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

March 28, 1986

Docket No. 50-267

MEMORANDUM FOR: Oliver D. T. Lynch, Jr., Section Leader
Standardization and Special
Projects Directorate
Division of PWR Licensing-B

FROM: Kenneth L. Heitner, Project Manager
Standardization and Special
Projects Directorate
Division of PWR Licensing-B

SUBJECT: SUMMARY OF MEETING WITH PUBLIC SERVICE COMPANY OF COLORADO (PSC) TO DISCUSS FORT ST. VRAIN (FSV) TECHNICAL SPECIFICATIONS (TS) - LCO 4.1.9 ON MARCH 13, 1986

References:
1. Letter to E. J. Butcher, NRC, from H. L. Brey, PSC, dated November 22, 1985 on Revised Draft of LCO 4.1.9, Core Region Temperature Rise
2. Letter to E. H. Johnson, NRC, from S. J. Ball, ORNL, dated January 10, 1986, on Monthly Report "ORNL Assistance in Evaluating Licensing Request - FSV LCO 4.1.9"
3. Memo to H. Berkow, NRC, dated December 20, 1986, on FSV TS Upgrade Changes

This memorandum summarizes a meeting held with PSC at the Region IV NRC Office in Arlington, Texas on March 13, 1986. Discussions were held with PSC on their proposed draft for LCO 4.1.9 (Reference 1). The staff's contractor, Oak Ridge National Laboratory (ORNL), had reviewed this submittal and provided comments in Reference 2. Additional staff comments in Reference 3 were also discussed with PSC.

The attendees at this meeting are given in Enclosure 1.

A summary of the resolution of the comments in References 2 and 3 follows.

Reference 1

Comment 1 - PSC stated that plant operators monitor compliance with LCO 4.1.9 more frequently as they manipulate the reactor controls during power changes. The staff observed that the approach for this LCO should be consistent with other LCOs that affect power, flow, and region temperature differential. Surveillance requirements at a higher frequency during power changes should be consistent with the time requirements for action in the LCO.

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Comment 2 - PSC stated that the final curves would include the 26 percent power level. These curves are shown in Enclosure 2, a redraft of the proposed Technical Specification.

Comment 3 - PSC agreed that the proposed action statements for the reactor shutdown were unclear. The proposed LCO would be revised with separate sections for the reactor in operation and the reactor in shutdown.

Comment 4 - PSC will explain in the basis why the reactor is operated in the equal flow mode below about 4 percent power. Potentially, Figure 4.1.9-3 could be labeled to show the range of equal flow operation.

The need to cross reference other LCOs will also be considered.

Comment 5 - No further discussion needed.

Comment 6 - PSC stated that the accuracy of the measured differential pressure used to calculate flow had been improved. Thus, accuracy of flow data at low flow rates was not a problem. The staff was concerned that if flow remained zero because of circulator problems, then no action would be required since thermal power would be zero. PSC agreed that a loss of flow with sufficient after heat would require consideration of LCO 4.2.18. The action statement would be modified to reflect this situation.

Comment 7 - PSC proposed that the equal orifice setting cover a range of 8 to 20 percent open. This would be clarified in the basis for the LCO.

All comments on the basis for the LCO were accepted by PSC.

Reference 2

Comment 1 - PSC agreed with the suggested changes.

Comment 2 - PSC stated that they had examined the instrumentation which supported LCO 4.1.9 and most was covered by current surveillance requirements. They still needed to compare the instrumentation against the proposed surveillance requirements of the TS Upgrade Program.

PSC agreed to consider including all supporting instrumentation in the upgraded TS.

Comments 3&4 - PSC supplied draft definitions of these terms in Enclosure 3.

Comments 5&7 - PSC agreed to relabel the curves to clarify that they apply for a range of helium densities.

Comment 6 - PSC agreed to utilize an expanded scale in the range of 0 to 5 percent power, as an aid to reading the figures. The limits to the curves in Figure 4.1.9-3 would be explained.

Comments 8&9 - PSC accepted these comments.

