this fraction allowed to exceed 1.0?

IV. STAFF POSITIONS AND INFORMATION REQUESTS ON APPENDIX D

1. Your submittal includes analyses of different RCS pressure transient causing events with a variety of mitigating measures. As indicated above, we will require an analysis of each event, based on the mitigating equipment you intend to install. Your response should clearly define the mitigating equipment assumed to be installed, the method of analysis, the single failures considered, and the operator action criterion assumed for:

   a. Inadvertent ECCS operation,

   b. Charging without bleed flow,

   c. Pressurizer heater operation without bleed flow,

   d. Loss of shutdown cooling heat removal capacity.

2. You have indicated that a higher capacity solenoid operated pressurizer relief valve will be installed by June 30, 1978. We require the following information with respect to this new pressure mitigating system.

   a. Your anticipated pressure-temperature limit curves (and Appendix G limits) as they will exist in June 1978.

   b. Your present pressure-temperature curves expire at the end of core cycle XII, (about mid-summer 1977). If analyses show a more restrictive Appendix G limit as a result of vessel irradation, what overpressure protective measures will you implement until the high-capacity valve is installed in June 1978?

   c. Provide justification that the proposed dual setpoint, high capacity pressurizer relief valve will provide sufficient relief capacity with adequate response time during those transients analyzed in your December 1976 submittal.