Florida Power
CORPORATION

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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating Licensing No. DPR-72
Reactor Coolant Pump Trip
NUREG 0737, Item II.K.3.5
Request for Additional Information (TAC 49668)

Dear Sir:

This letter responds to your March 28, 1988 request for additional information regarding the Crystal River Unit 3 (CR-3) Reactor Coolant Pump Trip issue.

Question 1

The generic BWOG analysis (Ref. 2 of NRC letter dated March 28, 1988) supports the use of "loss of subcooling margin" as the appropriate RCP trip criterion. The analysis indicated that each licensee needed to account for instrumentation uncertainties when determining the critical SCM setpo'nt value used to trip the pumps. The use of multiple subcooling margin (SCM) setpoints, which varied according to the reactor coolant pressure, was not discussed.

a. Explain how two SCM setpoints (20F and 50F) are used to assess the need for RCP trip, i.e. describe the Emergency Operating Procedures and training which enable the operator to properly diagnose the event and/or symptoms. Explain the significance of the 1500 psig switch-point (Ref. 1,6 of NRC letter dated March 28, 1988).

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Response to Question 1a

The selection of the two fixed margin SCM setpoints at 20F and 50F (RC pressure >1500 psig and SCM <20F; RC pressure ≤1500 psig and SCM <50F) was made for several reasons:

Florida Power Corporation has selected an approach where two fixed margin SCM setpoints are utilized in lieu of a single SCM setpoint. Use of a single SCM setpoint that bounds the errors for the entire measurement range would result in a very conservative (large) SCM setpoint which is required to bound instrumentation errors at low pressures and temperatures. This is due primarily to the slope of the saturation curve. For instance, a 100 psi pressure error at 2300 psig converts into approximately a 6F temperature error. The same 100 psi pressure error at 300 psig converts into approximately a 30F temperature error. For this reason, a single SCM setpoint of about 50F would be required to encompass the instrumentation errors at low pressures and temperatures.

The selection of the RCS pressure switch-point at 1500 psig was made for several reasons:

1. The original criterion for tripping RC pumps was at the low RC pressure ES actuation. Thus, the operators had been previously trained to trip the RC pumps at 1500 psig.

2. The 1500 psig ES and HPI actuations are alarmed. The alarms and previous training result in 1500 psig being a logical switch-point.

Note that if RC pumps are not tripped within two minutes of violating either of these criteria, then the operators are instructed to <u>not</u> trip the RC pumps, since forced circulation will ensure adequate core cooling even though it may result in RC pump damage.

The symptom based Emergency Operating Procedures direct the operator to trip the Reactor Coolant Pumps when the subcooling margin conditions are lost. There is an alarm to indicate High Pressure Injection at 1500 psig. There is another alarm which informs the operator that subcooling margin has been lost. The operator is trained to trip the reactor coolant pumps when subcooling margin conditions are not met.

Question 1 (continued)

b. Identify the preferred method for measuring the subcooling margin. SPDS pressure/temperature curve, or SPDS Inadequate Core Cooling curve. Verify that the operator is adequately trained to recognize a bad reading and to use an alternate method to get the correct SCM indication.

Response to Question 1b

There are only two methods used to measure SCM; the Tsat meters and the SPDS SCM curve. The preferred method for measuring subcooling margin is the Tsat digital subcooling margin meters. There are two (2) redundant Tsat digital meters in the control room. The SPDS SCM curve is utilized by the operator to determine the direction of change to the SCM plot. Per ATOG, ICC will only occur after the subcooled core cooling has been lost and the RCS has become saturated and severely voided to the point where the core has become uncovered. The ICC curve is only used by the operators after subcooling has been lost. The operator training programs adequately train the operators to recognize a bad reading and to use alternate methods to determine the correct subcooling margin indication.

Question 1 (continued)

c. The Licensee indicated [Ref. 1 of NRC letter dated March 28, 1988] that implementation of the RCP trip strategy and the calculation of instrumentation uncertainties is consistent with the B&W Reports [Ref. 4, 5 of NRC letter dated March 28, 1988]. The instrumentation uncertainties were identified for 1550 psig, but not for pressures below 1500 psig at which point the SCM setpoint value changes from 20F to 50F. The Licensee needs to verify that the maximum instrumentation uncertainties occur at 1500 psig, or demonstrate that the uncertainties at pressures below 1500 psig are less than 50F. The Licensee can provide information copies of the B&W Reports [4, 5 of NRC letter dated March 28, 1988] to resolve this question, if it is appropriate.