In addition, PSC noted that additional data on the basis for the 760°F bulk core temperature concept were submitted in their letter, P-86169. They noted that the supporting calculations for this evaluation would be provided by the reactor engineers, not the plant operators.

The staff and PSC agreed that LCO 4.1.9 should be submitted and initially approved in the current TS format. PSC agreed to submit a final draft by April 30, 1986 and an amendment request by June 15, 1986.

original signed by

Kenneth L. Heitner, Project Manager
Standardization and Special
Projects Directorate
Division of PWR Licensing-B

Enclosures:
As stated

cc w/enclosures:
See next page

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Kenneth L. Heitner

Kenneth L. Heitner, Project Manager
Standardization and Special
Projects Directorate
Division of PWR Licensing-B

Enclosures:
As stated

cc w/enclosures:
See next page

Mr. R. F. Walker
Public Service Company of Colorado

Fort St. Vrain

cc:

Mr. D. W. Warembourg, Manager
Nuclear Engineering Division
Public Service Company
of Colorado
P. O. Box 840
Denver, Colorado 80201

Mr. David Alberstein, 14/159A
GA Technologies, Inc.
Post Office Box 85608
San Diego, California 92138

Mr. H. L. Brey, Manager
Nuclear Licensing and Fuel Division
Public Service Company of Colorado
P. O. Box 840
Denver, Colorado 80201

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O.Box 640
Platteville, Colorado 80651

Kelley, Stansfield & O'Donnell
Public Service Company Building
Room 900
550 15th Street
Denver, Colorado 80202

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Chairman, Board of County Commissioners
of Weld County, Colorado
Greeley, Colorado 80631

Regional Representative
Radiation Programs
Environmental Protection Agency
1800 Lincoln Street
Denver, Colorado 80203

Albert J. Hazle, Director
Radiation Control Division
Department of Health
4210 East 11th Avenue
Denver, Colorado 80220

Mr. J. W. Gahm, Manager
Nuclear Production Division
Public Service Company of Colorado
16805 Weld County Road 19-1/2
Platteville, Colorado 80651

Mr. L. W. Singleton, Manager
Quality Assurance Division
Fort St. Vrain Nuclear Station
16805 Weld County Road 19-1/2
Platteville, Colorado 80651

Enclosure 1

Attendees
Meeting PSC - NRC
on March 13, 1986
in Arlington, Texas

Name	Organization
Ken Heitner	NRC/NRR/PBSS
M. H. Holmes	Nuclear Licensing, PSC
Syd Ball	ORNL
Chuck Fuller	PSC, FSV Station Manager
Rick Kapernick	GA Technologies
Jack Levin	Grove Engineering
D. Alberstein	GA Technologies
R. E. Ireland	NRC-RIV
D. R. Hunter	NRC-RIV, RSB
J. P. Jaudon	NRC-RIV
J. E. Gagliardo	NRC-RIV

DRAFT - MARCH 13, 1986

REACTOR CORE AND REACTIVITY CONTROL

LCO 4.1.9 CORE INLET ORIFICE VALVES/MINIMUM HELIUM FLOW and MAXIMUM CORE REGION TEMPERATURE RISE

LIMITING CONDITION FOR OPERATION

The total reactor helium coolant flow or the helium coolant temperature rise for all core regions shall be maintained within the limits given in Table 4.1.9-1.

APPLICABILITY: Power levels below 25%, including shutdown with decay heat.*

ACTION: a. Wi' any of the above limits exceeded, either:

1. Increase the region helium coolant flow or correct the out-of-limit condition within 15 minutes, or
2. Be in at least REACTOR SHUTDOWN within 1 hour with the inlet orifice valves adjusted for equal region coolant flows within the following 8 hours.

SURVEILLANCE REQUIREMENTS

The total reactor coolant flow or the helium coolant temperature rise through all core regions shall be determined to be within the above limits at least once per 12 hours.

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* With the calculated bulk core temperature greater than 760 degrees F.

