

May 12, 1981

Docket No. 50-206
LS05-81-05-013



Mr. R. Dietch
Vice President
Nuclear Engineering and Operations
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Dietch:

SUBJECT: SAN ONOFRE 1 - SEP TOPIC XV-9 STARTUP OF AN INACTIVE LOOP OR
RECIRCULATION LOOP AT AN INCORRECT TEMPERATURE, AND FLOW CONTROLLER
MALFUNCTION CAUSING AN INCREASE IN BWR CORE FLOW RATE.

Enclosed is a copy of our evaluation of SEP Topic XV-9 for San Onofre Unit 1. This assessment compares your facility with the criteria currently used by the regulatory staff for licensing new facilities. Please inform us if your as-built facility differs from the licensing basis assumed in our assessment within 30 days of receipt of this letter.

This evaluation will be a basic input to the integrated safety assessment for your facility unless you identify changes needed to reflect the as-built conditions at your facility. This assessment may be revised in the future if your facility design is changed or if NRC criteria relating to this subject is modified before the integrated assessment is completed.

Sincerely,

Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

Enclosure: As stated

cc w/enclosure:
See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D. C. 20555

May 11, 1981

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A handwritten signature in cursive script that reads "Dennis M. Crutchfield".

Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing

Enclosure: As stated

cc w/enclosure:
See next page

Mr. R. Dietch

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TOPIC XV-9 STARTUP OF AN INACTIVE LOOPIntroduction

Operation of a reactor at power with a reactor coolant loop out of service (i.e., the reactor coolant pump shutdown) results in a decrease in the coolant temperature in that loop. A subsequent restart of the idle reactor coolant pump without bringing that loop closer to system average temperature would then inject colder water mixed with the flow from the active loops into the core. The resultant reactivity insertion could exceed that which the Reactor Control System is able to follow, leading to an increase in power and pressure and subsequent reduction in margin to departure from nucleate boiling (DNB).

Criteria

The criteria presently used by the staff for evaluating startup of an inactive loop are given in Standard Review Plan Sections 15.4.4 and 15.4.5. The review should verify that the plant responds in such a way that the criteria regarding fuel damage and system pressure are met (i.e., no more than a small fraction of the fuel rods fail, that radiological consequences are a small fraction of the 10 CFR Part 100 guidelines, and that the system pressure is limited in order to protect the reactor coolant pressure boundary from overpressurization).

Evaluation

San Onofre 1, a three loop plant, has no valves to isolate a reactor coolant loop; therefore, operation of two reactor coolant pumps will result in backflow through the idle loop, in turn causing a reverse ΔT in the loop; i.e., the temperature of the normal hot leg falls below that of the reactor inlet. A temperature interlock and alarm is provided for each loop to prevent starting a reactor coolant pump in an inactive loop if a reverse ΔT exists greater than a preset value. Restarting an idle loop can be accomplished by reducing load which reduces the ΔT in the active loops to a value which will allow the idle loop pump to start. By Technical Specifications, the power level for operation with a loop out of service is limited to 10%.

Since there is no means of isolating a steam generator, the maximum idle loop temperature depression (with very small backflow) is limited by the temperature of the turbine cycle, thus providing an inherent limit on the severity of the transient. The range of possible inverse ΔT conditions is determined for a range of predicted backflow rates, and an analysis of the core response was performed by the licensee in the Final Safety Analysis for the most severe cases assuming the ΔT interlock to fail.

The transient following startup of an inactive loop is calculated with a detailed plant simulation on computer. A conservative calculation is made for low backflow and a conservative estimate of the overall heat transfer coefficient for the idle steam generator is made. These conditions yield the maximum idle loop temperature depression and the maximum initial power with two out of three loops. The reverse ΔT interlock and alarm will prevent a restart of the idle loop until the temperature difference is less than 5°F. For this transient the interlock is assumed to be inoperative. The pump is assumed to accelerate to full flow instantaneously and the entire idle loop hot leg at the reduced temperature is swept into the core. A conservative maximum negative moderator coefficient is assumed. As a limiting condition the cold water is assumed to reach the core without mixing with the active loop flows, but is assumed to mix with the water in the inlet plenum. The core response is calculated assuming a temperature change is occurring throughout the core. A low value of Doppler coefficient is assumed thus yielding the maximum power increase as a result of the cold water.

For the purpose of this transient calculation, the ratio of power level to coolant flow through the core is assumed to be a constant, since this yields the minimum steam pressure, and the greatest possible temperature decrease in the inactive loop. This assumption also results in the smallest initial margin to DNB. A high heat transfer coefficient from reactor cycle to turbine cycle in the inactive loop is used. This is approximately 85 percent of its normal full load value, whereas, the heat transfer coefficient will decrease a greater amount at the low load level at which the inactive loop is operating - approximately 18 percent of its normal full load value.