Response to Question 1c

Florida Power Corporation presently uses two methods of monitoring SCM at Crystal River 3: (1) Tsat meter (preferred method), and (2) SPDS SCM curve. The results of the uncertainty analysis for these two methods are given in Table 1. Note that the instrumentation uncertainties for the "accident environment" were calculated using the worst-case large break LOCA conditions (i.e. 298F and 1.9 x10 RADS), even though the RC pump trip issue is limited to concerns during small break LOCA's. This conservative approach was selected because of the availability of detailed environmental conditions in the reactor building for the DBA event and the limited environmental information available for the small break LOCA conditions.

The results given in Table 1 indicate that the 20/50F SCM setpoints are not bounding for either the SPDS SCM curve under accident conditions or the Tsat meter below 300 psia. The inability to satisfy the 20/50F SCM setpoints appears to be due largely to the use of conservative large break LOCA containment environmental conditions. However, actual instrument errors during the early phases of a small break LOCA should be similar to the normal environment errors given in Table 1 which are bounded by the 20/50F SCM setpoints. The engineering judgement basis is that a small break LOCA contributes a less harsh environment because fuel damage has not occurred and reactor building temperatures are less severe than a DBA event.

Question 1 (continued)

d. Verify that the uncertainty values and SCM setpoints are applicable for the three methods of measuring SCM, identified in question b. If the uncertainties and SCM setpoints for any method are different than those described, indicate the basis for acceptance.

Response to Question 1d

As stated above, Florida Power Corporation presently uses two methods of monitoring SCM at Crystal River Unit 3: (1) Tsat meter (preferred method), and (2) SPDS SCM curve. The uncertainties associated with the measurement of SCM for the Tsat meter and SPDS SCM curve are given in Table 1. The difference in uncertainty between the Tsat meter and the SPDS SCM curve are due primarily to the following:

1. The Tsat meter uses a single pressure input over the entire measurement range, while the SPDS uses pressure inputs (i.e., 2 low-range and 2 wide-range). the use of the low-range pressure transmitters in the SPDS gives the SPDS a higher accuracy at low pressures (i.e. RCS <450 psia) than the Tsat meter.

2. At high pressures (i.e. RCS >450 psia), the SPDS uses two different models of pressure transmitters:

   - Rosemount 1154 with an "R" series output board for improved response under high radiation fields, and

   - Rosemount 1153 with a "P" series output board.

Based on the SPDS string error calculations under accident conditions, the Rosemount 1154 string error is ±103.75 psig and the Rosemount 1153 string error is ±302.70 psig. Since the SPDS can select either pressure string, the total SPDS string error was calculated assuming the worst-case errors using the Rosemount 1153 pressure string. The Tsat meter uses a single Rosemount 1154 pressure transmitter with an "R" series output board. Based on the Tsat error calculation, the error in the Rosemount 1154 pressure string for the Tsat meter under accident conditions is ±114.5 psig. Consequently, at high pressures the Tsat meter uncertainties are significantly less than the SPDS uncertainties.

The basis for acceptance of the difference in uncertainty values is Tsat is digital and the preferred measuring parameter used to determine RCP trip while the SPDS SCM curves are primarily used to determine a trend. Furthermore, CR-3 operators are trained to base the tripping of the RCP's when subcooling margin is lost.

Question 2

The Licensee's response to Question A.3 did not provide enough information to determine how the generic assumptions used in the BWOG analyses affect the results as they apply to Crystal River Unit 3. Therefore, identify the plant specific features that are not representative of the reference plant used in BWOG 77-1149091 (Ref. 2 of NRC letter dated March 28, 1988). At a minimum FPC should discuss core power, decay heat, HPI capacity, makeup flows, setpoints for steam generator safety valves, reactor trip, safety injection, and accumulator injection. Show that the values used in the generic analyses are either representative of those for Crystal River or are conservative. If a reference plant parameter is not conservative for Crystal River, discuss

how this was considered in determining the plant specific setpoints.

Response to Question 2

The BWOG analysis performed, which supported using loss of SCM as an appropriate criterion for tripping RCP's, included a combination of conservative analysis as well as realistic or "best-estimate" analysis for two types of events: (1) small break LOCA's and (2) SGTR events.