Table 4.1.9-1

REGION ORIFICE POSITION	REACTOR PRESSURE HELIUM DENSITY	LIMITING CONDITION FOR OPERATION
All regions set for equal region coolant flow*** EXCEPT Up to 5 regions may have their orifices further open.	Greater than 50 psia with helium density* greater than 60%.	The total core helium coolant flow shall be greater than or equal to the minimum allowable value shown on Figure 4.1.9-1.
As above.	Greater than 50 psia with helium density* less than or equal to 60%.	The total core helium coolant flow shall be greater than or equal to the minimum allowable value shown on Figure 4.1.9-2
All regions set for equal region coolant flow.***	Less than or equal to 50 psia.	The helium coolant temperature rise** through any core region shall not exceed 600 degrees F.
Orifice valves at any position (Adjusting for equal region outlet temperature).	Greater than 50 psia	The helium coolant temperature rise** through any core region shall not exceed the limit shown in Figure 4.1.9-3.
Orifice valves at any position (Adjusting for equal region outlet temperature).	Less than or equal to 50 psia	The helium coolant temperature rise** through any core region shall not exceed 350 degrees F.

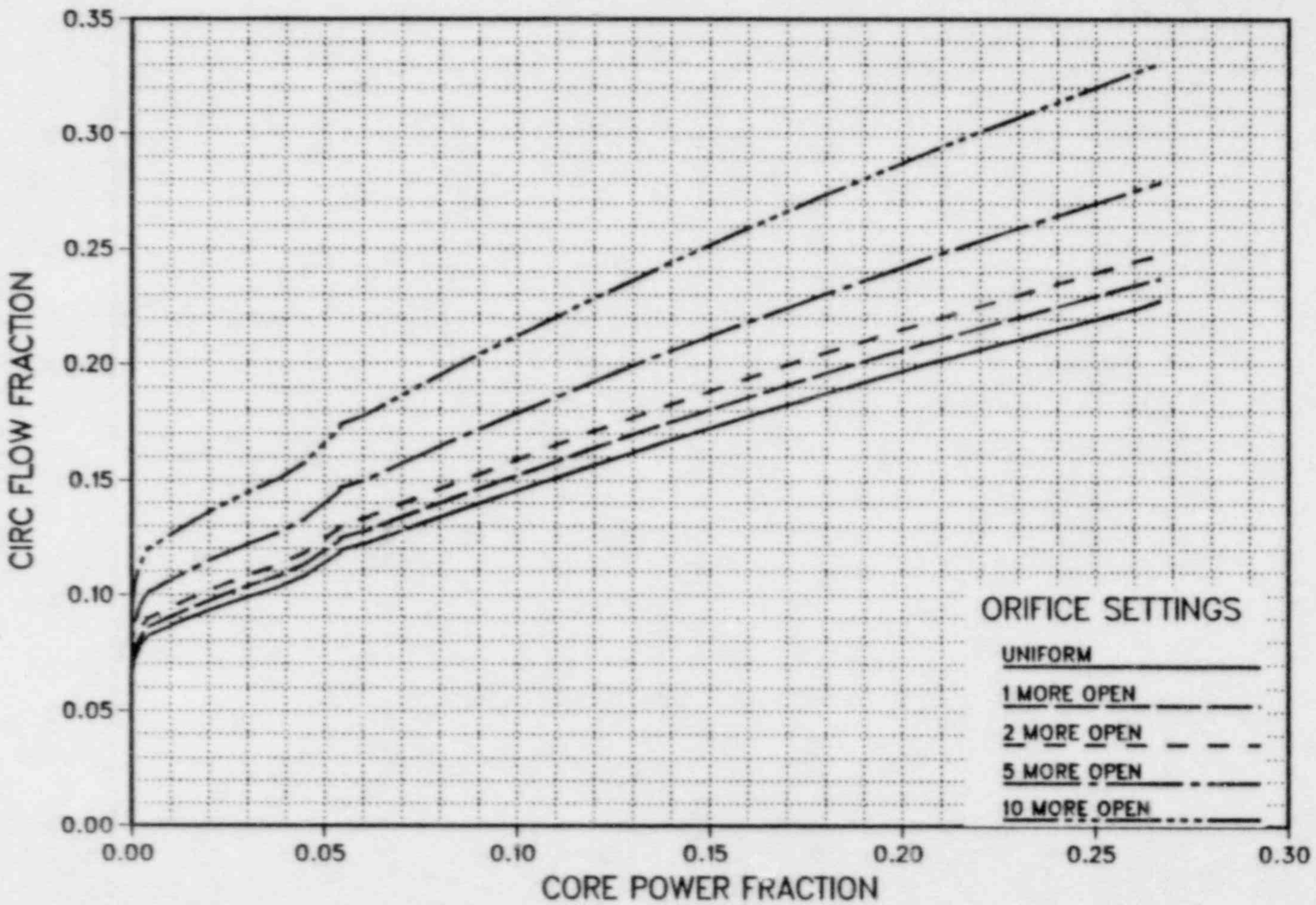
* Percent helium density equals:

$$\frac{175.12 \times \text{Reactor Pressure (psia)}}{\text{(Circulator inlet temperature (degrees F) plus 460)}}$$

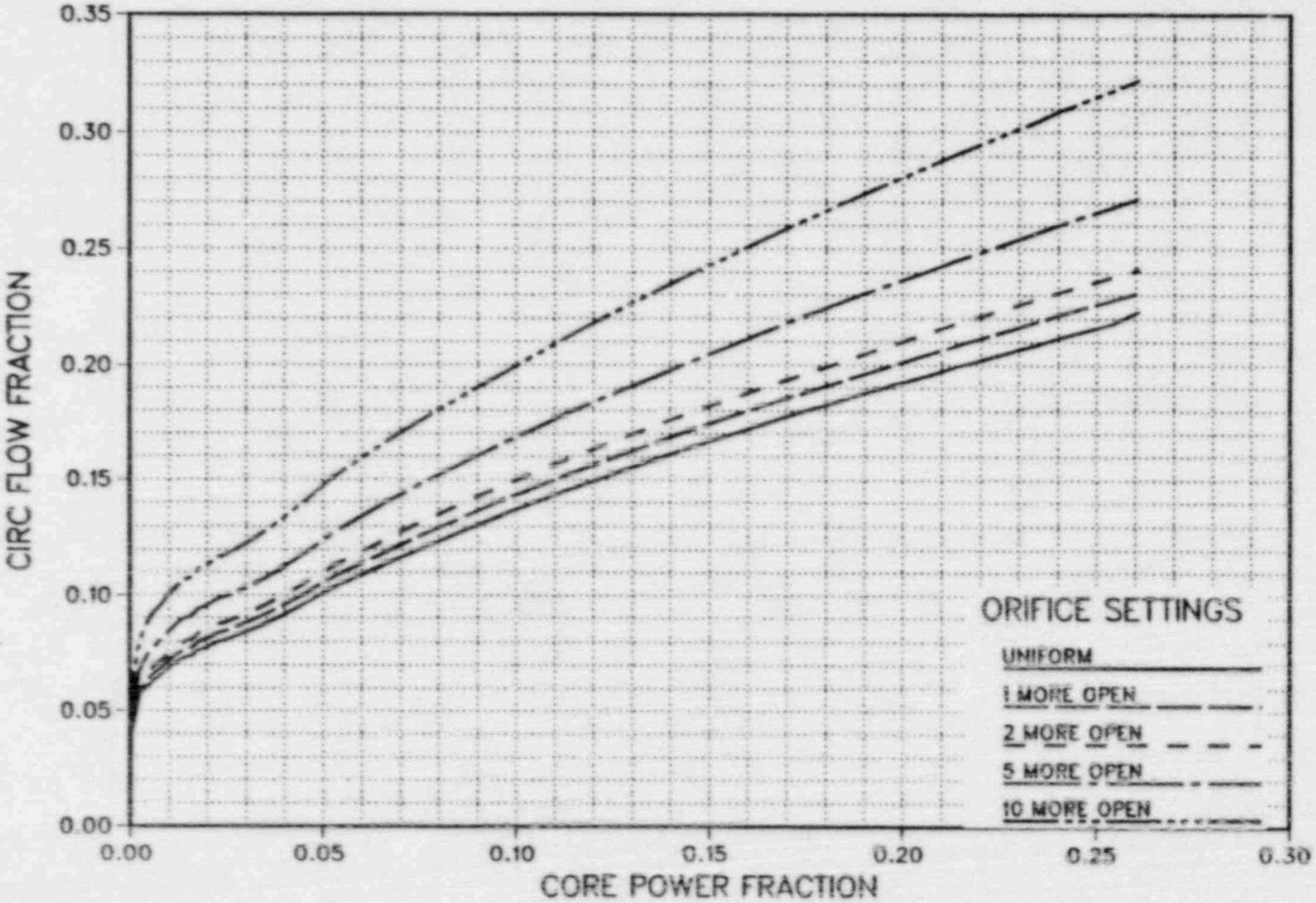
** Helium coolant temperature rise equal INDIVIDUAL REFUELING REGION OUTLET TEMPERATURE minus CORE AVERAGE INLET TEMPERATURE

