Public Service Company of Colorado

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50-267

August 14, 1984
Fort St. Vrain
Unit #1
P-84223

Mr. E. H. Johnson, Chief
Reactor Project Branch 1
Region IV
Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

SUBJECT: PSC Response to ORNL Questions & Comments Regarding LCO 4.1.9

REFERENCES: (1) NRC Letter, Johnson to Lee, Dated 5-23-84

(2) PSC Letter, Warembourg to Johnson, Dated 6-22-84

(3) NRC Notice of Significant Licensee Meeting (G-84196)

(4) NRC Notice of Significant Licensee Meeting (G-84280)

Dear Mr. Johnson:

By way of Reference (1), Public Service Company of Colorado (PSC) was requested to provide a response to the concerns and proposal identified in the May 9, 1984 Oak Ridge National Laboratory (ORNL) Interim Report. Due to the complexity of the issue, PSC, in Reference (2), suggested that a meeting be held with cognizant individuals from each organization involved. This suggestion was found mutually agreeable, and the meeting was scheduled for June 28, 1984, via Reference (3). On June 23, 1984, however, an additional PSC and NRC concern manifested itself when 6 of 37 control rods failed to automatically insert upon a high reactor pressure scram signal, and the meeting to discuss LCO 4.1.9 was cancelled. On August 9, 1984, this meeting was rescheduled for August 23, 1984, by way of Reference (4).

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This letter serves to provide a written response to the ORNL concerns and proposal provided with Reference (1) and to provide a basis for discussion of ORNL/PSC concerns and a more expeditious resolution to the issues delaying the implementation of a revised LCO 4.1.9. The PSC responses are provided in Attachment 1.

If you have any questions, please contact Mr. Chuck Fuller of my staff at (303) 785-2223.

Very truly yours,

J W Gahm

J. W. Gahm
Manager, Nuclear Production

Attachment

cc: S. J. Ball (ORNL)

JWG/djm

RESPONSES TO ORNL QUESTIONS AND COMMENTS

1. ORNL has stated the proposed amendment contains non-conservative features. This comment appears to stem at least in part from a misunderstanding of the intent of LCO 4.1.9. The intent of LCO 4.1.9 is not by itself to ensure that fuel temperatures are limited. The intent of LCO 4.1.9 is to ensure that flow stagnation or reverse flow will not occur during low power operation. LCO 4.1.9 is part of a group of LCOs which collectively serve to limit fuel temperatures.

   At low power, these are LCO 4.1.3 (limits power distributions), LCO 4.1.7 (limits region exit temperature mismatches), as well as LCO 4.1.9. At higher power, the potential for flow stagnation ceases to be a concern, and fuel temperatures are limited by the combination of LCO 4.1.3, LCO 4.1.7, and S.L. 3-1 (the core thermal safety limit).

   The role of LCO 4.1.7 in limiting fuel temperatures is acknowledged by ORNL; however, it is implied by ORNL that, even considering LCO 4.1.7, cases exist where fuel temperatures are not properly limited. We would like to obtain further understanding of these concerns through discussions with ORNL.

2. Another comment concerns "an overly conservative approach that has been taken for specifying the range of allowable RPFs, intra-region maximum column power tilts and region orifice coefficients for a given power level." The development of any limit involves a tradeoff between the range of applicability and simplicity of implementation and enforcement on one hand, and the degree of conservatism and potential operational difficulties on the other. These were carefully evaluated when the LCO 4.1.9 limit was developed, because it was known the limit would be difficult to meet in a low power (1% to 5%) range. The conservatisms that were included all had beneficial aspects, as discussed below, without greatly increasing the limit.

The areas where conservatisms exist are:

	Values Used
Core inlet temperature	100°F → 750°F
RPF/TILT combination	3.0/1.61 (for LCO 4.1.9-1)
	0.4/1.61 (for LCO 4.1.9-2)
Flow control valve positions	8% - 20% open (for LCO 4.1.9-1)

In addition, the primary coolant density is taken at its maximum permissible value of 107.5%, and generally conservative values for uncertainties in bypass flows are used. Each of the areas where conservatism exists is discussed in more detail below.

Core Inlet Temperature

As can be seen, the LCO 4.1.9-1 limit is not particularly sensitive to core inlet temperature. Further, the lower core inlet temperatures are generally more restrictive, and these are the normal temperatures in the low power range of operation.

The benefit of having LCO 4.1.9 valid for a wide range of core inlet temperatures is that the limit becomes applicable for potential operating conditions other than normal startup and shutdown, such as rapid power reduction to a lower power level. In this case, a relatively high core inlet temperature may exist for some time at low power.

RPF/TILT Combination

Consideration was given to the possibility of reducing the RPF/TILT combination for LCO 4.1.9-1 from the limiting values of 3.0/1.61. A review of the low power analysis through cycles 1-3 had shown less conservative combinations of 3.0/1.34 and 1.5/1.61 could potentially be justified.

Flow Control Valve Positions

Finally, consideration was given to the range of "equal flow" orifice positions for LCO 4.1.9-1. The effect of orifice position on the limit is twofold. More closed orifices tend to reduce the limit by reducing the flow defect in high power regions. However, they tend to increase the limit by increasing the core bypass flow, and even though more closed orifices reduce the limit, the effect is small at low power (where the flow defects in the higher power regions are smaller).

The range of 8% to 20% was selected because going to 20% open did not significantly increase the limit, especially in the critical low power range, and startup was permitted with the preferred "equal flow" orifice positions of 15% to 20% open. [Orifice positions in this range are preferred since they minimize the number of adjustments necessary to go from uniform flow positions (LCO 4.1.9-1) to equal exit gas temperature positions (LCO 4.1.9-2).] Also, a wider range of permissible orifice positions increases the chances of being able to start up with a stuck orifice.