For the small break LOCA's evaluated, both a conservative and a "best-estimate" analysis was performed. The major difference between these two analyses is that the conservative analysis assumed a decay heat multiplier of 1.2, while the "best-estimate" analyses assumed a decay heat multiplier of 1.0. A comparison of both of these analyses to Crystal River 3 is given in Table 2. These results indicate that the generic small break LOCA analyses performed for the 177 Fuel Assembly (FA) plants is representative for Crystal River 3.

For the SGTR event, only a "best-estimate" analysis was performed. A comparison of this analysis to Crystal River 3 is given in Table 3. These results indicate that the generic SGTR analysis performed for the 177 FA plants is also representative for Crystal River 3.

Based on these comparisons, it is concluded that the B&W Owner's Group generic analyses performed to justify tripping RC pumps on loss of SCM can be applied to Crystal River 3.

Question 3

In the response to question B.1 the Licensee indicated that certain valves (seal injection, NSCW supply and return line) must be removed from the containment isolation signal in order to permit RCP operation. Provide justification of this modification to demonstrate that the RCP is operable after a containment isolation signal occurs.

Response to Question 3

The RCP's are tripped upon loss of SW flow caused by containment isolation. The Byron Jackson owners have developed a significantly improved RCP seal which will be utilized at CR-3 beginning in 1989. FPC is re-evaluating the need and justification for removal of the containment isolation signal to the seal return and RCP cooling flow paths. This will be provided with the associated license amendment request.

Question 4

In the response to question C the Licensee indicated that the Crystal River Unit 3 Emergency Operating Procedures (EOPs), which address primary system voids, are in compliance with the generic Technical Basis Document (TBD). Describe the basis for acceptance by identifying the appropriate procedures. e.g. operator training, restore natural circulation, restore primary to secondary heat transfer, "feed and bleed" procedures, and (if applicable) monitoring RCP motor current as an indication of primary void fraction.

Response :

The Technical Basis Document indicates that the lack of adequate subcooling margin may cause voids in the hot legs which could impede heat transfer to the secondary side. The Technical Basis Document recommends actions to be taken when adequate subcooling margin does not exist. Emergency Operating Procedures AP-380, Engineered Safeguard Actuation and AP-530, Natural Circulations cover restoration of primary to secondary heat transfer, natural circulation, and "feed and bleed" operations provide guidance to the operator to recognize the loss of subcooling margin and to perform immediate and followup actions. All operators are trained on Emergency Operating Procedures through the requalification program and the B&W simulator.

Sincerely,

Rolf C. Widell, Director
Nuclear Operations Site Support

RCW/EMG/sdr

xc: Regional Administrator, Region II

Senior Resident Inspector

TABLE 2, SMALL BREAK LOCA COMPARISON

PARAMETER	GENERIC 177FA ANALYSIS	CRYSTAL RIVER-3	C.	COMMENTS
Core Thermal Power	2772 MW_t	2544 MW_t	Conservative	A higher core thermal power level in the analysis is conservative because this results in a larger shutdown decay heat load and a lower initial subcooling margin.
Decay Heat Multiplier				
o Conservative	1.2	Not Applicable	Not Applicable	Analysis Assumption.
o "best-estimate"	1.0	Not Applicable	Not Applicable	Analysis Assumption.
HPI System Capacity (1 Pump)	500 gpm @ 600 psig	500 gpm @ 600 psig	Representative	The HPI system capacity used in the analysis is consistent with the HPI design flow curve used in the ECCS analysis.
MU System Capacity (1 Pump)	No Makeup	150 gpm @ 2100 psig with MU Valve at VWO	Conservative	No makeup was modeled in the analysis.
LPI Capacity	3150 gpm @ 0 psig/pump	4600 gpm @ runout/ pump	Conservative	The LPI flow curve used in the analysis is consistent with the LPI design flow curve used in the ECCS analysis. The conservative analysis assumed that 1 LPI pump was operating while the "best-estimated" analysis assumed that 2 LPI pumps were operating.

