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TOURIGNY, E. G. PWR Project Directorate 8

SUBJECT: Forwards response to 860818 request for addl info re proposed Tech Specs to incorporate revised pressure temp & low temp overpressure protection limits for RCS.

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FLORIDA POWER & LIGHT COMPANY

SEP 4 1986
L-86-353

Office of Nuclear Reactor Regulation
Attention: Mr. E. G. Tourigny, Project Manager
PWR Project Directorate #8
Division of PWR Licensing - B
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Tourigny:

Re: St. Lucie Unit 2
Docket No. 50-389
Low Temperature Overpressure Protection

By letter L-86-281, dated July 15, 1986, Florida Power & Light Company submitted proposed Technical Specifications to incorporate revised pressure-temperature and low temperature overpressure protection limits for the reactor coolant system. On August 18, 1986 you issued a request for additional information pursuant to NRC staff review of our proposal. The information you requested is attached.

Please contact us if you have any questions about this submittal.

Very truly yours,

C. O. Woody
Group Vice President
Nuclear Energy

COW/MAS/cvb

Attachment

cc: Dr. J. Nelson Grace, USNRC, Region II
Harold F. Reis, Esquire, Newman & Holtzinger

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ATTACHMENT

Re: St. Lucie Unit 2
Docket No. 50-389
Low Temperature Overpressure Protection

Question I

Provide the results of the analyses performed for the St. Lucie Unit 2 plant for the most limiting mass and heat input transients with either Power Operated Relief Valves (PORVs) or Shutdown Cooling Systems (SDCS) relief valves mitigating including the following:

a. Initial conditions and other major assumptions.
b. Systems and components used for event mitigation.
c. Sequence of events including time scale and system parameters.
d. Compare the results of the transients to the acceptance criteria and show that overpressure protection is provided (i.e., does not violate Appendix G limits) over the range of conditions applicable to shutdown and heatup operations.
e. Operator's action during the transients.

Response I

a. Results of the pressure transient analyses of the following over pressurization events provided the basis for the St. Lucie Unit 2 LTOP system:

- RCP start (energy addition)
- Two charging pump operation (mass addition, $T_c \leq 200^oF$)
- Inadvertent actuation of a HPSI pump, with simultaneous operation of three charging pumps (mass addition, $T_c > 200^oF$)

Initial conditions and major assumptions used in these pressure transient analyses are listed below:

Response 1 (con't)

1. Initial RCS pressure = 300 psi

2. Pressurizer inventory is at 417.3°F, i.e., the saturation temperature at 300 psia. This temperature remains constant throughout each transient.

3. Only one PORV or SDCS relief valve (SDCSRV) is available for transient mitigation.

4. RCS is water-solid.

5. Letdown flow paths are isolated.

6. Full pressurizer heaters input and one percent decay heat are considered as additional heat sources.

7. There is no heat absorption or metal expansion at the reactor coolant pressure boundary.

8. PORV capacity is determined based on two discharge models:

   - 'Subcooled water, flashing at outlet' model, for PORV inlet pressures _ 600 psia,
   - 'Subcooled water, non-flashing' model for PORV inlet pressured 600 psia.

9. SDCSRV discharge model is consistent with the ASME Code requirements to relief valves, i.e., the valve opens at 103% of the set pressure, and a rated lift occurs at 10% accumulation.

10. Transients are analyzed up to the point in time, when the transient pressure is either stabilized or starts decreasing.

In addition to the generic assumptions listed above, a number of transient-specific assumptions were used as follows:

Response I (con't)

RCP Start Transient:

1. Secondary-to-primary temperature differential is 40°F.

2. PORV pops open instantaneously up to its full flow position as soon as a PORV setpoint is reached.

3. RCP heat input is considered as an additional heat source.

4. Pressure transient results of the computer code used to analyze these transients represent pressure transients at the relief valve inlets.

Mass Addition Transients:

1. Steam bubble in the pressurizer was assumed to mitigate the one HPSI and three charging pump transient, in addition to Assumption a.4.