3. The "problem" noted concerning Figure 4.1.7-1 of LCO 4.1.7 is one of interpretation. The interpretation by PSC, and the manner in which LCO 4.1.7 is enforced, is that for operation above a core outlet temperature of 950°F, the maximum region temperature mismatches are +200°F/+50° F. A proposed revision to LCO 4.1.7 will clarify this point.

4. A statement is made by ORNL that "the method of deriving flow used for the tech spec should be clearly established, understood, and verified where possible." We believe that the method of deriving flow is understood, and to the extent uncertainties exist in the measurements or models used, they have been accounted for in the development of the limit.

The method of deriving coolant channel flow rates may be separated into two parts: a) determination of circulator flow and b) development of a model which relates circulator flow to coolant channel flow. The mode which relates circulator flow to coolant channel flow is provided in Attachment 2 of Reference 1. The values for the bypass flows, and the undertainties in these values, are based on various analyses and evaluations of reactor operating performance. For example, steam generator bypass flows were determined by comparing primary and secondary side heat balances across the steam generator. Core bypass flows were established from region exit and steam generator helium inlet temperature measurements together with estimates for the heat removed by the core bypass flows.

Circulator flows are determined from static pressure measurements in the inlet nozzles of the circulators, together with local pressure and temperature measurements. As part of the performance testing of the circulators, the inlet nozzle pressure measurements were calibrated to determine flow. To cover the wide range of pressure measurements, two transducers are used: a low range transducer which covers measurements in the range up to 0.5 psi, and a high range transducer for measurements above 0.5 psi. For instance, a core flow of about 9% can be measured by the low range transducers within 3% accuracy, assuming the flow is being provided by two operating circulators (normal startup configuration), and given the pressure transducers measure at 1% of full scale accuracy. At higher powers and flows the accuracy is better.

5. Some thought has been given to the suggestion of developing an alternative approach, where the orifices are set according to the calculated core power distributions. The objective of an alternative approach would be to reduce the core flow requirement at a given core power level. The potential exists to do this because the current LCO 4.1.9 limit has a "margin" in the following sense: For the LCO 4.1.9-1 limit, the orifices are set at equal positions and the critical region is the highest power region. The limit is set for this region, and all other regions have more flow than is necessary to prevent flow stagnation. Similarly, for LCO 4.1.9-2 the orifices are set to achieve equal exit gas temperatures. For this orifice configuration, the critical region is the lowest power region and the limit is set for this region.

In between these two orifice configurations is an optimum configuration, which would minimize the core flow requirement at a given power level. In this configuration the flow in each region could be reduced to just what is necessary to prevent flow stagnation. In order to implement such a limit, core power distributions would be calculated for several startup control rod configurations. These calculations would need to be repeated periodically to account for burnup effects. The orifices would be et according the calculated power distribution. During rise to power, the orifices would need to be adjusted periodically, most likely as a function of rod positions since they have the largest effect on power distribution.

Several problems and complications would exist in the development and enforcement of such a limit. An allowance must be made for changes in core power distributions between orifice readjustments. Uncertainties in the calculated core power distribution and in orifice loss coefficients must be taken into account. For a given core power distribution, the orifice positions which produce the optimum core flow distribution depend on the core inlet temperature and on core power level. Also, the limit depends on the core power distribution to a small extent. Allowance for the effect of core inlet temperature and core power level on the optimum orifice positions was not taken into account and would need to be large.

Enforcement of such a limit would also be somewhat complicated. The operator would have to set the orifices to predetermined orifice positions at specified control rod positions. This would need to be done several times during a startup. Also, the predetermined orifice positions would have to be changed periodically, to make allowance for the effect of burnup on core power distribution, and the orifice positions may need to be made a function of core power level.

The suggestion by ORNL that the acceptability of the limit and selected orifice positions could be established by simple tests is disputed. The objective of the limit is to prevent the stagnation or reversal in the highest power channels within a region. This situation would arise long before it could be detected by looking at changes in region flow distributions as a function of core flow perturbations.

Because of the complexity of developing and enforcing a limit where the orifices would be adjusted according to the calculated power distribution, a much simpler solution was sought to take advantage of some of the "margin" in the current limit. As noted in Attachment 2 of Reference 1, it was recommended that the LCO 4.1.9-1 limit include the possibility of operating with a few orifices more open than the uniform flow positions. The LCO 4.1.9 curves for these orifice configurations are established such that flow in any region is equal to or greater than that with the equal orifice positions. This is accomplished by increasing the total core flow required to offset the additional flow taken by regions with the more open orifices.

The objectives of this recommendation were to facilitate the transition between the uniform flow orifice positions and the equal exit gas temperature orifice positions, and to permit startup in some situations where orifices were stuck. Because of the latter objective, it was not assumed that the highest power region orifices would be opened.

This strategy could be combined with a strategy to open the orifices on the highest power regions also. For example, a review of startup power distributions to date has shown that, while the maximum RPF is near 3.0, the maximum third highest peaking factor is less than 2.0. Opening the orifices in the two highest power regions, such that their flow is increased by about 25%, would reduce the LCO 4.1.9-1 limit. Further, if the maximum tilt in the RPF ≤ 2.0 region is reduced from 1.61 to 1.34 (which is also supported by the startup power distributions calculated to date), the limit could be further reduced.

This change to the LCO 4.1.9 limit is also being evaluated at this time and may be incorporated at a later date.

REFERENCES

1. PSC Letter, O. R. Lee to John T. Collins, dated 12/15/83 (P-83403).