The licensee's results show that a backflow rate of 20,800 gpm in an idle loop was determined for operation with two out of three reactor coolant pumps running. The flow rate through the active loops is 74,500 gpm each, an increase over the normal flow with three loop operation. The resulting total core flow is then 128,200 gpm or about 65 percent of normal three loop flow. The resulting cold leg temperature in all loops is 542°F and the hot leg temperature in the inactive loop is 505°F. The steam generator temperature in the inactive loop is 500°F so the inactive loop is approaching its minimum possible value using the high transfer coefficient. The hot leg temperature in the idle loop cannot go below the steam temperature. The assumed Doppler coefficient is -1×10^{-5} δk per °F and the moderator temperature coefficient is -3.5×10^{-4} δk per °F. The transient results shown in Figure 1 are computed assuming the full 37°F temperature decrease is imposed at the inlet to the reactor vessel. Credit is taken for a mixing delay in the reactor inlet plenum but no credit for flow mixing with the two active loops.

The peak nuclear power drops from 185% in about eight seconds. Thermal flux of about 85 percent is reached. The reactor trip is from overpower at 100 percent. The licensee believes this is a conservatively high value since the overpower trip at this power level would be set to give a maximum trip level of 80 percent of full power.

Since the peak thermal power is less than full power and the inlet temperature is less than the full power value there is margin to DNB. The minimum DNB ratio is 3.1 and occurs at about 10 seconds.

Figure 2 shows the effect of flow mixing with the active loops. The temperature change at the reactor vessel inlet plenum then becomes -12°F instead of -37°F . All other parameters are identical to those for the transients shown in Figure 1. In the case of the reduction of flow mixing with the active loops the pressurizer's pressure peak is significantly reduced. The actual transient would lie somewhere between the two results and would most likely be represented by the results which assume flow mixing. The results also show that the change in pressurizer pressure is less than 100 psia.

Conclusion

The San Onofre 1 plant has an interlock which prevents startup of an inactive loop unless the temperature in the idle loop is within 5°F of the temperature in the other loops. Even under the assumption that this interlock fails, the consequences have been shown to satisfy the criteria. Therefore, we conclude that with respect to this topic, the San Onofre analysis meets current criteria and is acceptable.