2. Peak pressurizer pressures equal the equilibrium pressures if the latter exceed the relief valve opening pressures.

3. If the equilibrium pressures are lower than the relief valve opening pressures, peak pressurizer pressures equal the valve opening pressures (corrected for the PORV inlet piping pressure drops) for transients with the PORV; or the difference in elevations between the SDCSRV and pressurizer for transients with SDCSRV.

b. For transient mitigation, either a PORV (V1474 or V1475) or a SDCSRV (V3666 or V3667) were assumed in the analyses.

c. Attached Figures 3-1 and 3-3 demonstrate RCP start pressure transients mitigated by a PORV with various setpoints and by a SDCSRV with the current setpoint of 350 psia, respectively.

Response I (con't)

d. Pressure transient analysis results, i.e., maximum transient pressures, were evaluated along with pressure/temperature curves to identify conditions which would provide adequate LTOP. So-called controlling pressures were used as the criteria in the evaluation.

The controlling pressure is a pressure limit which will not be exceeded during postulated worst-case overpressurization transients mitigated by a relief valve. Thus, for the SDCSRVs, with the current setpoint of 350 psia, a controlling pressure P = 343 psia was identified. Intersection of the horizontal line corresponding to P = 343 with the P/T limit curves for cooldown, for example, indicate the temperatures below which allowable cooldown rates are reduced to the values marked on the curves next to the subject curves on the left. (Refer to attached Figure 1-4 of Reference 2).

It can be seen that, in the temperature range of 112-128°F, P is more limiting that the 75°F/hr cooldown curve, but less limiting that the 100°F/hr curve. Therefore, in this temperature range, the maximum cooldown rate of 75°F/hr could be allowed.

Thus, applying various controlling pressures to pressure/temperature curves, allowable heatup/cooldown rates, temperature limits for these rates and relief valve alignment temperatures could be determined. These parameters represent operational limitations which should be followed to ensure adequate LTOP.

e. Where applicable operator action was assumed to mitigate a transient 20 minutes following the outset of the transient.

Question 2

Provide a description of the modified Low Temperature Overpressure Protection (LTOP) systems including the subsystem with PORV's and the subsystem with SDCS relief valves. Attach updated Piping and Instrumentation Diagrams (P&IDs) of the systems involved.

Response 2

The modified LTOP configuration includes SDCS relief valves V3666 and V3667, with the current setpoint of 350 psia, and PORVs V1474 and V1475, with a single setpoint of 470 psia.

The SDCSRVs are required to be aligned to the RCS for LTOP at $T_c \leq 42^oF$, during heatup, and at $T_c \leq 161^oF$ during cooldown. The PORVs are required to be aligned at $142^oF < T_c \leq 295^oF$, during heatup, and at $161^oF < T_c \leq 286^oF$, during cooldown. Note that the above temperature limits refer to the operating period up to 5 EFPY. For other operating periods, see Reference 3, Tables 1 thru 7.

It should also be noted that these temperatures are important indicators to watch, especially for cooldown, when failure to take proper actions could result in challenging the Technical Specification P/T limits should an overpressurization event occur. This is demonstrated below using these 5 EFPY temperature limits for illustration.

During cooldown, upon approaching $T_c = 286^oF$, an action is required to verify that both PORV setpoints are switched from the high pressure setpoint used for normal operaton to the low pressure LTOP setpoint of 470 psia. This temperature, 286^oF, identifies the maximum LTOP temperature during cooldown.

$T_c = 161^oF$ indicates a limit, below which the PORV setpoint of 470 psia could no longer provide adequate LTOP without a possibility of exceeding the 5 EFPY P/T limits. Consequently, upon approaching this temperature, an action is required to verify that both SDCSRVs are aligned to the RCS. The PORVs could also remain aligned but the primary means of LTOP are the SDCSRVs.