TABLE 1, SUMMARY OF STRING ERROR UNCERTAINTIES
FOR HOT LEG RTD TEMPERATURE INPUTS

RCS Pressure in psia	Fixed Subcooling Margin (SCM) in °F	T_{sat} Meter Uncertainties in Terms of SCM (°F)		SPDS P/T Curve Uncertainties in Terms of SCM (°F)	
		Normal Environment	Accident Environment (NOTE 1)	Normal Environment	Accident Environment (NOTE 1)
150	50	23.29	87.03	42.83 (Note 2)	67.57 (Note 2)
350	50	13.51	45.57	27.33 (Note 2)	40.08 (Note 2)
550	50	10.83	32.78	23.14	72.68
750	50	9.61	26.33	21.31	60.27
950	50	8.95	22.47	20.19	52.70
1150	50	8.54	19.90	19.43	47.55
1350	50	8.28	18.61	18.90	43.92
1550	20	8.08	16.67	18.45	40.89
1750	20	7.94	15.55	18.09	38.47
1950	20	7.82	14.57	17.78	36.35
2150	20	7.74	13.90	17.55	34.84
2350	20	7.66	13.24	17.33	33.33
2550	20	7.61	12.72	17.15	32.12

NOTE 1 A conservative reactor building environment based on large break LOCA worst-case temperatures and radiation was assumed for the accident environment.

NOTE 2 Below 450 psia, the SPDS transfers to low range pressure transmitters.

TABLE 2, SMALL BREAK LOCA COMPARISON
(Continued)

PARAMETER	GENERIC 177FA ANALYSIS	CRYSTAL RIVER-3	CATEGORY	COMMENTS
Core Flood Tank				
o total volume	1410 ft^3	1410 ft^3	Representative	
o borated water	1040 ft^3	1040 ft^3	Representative	
o cover gas pressure	600 psig	600 psig	Representative	
Automatic Reactor Trip				
o signal	Low RC Pressure	Low RC Pressure		
o setpoint	1900 psia/1885 psig	1800 psig	Representative	For the break sizes analyzed, the higher RPS trip setpoint used in the analysis could result in a few second delay in reactor trip. However, this would not significantly affect the results. Conclusions drawn from the analysis will remain valid.
MSSV Lift Setpoints	1061/1081/1101/1110 psig	1050/1070/1090/1190 psig	Representative	The analysis assumed a slightly higher SG heat sink pressure. This will tend to maintain the RCS at a slightly higher total energy level which will result in a slight reduction in the time to lose subcooling margin.

TABLE 3, STEAM GENERATOR TUBE RUPTURE (SGTR) COMPARISON

PARAMETER	GENERIC B&W ANALYSIS	CRYSTAL RIVER-3	CATEGORY	COMMENTS
Core Thermal Power	2568 MW_t	2544 MW_t	Conservative	A higher core thermal power level in the analysis is conservative because this results in a larger shutdown decay heat load and a lower initial subcooling margin.
Decay Heat Multiplier	1.0	Not Applicable	Not Applicable	Analysis Assumption
HPI System Capacity in(1 Pump)	500 gpm @ 600 psig	500 gpm @ 600 psig	Representative	The HPI system capacity used the analysis is consistent with the HPI design flow curve used in the EOTS analysis.
MU System Capacity (1 Pump)	150 gpm @ 2100 psig	150 gpm @ 2100 psig	Representative	The makeup (MU) flow rate used in the analysis is always less than or equal to the actual valve wide open (VWO) flow at Crystal River 3. The analysis is bounding with respect to the plant because less makeup flow results in a faster reduction in pressurizer liquid volume.
LPI Capacity	4000 gpm @ 0 psig	4000 gpm @ runout	Representative	No LPI Actuation
Core Flood Tank				
o total volume	1410 ft^3	1410 ft^3	Representative	
o borated water volume	1040 ft^3	1040 ft^3	Representative	
o cover gas pressure	600 psig	600 psig	Representative	

TABLE 3, STEAM GENERATOR TUBE RUPTURE (SGTR) COMPARISON
(Continued)

PARAMETER	GENERIC 177FA ANALYSIS	CRYSTAL RIVER-3	CATEGORY	COMMENTS
Automatic Reactor Trip	None	Not Applicable	Not Applicable	With operator actions per ATOG, no automatic reactor trip occurs.
MSSV Lift Setpoints	1050/1085/1102/1102 psig	1050/1070/1090/1100 psig	Representative	Since operator actions are taken per ATOG to reduce reactor power and then manually trip plant at low power, the MSSV's do not lift. Therefore, these setpoints have no effect on the analysis.
Initial Pressurizer Level	180 inches	220 inches	Conservative	A lower initial pressurizer level in the analysis is conservative because it provides a reduced margin to reactor trip and primary system saturation.
Total Pressurizer Heater Power	1553 KW	1638 KW	Conservative	A lower pressurizer heater power in the analysis is conservative because it gives a reduced capacity to stabilize primary pressure and avoid a reactor trip while operating at high power levels.