*** Equal region coolant flow with orifice valves set between 8% and 20% open.

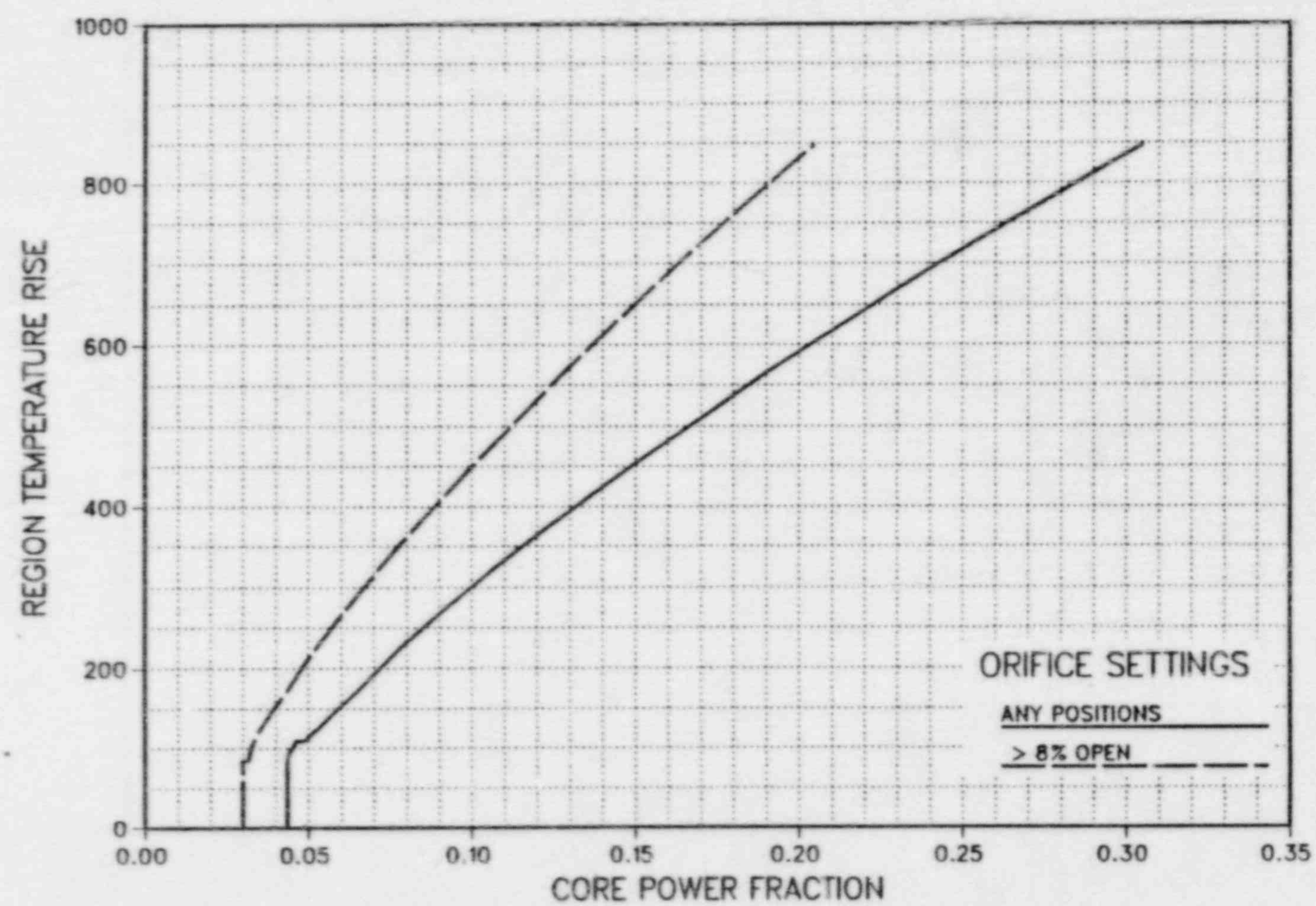
60%–107.5% HELIUM INVENTORY
ORIFICE POSITIONS OF 8%–20% OPEN