Response 2 (con't)

The SDCSRVs must remain aligned during cooldown until (1) the reactor vessel head is off, or (2) the RCS is depressurized with an RCS vent of greater than or equal to 3.58 sq. in.

During heatup, T_c = 142°F indicates a temperature limit above which the PORVs with the setpoint of 470 psia could take over the LTOP function from the SDCSRVs. Failure to switch to this setpoint would not create a concern over LTOP. Longer operation under limited pressure conditions such as those prescribed by the SDCSRVs would be the only drawback.

Once the SDCS is secured, the PORVs become the primary means of LTOP. The LTOP setpoint of 470 psia must be maintained up until the RCS temperature reaches T_c = 295°F, at which time the PORV setpoint could be switched back to that used for normal operation. This temperature identifies the maximum LTOP temperature during heatup.

Since no hardware changes are needed to implement the modified LTOP system, the pertinent P&IDs remain unchanged and can be referred to in the St. Lucie Unit 2 Final Safety Analysis Report.

Question 3

Discuss the shutdown and startup plant operating procedures with respect to the instructions for aligning the LTOP systems. Specify the temperatures at which the LTOP systems will be aligned.

Response 3

Operating Procedure 2-0030127, "Reactor Plant Colldown - Hot Standby to Cold Shutdown", provides instructions for the cooldown of the reactor coolant system (RCS) from hot standby to cold shutdown. The procedure states that the aligning of the LTOP system is to be preceded by a functional test of the PORV actuation channels as per Instrument and Control (I&C) Procedure 2-1200054, "Low Temperature Overpressure Protection Setpoint Verification." At this point, the procedure states that the test is to be performed prior to reaching 280°F; a procedure change request is being issued which will be instituted at the time of the license amendment issuance that changes this temperature to be within the limits specified in the response to question two of this submittal, namely $161^{o}F < T_c \leq 286^{o}F$.

An administrative control is imposed by the procedure which states that cooldown is to be suspended until the channel checks are performed.

Instructions are then given to select the "LTOP" setting for the PORV valves; the procedure states that the annunciator will alarm at 280°F, alerting the operator to the need to activate the LTOP system. Annunciation setpoints will be changed and the procedure changed when the license amendment is issued to reflect the new LTOP actuation settings.

After the selection of the LTOP setting for the PORV's, RCS pressure is reduced to approximately 260 psia to allow for the simultaneous operation of the reactor coolant pumps and entry into shutdown cooling. The operator is cautioned to ensure that the RCS hot leg suction valves (V3651, 3652, 3480, and 3481) are open before reducing RCS temperature below 152°F to ensure LTOP protection. As indicated in the response to Question 2, this step of the procedure will be altered to reflect the new limits as given. The lineup of the hot leg suction valves ensures the availability of the SDCRV's to relieve overpressure.

Response 3 (con't)

Additional overpressure protection is provided in Operating Procedure 2-0010125, "Schedule of Periodic Tests, Checks and Balances." A shift surveillance is performed to ensure that a manual vent of $\geq$ 3.58 sq. in. remains open when required for overpressure protection.

During heatup, extensive system venting is performed if required once the RCS is filled, and temperature is raised to 325°F whereupon shutdown cooling is isolated. At approximately 320°, annunciators will alarm, alerting the operator to select the "normal" setting on the PORV valve switches, thus returning the PORVs to the normal high pressure setting.

Question 4

Discuss the technical specifications for the modified LTOP systems operability and necessary Limiting Conditions for Operation (LCO) for plant protection from overpressure during shutdown and startup operations.

Response 4

The response to Question 2 defines the modified LTOP configuration as consisting of the two SDCRV's, V3666 and V3667, and the two PORV's, V1474 and V1475.

The LCO's specifically relating to the PORV's and overpressure protection are a part of the proposed license amendment and are directly available to the reviewers.

