OAK RIDGE NATIONAL LABORATORY
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April 6, 1984

Mr. Eric H. Johnson, Manager
U. S. Nuclear Regulatory Commission Region IV
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Dear Mr. Johnson:

Subject: Monthly Report - "ORNL Assistance in Evaluating Licensing Request - FSV L.C.O. 4.1.9", for Period Ending March 31, 1984 (FIN No. A9351).

Work Completed During Reporting Period

Investigations of the proposed amendments to Fort St. Vrain (FSV) Tech Spec L.C.O. 4.1.9 continued. The intent of this tech spec is to ensure that core temperatures are properly limited during startup and shutdown (typically between 0-15% power and flow). The object of this task is to provide technical support to NRC-RIV in their review of the changes to L.C.O. 4.1.9 proposed by Public Service Co. of Colorado (PSC). This work is supported in part by the Division of Accident Evaluation's HTGR safety research program at ORNL (B0122).

Information requested from PSC on FSV startup and shutdown transients was received and reviewed. Mag tapes with plant data logger outputs for a Nov. 1983 startup and the most recent (Jan. 1984) shutdown have been adapted for use on ORNL computers, along with PSC's "HISTORY" program for reading, deciphering, printing, and plotting the data. PSC also supplied calculated region peaking factors (RPF's) at crucial points in the runs so that the ORECA code could be set up to simulate the runs. PSC personnel have been very cooperative and helpful in this phase of the project.

The ORECA code was set up and run for the major "stopping points", and good agreement between the steady-state calculations and data was found. In each case the agreement was optimized by varying the assumed core bypass flow fraction, and the optimum bypasses were well within expected ranges.

The PSC HISTORY code was modified to do further investigations of possible problems with tech spec violations. The L.C.O. 4.1.9 and 4.1.7 "sniffer" routines recently added to ORECA were adapted to HISTORY and run with the startup and shutdown data. For L.C.O. 4.1.9, flow "margins" (actual core flow/minimum allowable flow) are output when Fig. 1 (equal-flow orifice settings)

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is applicable, and region temperature rise "margins" (maximum allowable ΔT minus worst-case measured ΔT) are output when Fig. 2 (orifices anywhere) is applicable. For L.C.O. 4.1.7, the worst-case margin (maximum allowable region outlet temperature minus the worst-case measured outlet temperatures) is calculated both for the startup case (average core outlet <950°F) and for the conditions (>950°F) specified by Fig. 4.1.7-1. In the latter analysis, all region outlet temperature readings are taken at face value rather than using comparison regions for some, as is done in the most recent version of the tech spec.

Preliminary observations from the runs made to date are:

1) The L.C.O. 4.1.9 sniffer detected periods of (Fig. 1) "violations" before the actual startup, when the reactor power was zero and the maximum core temperatures were <250°F. This indicates a need for clarification of the tech spec.

2) The sizes of the margins (or approaches to non-compliance) depended a lot on the method of core flow calculation. Core flow is used directly as a margin parameter in L.C.O. 4.1.9 Fig. 1, and figures into the power calculation for both Figs. 1 and 2. The data logger program generates several estimates of core flow that sometimes differ widely. The method of deriving flow used for the tech spec calculations should be clearly established, understood, and verified where possible. For example, using the flow calculation from the reactivity status ("REACT") program (data logger list #183) the L.C.O. 4.1.9 sniffer showed total non-compliance times after the actual startup of 0.2 hr (Fig. 1) and 6.2 hr (Fig. 2), while if the HISTORY program "RX" flow calculation (data logger list #251) is used, the total times out of compliance were much less - 0.4 hr (Fig. 1) and 1.0 hr (Fig. 2). In none of these cases was the maximum core temperature near an unsafe limit nor were any regions close to a flow stagnation condition. Assuming the "RX" flow calculation to be correct, the periods of non-compliance were short enough such that no tech spec violations were detected.

3) Using an algorithm for detecting compliance to L.C.O. Fig. 4.1.7-1, which shows allowable mismatches between region outlet temperatures and the average core outlet, some non-compliance times were detected for cases that were off-scale on the graph - i.e. where the curves were extrapolated to values of average core ΔT below 660°F. These were all cases where the measured region outlet temperatures were quite low (<1200°F), so there would not be any real problem with overheating. However, this does point out operating regions where there are no applicable tech specs for limiting core temperatures. Again, some clarifications would be in order.

Funds Spent for Person Power (Estimated Costs)

Previous	Present Period	Cumulative
\$6300	\$4700	\$11,000

Note: Funding authorization for an additional \$13,000 for this project was sent to ORNL on March 23, 1984, making the total \$33,000.

Problems or Delays Encountered or Anticipated

The data tape from FSV containing plant data logger outputs for the startup of Nov. 3, 1983 and the shutdown of Jan. 17, 1984 arrived at ORNL Mar. 7, 1984. It soon became obvious that a special program was needed to decipher the tape, and, per our request, PSC sent us a copy of the "HISTORY" program for reading their data tapes. This arrived on Mar. 19. Subsequent delays were encountered when the initial outputs from the HISTORY program were garbage. The problem turned out to be due to machine errors made here when copying the original FSV data tape onto a "working tape". After a second try at copying the tape, all data looked correct. These delays have set us back about 2-3 weeks total.