BELOW 60% HELIUM INVENTORY
ORIFICE POSITIONS OF 8%–20% OPEN



107.5% HELIUM INVENTORY



BASIS FOR SPECIFICATION LCO 4.1.9

The minimum reactor helium coolant flow or the maximum core region helium coolant temperature rise as a function of calculated reactor thermal power (including power for decay heat) have been specified to prevent very low helium coolant flow rates through any coolant channel. Very low helium coolant flow rates may result in laminar flow conditions with resultant high friction factors, low heat transfer film coefficients, and potential for possible local helium flow stagnation or reverse flow, which could result in excessive fuel temperatures.

This Specification addresses minimum flow requirements for all coolant channels. Since low coolant flows exist at lower reactor powers, its applicability is limited to less than approximately 25% RATED THERMAL POWER. Since thermal power is continuously generated by decay heat even after the reactor is shutdown, the flow requirements are also applicable in the REACTOR SHUTDOWN mode. **This specification is not applicable when the CALCULATED BULK CORE TEMPERATURE is less than 760 degrees F. If the active core is below this temperature, which corresponds to the design maximum core inlet temperature, then the design core inlet temperature could not be exceeded and there is no possibility of damage to fuel or PCRV internal components regardless of the amount, or even total absence of, primary coolant helium flow. The applicability of this Specification is lso limited to the range of power level indicated in**

Figures 4.1.9-1, 4.1.9-2 and 4.1.9-3. Above the power levels for which limits are shown in the Figures, the Reactor Core Safety Limit, Specification 3.1, governs. In addition to this Specification, fuel integrity is ensured for power levels from 0 to 100% by limiting the INDIVIDUAL REFUELING REGION OUTLET TEMPERATURES to values given in Specification 4.1.7.

The CALCULATED BULK CORE TEMPERATURE is the predicted, time dependent, average temperature of the core, including graphite and fuel, but not the reflector, that occurs following a loss of all forced circulation of primary coolant flow. The calculation uses several conservative assumptions including: 1) that the core heatup rate remains constant during the heatup at the initial value which is calculated based on the decay heat from most restrictive recent power history or at an empirically determined, 2) that the composite specific heat, volume, and density of the core remain constant during the heatup at the initial values, and 3) that all decay heat generated after the assumed loss of forced circulation is retained in the active core with no heat transfer to the reflector, PCRV internals or primary coolant.