The shutdown cooling relief valves are a part of the shutdown cooling system, and are considered to be a part of the individual shutdown cooling loops. These loops are required to be available, in various configurations, in modes 4 through 6. As the SDCRV's are passive components of these systems, no specific LCO addresses the valves. Surveillance requirements are covered under specification 4.0.5; as the valves are the Quality Class B, they are included as Class 2 equipment and must meet the specifications of ASME Code Section XI.

Question 5

Discuss all administrative controls required to implement the LTOP systems.

Response 5

The administrative controls necessary to provide LTOP are procedural in nature, and are discussed in the response to Question 3.

Procedural controls require that the LTOP system be aligned when the RCS pressure/temperature parameters fall within the bounds given by the appropriate pressure/temperature curves. Initially, the PORV's are aligned via a valve selection switch to the "LTOP" position; no further administrative controls are required as the PORV's will remain in this configuration while the RCS is at low temperatures and the reactor vessel head secured.

Procedural controls also govern the SDCRV's; shutdown cooling is required to be available through modes 4 to 6. As stated in the response to Question 5, a procedural requirement is given for the entry point into shutdown cooling according to the appropriate pressure/temperature curve parameters.

Question 6

Demonstrate that water solid overpressure transients will not exceed 110% of the design pressure of any component in the SDCS.

Response 6

Water-solid overpressure transients will not exceed 110 percent of the design pressure of any component in the SDCS. Justification is provided below.

At the lower RCS temperatures such as those below 142°F during heatup and below 161°F during cooldown, for operation up to 5 EFPY, (1) the most limiting postulated overpressurization event is the RCP start transient, with a secondary-to-primary Δt of 40°F. The maximum pressurizer pressure during this transient when mitigated by one SDCSRV is 342.7 psia, per Reference 2, page 38. Note that this pressure is the basis for establishing the controlling pressure of 343 psia which is discussed earlier in the response to Question 1, Item d. Also note that this pressure refers to the pressurizer upper instrument nozzle elevation.

The most limiting SDCS design pressure was assumed to equal 350 psig, which is the LPSI pump maximum suction pressure, per Reference 4, Table 6.3-1, and also the SDCS suction piping design pressure. Note that this pressure refers to the LPSI pump suction centerline. The value of 110 percent of this pressure is 1.1 x 350 = 385 psig, or 399.7 psia.

To make a comparison, the maximum transient pressure of 342.7 psia is adjusted to the LPSI pump suction centerline elevation, which is approximately 82 ft. below the pressurizer upper instrument nozzle elevation, per References 5, 6, 7, and 8. The corresponding static head at a conservatively assumed temperature of 100°F is (82) x (62.035)/144 = 35.3 psi.

Accordingly, the maximum transient pressure adjusted to the LPSI pump centerline is 342.7 + 35.3 = 378.0 psia, which is less than 110 percent of the most limiting SDCS design pressure of 399.7 psia.

(1) Refer to Tables 1 thru 7, of FPL letter L-86-281, dated July 15, 1986, for these and similar temperature limits for other operating periods.

Question 7

Describe how the flashing of water at the discharge of the SDCS relief valve has been accounted for in the sizing of the valve or in the overpressure analysis.

Response 7

The SDCSRV discharge model used in the pressure transient analyses was based on liquid discharge, i.e., subcooled water with no flashing all the way through the valve outlet.

As indicated in the response to Question 1, Item a, the initial RCS pressure of 300 psia was assumed in the pressure transient analyses. The corresponding saturation temperature is approximately 417°F.

The SDCSRVs are required to be aligned to the RCs for LTOP up to a RCS temperature (T_C) between 161°F and 207°F for 5 EFPY and 32 EFPY, respectively, per Reference 3, Tables 1 thru 7. Accordingly, during SDCSRV discharge, minimum water subcooling at the valve inlet will be 256°F and 210°F, respectively.

Based on test data, such a degree of subcooling is considered high enough to sustain liquid flow through the valve outlet. It should be noted that due to the valve excessive rated capacity, i.e., 2300 gpm at the setpoint of 335 psig, per Reference 4, page 6.3-9, the pressure transients are mitigated even before the rated lift is reached. The valve discharge model is outlined in the response to Question 1, Item a.