Plans for the Next Reporting Period

As noted in previous monthly reports, the basis and method used to generate the limitations in L.C.O. 4.1.9 are seen to be unnecessarily restrictive. By limiting the operating parameters to more reasonable and achievable values, more latitude on allowable core flows and region outlet temperatures could be achieved without the danger that region flow stagnation would occur. In the next reporting period, the ORECA code will be used to check the actual margins for flow stagnation at various crucial points in the startup and shutdown runs for which data was supplied by PSC. A recommended format and outline of an alternative L.C.O. 4.1.9 will be developed.

Yours truly,

Syd Ball

S. J. Ball, Manager
HTGR Safety Studies for NRC

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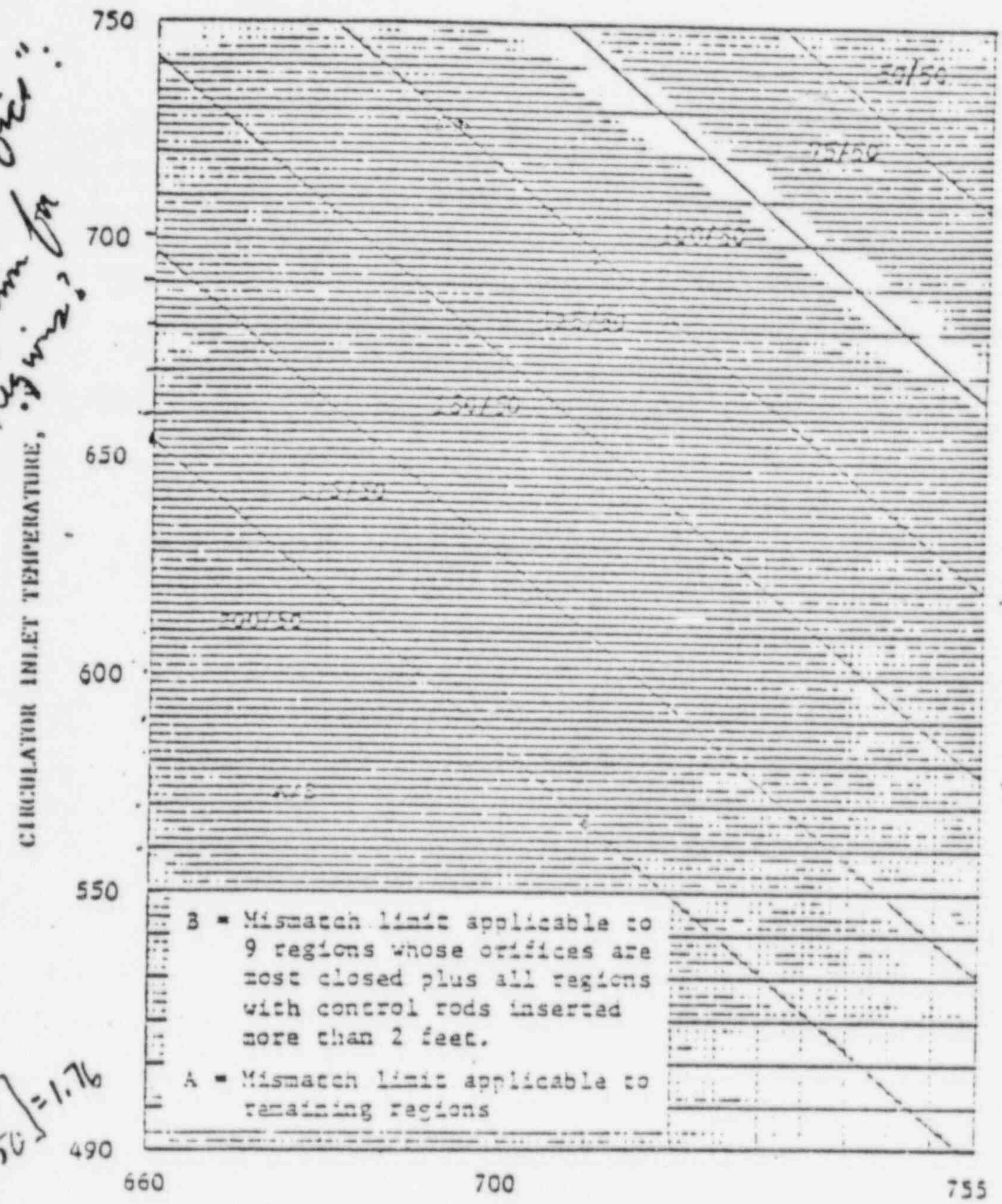

AVERAGE TEMPERATURE RISE FROM CIRCULATOR INLET TO CORE OUTLET, °F

↙ FOR T_{CO} AVG > 950°F

Figure 4.1.7-1. Allowable Difference (Mismatch) Between Region Outlet Temperature and Core Average Outlet Temperature

[For T_{CO} AVG < 950°F, TMAX = T_{CO} AVG + 400°F]