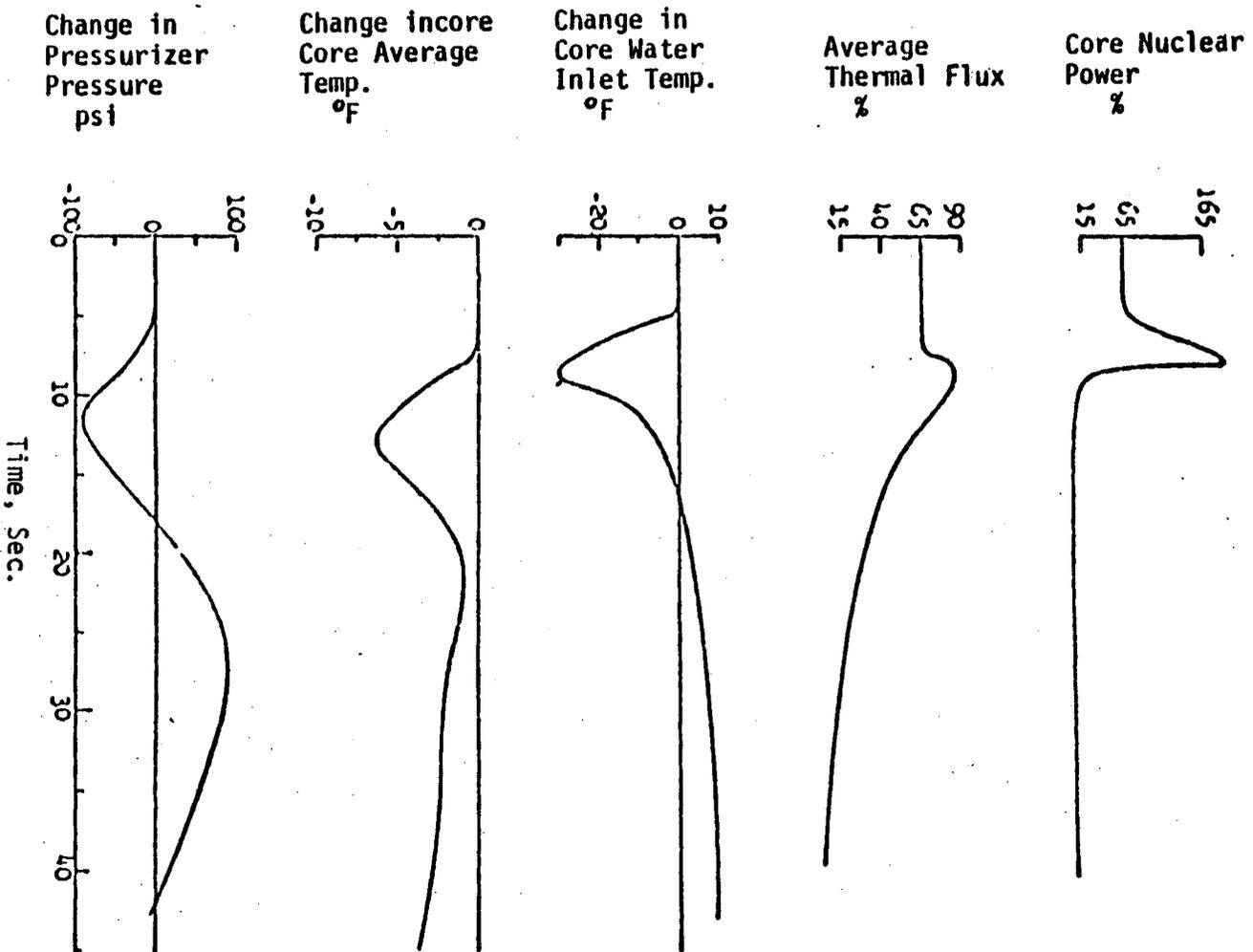


Figure 1
 Transient Response for Startup of an Inactive Loop With Full Temperature Decrease

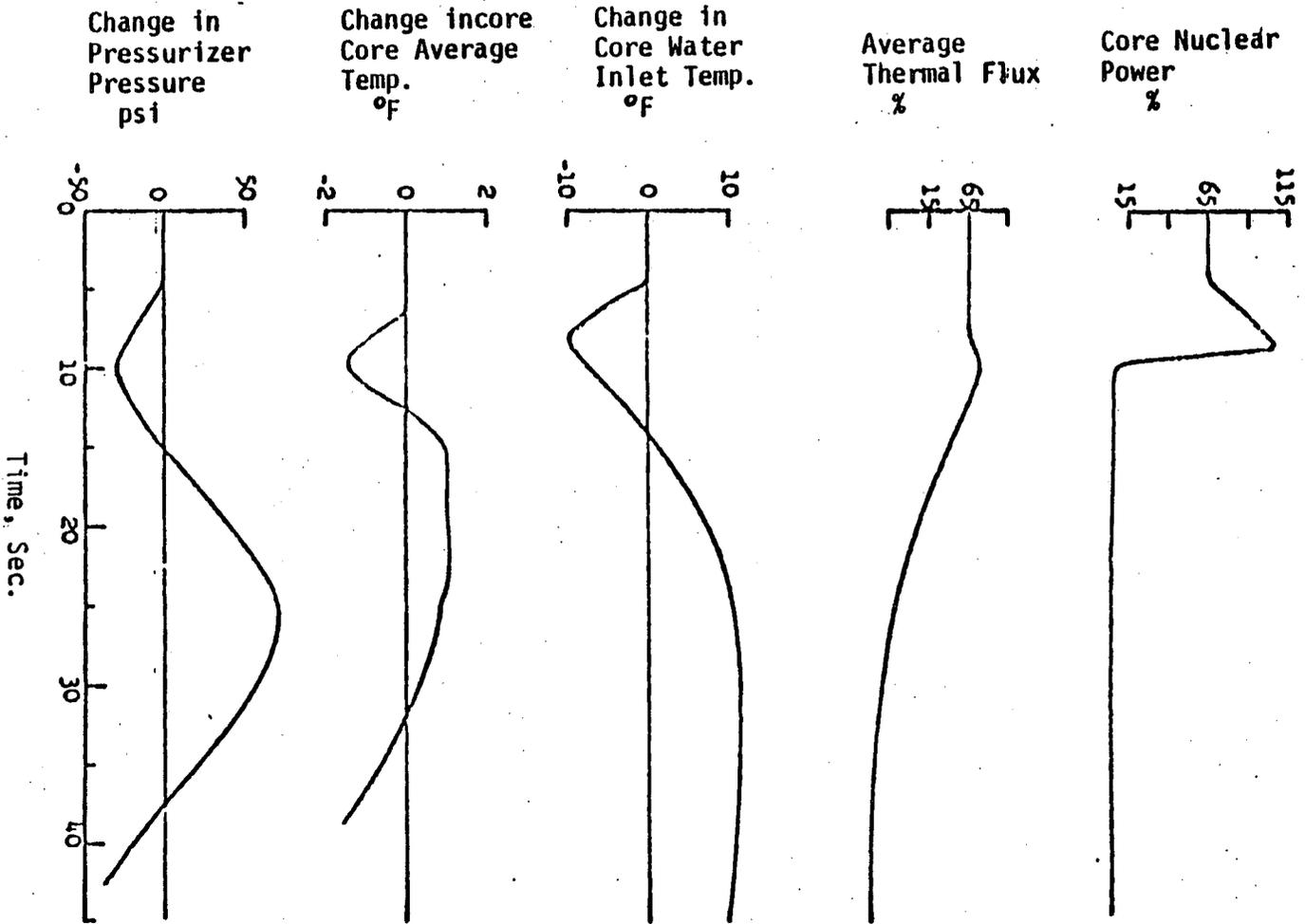


Figure 2
 Transient Response for Startup of an Inactive Loop Without
 Full Temperature Decrease