Question 8

Discuss the adequacy of the margin between the maximum pressure resulting from an overpressurization event and the setpoint for the automatic isolation of the shutdown cooling system.

Response 8

Per Reference 4, Subsection 7.6.1.1, the SDCS suction isolation valves are interlocked with pressurizer pressure such that they will automatically close as RCS pressure increases above 500 psia.

As indicated in the response to Question 6, the maximum pressurizer pressure during the most limiting overpressure transient mitigated by one SDCSRV is 342.7 psia.

Comparison of the above pressure values shows that a margin of approximately 157 psi exists between the maximum transient pressure and the pressure at which the SDCS is automatically isolated. This margin is considered to be more than adequate to preclude losing LTOP during startup and cooldown operations.

Note that the pressure signals to the interlocks are provided by the same pressure channels which are used for pressurizer pressure indication.

Question 9

Describe the alarms provided to alert the operator to: .

a. Properly enable the systems at the correct plant conditions during cooldown.
b. Indicate if a pressure transient is occurring.

Response 9

LTOP System Alarms

a. PORV LTOP Condition Alarm

During cooldown when the "Mode Selector Switch" is in the "Normal" position and cold leg temperature reaches the new setpoint determined by the applicable P/T curve, a "PORV LTOP Condition" alarm will alert the operator to select "LTOP" on the "Mode Selector Switch", thus changing the PORV actuation setpoint from 2370 psia to 470 psia for V1474 and V1475. This alarm will not reset unless the PORV mode selector switch is in the "LTOP" position and the motor operated isolation valve of the associated PORV is "OPEN".

b. PORV Normal Condition Alarm

During heatup when the "Mode Selector Switch" is in the "LTOP" position and cold leg temperature is greater than 320°F, a "PORV Normal Condition" alarm will alert the operator to select "Normal" on the "Mode Selector Switch"; thus changing the PORV actuation setpoint from 470 psia for V1474 and V1475 to 2370 psia. This alarm will not reset unless the PORV Mode Selector Switch is in the "Normal" position and its associated isolation valve is "OPEN". Therefore, one alarm will be lit during normal operation as long as one PORV remains isolated.

c. LTOP Transient Alarm

When RCS temperature (cold leg) is less than the given setpoint or the mode selector switch is in "LTOP" and pressurizer pressure is greater than 460 psia, an LTOP transient is occurring, actuating the "LTOP Transient" alarm.

d. PORV Test Condition Alarm

A "PORV Test Condition" alarm will alert the operator whenever the PORV protective system is in the "Override" or "Test" position, bypassing all setpoints. The PORV will remain closed in this condition until the selector switch is placed in the "OFF" position at which time the alarm will reset.

e. Indicating Lights

Open and close position indicating lights have been located in the control room, informing the operator of the actual stem position of each PORV. Indicating lights are not energized or deenergized from the solenoid valve circuitry. Indicating lights are controlled from the valve stem position.

Each isolation valve is provided with a two-position open-close switch for valve operation. Open and close position indicating lights are also provided for each motor operated isolation valve.

A test indicating light will be provided for each PORV and let whenever the PORV protective system control circuitry has been bypassed (in "OVERRIDE") or has been tested satisfactorily.

Question 10

To assure operational readiness the LTOP system must be tested in the following manner:

a. A test must be performed to assure operability of the system's electronics prior to each shutdown.
b. A test for valve operability must, as a minimum, be conducted as specified in the ASME Code Section XI.

Response 10

As was mentioned in the response to Question 3, PORV channel checks are performed by the Instrument and Control department before reaching the PORV LTOP actuation temperature and before the reactor head may be reset after refueling or head removal. This specification is included in the license amendment proposed by FPL for St. Lucie Unit 2.

The SDCRV's are Quality Class B, Class 2 valves and are therefore surveilled according to Technical Specification 4.0.5 within the requirements of ASME Code Section XI.