The limits have been developed based upon a number of conservative assumptions. For the limits in Figures 4.1.9-1 and 4.1.9-3, it was assumed that the primary system was pressurized to full inventory (107.5 percent of design helium density was used in the analysis). At lower densities, higher region temperature rises and lower core coolant flow are acceptable. Since startup operations can proceed

with lower helium densities, after the reactor has been pressurized to greater than 100 psia, which corresponds to about 30 percent helium inventory at 200 degrees F, flow requirements were calculated for 60% helium density and are given in Figure 4.1.9-2. Percent helium density equals:

$$\frac{175.12 \times \text{Reactor Pressure (psia)}}{\text{(Circulator inlet temperature (degrees F) plus 460)}}$$

The core inlet helium temperature used in the analysis cover the range of 100-400 degrees F between 0 and 5% RATED THERMAL POWER and 100-700 degrees F between 5 and 25% RATED THERMAL POWER. These are reasonable assumptions for low power operation.

In the analysis to determine the limits, the effects of heat conduction between columns in a region, or between regions, were conservatively neglected. Envelope values of RPF/Intra Region Peaking Factors (3.0/1.25 and 1.6/1.61) were used to anticipate worst case conditions considering all future fuel cycles. Consistently conservative nominal values and uncertainties were used for bypass flows and measured parameters throughout the analysis. For the condition with orifice valves at any position, the allowable region delta T is based upon a region peaking factor equal to 0.4. For regions with high[illegible]wer densities, higher region delta T's are acceptable.

The analysis also accounts for maximum uncertainty in the instrumentation used to measure the necessary input parameters. Thus, the Specification limitations can be

applied directly to measured values without further consideration of instrument calibration accuracy and no instrumentation surveillance beyond routine calibration is required.

Besides the minimum flow requirement curves with the orifices set for equal region flows in Figures 4.1.9-1 and 4.1.9-2, flow requirements are provided with a number of orifice valves positioned further open. These curves allow for a minimum number of orifices stuck open as well as assisting in the transition between equal region flows and equal region outlet temperatures. By monitoring the total reactor coolant flow when the orifices are adjusted for equal region coolant flows, minimum flow through each region at the appropriate power can be assured. When the orifice valves are adjusted to different positions, minimum coolant flows can be assured for each region by monitoring the helium coolant temperature rise in that region.

- For depressurized operations, limits area also specified to prevent very low helium coolant flow rates through any coolant channel. These limits have been established based upon a 50 psia reactor pressure.

To ensure that flow stagnation in a fuel column or region does not persist. an action time of only 15 minutes is allowed to correct the out of limit condition.

The requirement to be in REACTOR SHUTDOWN within 1 hour with the orifices set for equal flows in an additional 8 hours is realistic because it takes from 4-6 hours to set the orifice valves from

equal temperatures to equal region flows. This is considered acceptable since there is sufficient primary coolant flow from the circulators which are driven by steam generated from residual heat in the system following REACTOR SHUTDOWN.

In performance of the surveillance, the total reactor helium coolant flow is determined by calculation based on measured circulator inlet nozzle low range delta P, temperature and pressure. This is consistent with the method to determine the required flow in the analysis. Procedures require that the flow rate be monitored whenever the power level is being changed to ensure that the requirements of this Specification are satisfied, but the surveillance is required once per shift (12 hours) and is consistent with other Specifications.

DEFINITIONS

CALCULATED BULK CORE TEMPERATURE

The CALCULATED BULK CORE TEMPERATURE shall be the calculated average temperature of the core, including graphite and fuel, but not the reflector, assuming a loss of all forced circulation of primary coolant flow.

CORE AVERAGE TEMPERATURE

a. During SHUTDOWN and REFUELING, CORE AVERAGE TEMPERATURE shall be the arithmetic average of CORE AVERAGE INLET TEMPERATURE and the CORE AVERAGE OUTLET TEMPERATURE.

b. During STARTUP, LOW POWER, and POWER, CORE AVERAGE TEMPERATURE shall be thermodynamically calculated based on CORE AVERAGE INLET and CORE AVERAGE OUTLET TEMPERATURES, PRIMARY COOLANT FLOW, and reactor power.

CORE AVERAGE INLET TEMPERATURE

The CORE AVERAGE INLET TEMPERATURE shall be the arithmetic average of the operating circulator inlet temperatures, adjusted for circulator power input, steam generator regenerative heat loads, and PCRV liner cooling system heat losses.