September 25, 2001

Mr. G. R. Peterson
Site Vice President
Catawba Nuclear Station
Duke Energy Corporation
4800 Concord Road
York, South Carolina 29745-9635

SUBJECT: CATAWBA NUCLEAR STATION, UNIT 2 RE: DRAFT SAFETY EVALUATION FOR A PROPOSED AMENDMENT (TAC NO. MB1498)

Dear Mr. Peterson:

The Nuclear Regulatory Commission has prepared the enclosed draft Safety Evaluation for a proposed Amendment to Facility Operating License NPF-52 for the Catawba Nuclear Station, Unit 2. The proposed amendment is in response to your application dated March 9, 2001, as supplemented by letters dated July 25, September 10, and September 13, 2001.

The proposed amendment would revise the cold leg elbow tap flow coefficients used in the determination of Reactor Coolant System flow rate. Please review the technical accuracy of the information discussed in the enclosed draft Safety Evaluation and let us know if you find any inconsistencies as soon as possible. There are no changes to the Technical Specifications associated with this proposed amendment.

Sincerely,

/RA/

Chandu P. Patel, Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-414

Enclosure: As stated

cc w/o encl: See next page

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DRAFT

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO.   TO FACILITY OPERATING LICENSE NPF-52

DUKE ENERGY CORPORATION, ET AL.

CATAWBA NUCLEAR STATION, UNIT 2

DOCKET NO. 50-414

1.0 INTRODUCTION

By letter dated March 9, 2001, as supplemented by letters dated July 25, September 10, and September 13, 2001, Duke Energy Corporation, et al. (the licensee), submitted a request for changes to the Catawba Nuclear Station, Unit 2, cold leg elbow tap flow coefficients used in the determination of Reactor Coolant System (RCS) flow rate. There are no changes to the associated Technical Specifications with this amendment. The supplements dated July 25, September 10 and September 13, 2001, provided clarifying information that did not change the scope of the March 9, 2001, application nor the initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

As in most Westinghouse-designed pressurized water reactors (PWRs), the initial determination of RCS flow rate at Catawba is based on an initial secondary-side calorimetric to determine thermal power, and this is converted to an RCS flow rate using hot and cold leg temperatures (T_{hot} and T_{cold}, respectively). Three elbow tap flow meter indications in each RCS loop (referred to below as “elbow”) are then “calibrated” by calculating flow coefficients from the calorimetrically-determined flow rates. In Reference 1, we approved averaged elbow coefficients based on 11 calorimetric determinations accumulated over 7 years of power operation. These coefficients were assumed to be constant and were to be used in future flow rate predictions.

There is an uncertainty with this approach because T_{hot} is not easily determined. To understand this, envision a plane perpendicular to the centerline of a hot leg and assume you measure temperature at all locations in the plane. The temperature variation will typically be roughly 15°F and it will be nonsymmetric with respect to both radial and angular position. If you assume a plane at a different location, the variation will change. This behavior is attributed to “thermal streaming” caused by variation in core outlet temperature, with flow from peripheral fuel with a lower-than-average outlet temperature swept into the bottom of the hot leg with diminished mixing since peripheral fuel is closer to the hot legs than centrally-located fuel. There is also a swirl or twisting of hot leg flow with distance from the reactor vessel accompanied by localized mixing; the cause of temperature variation with distance. Additional perturbations have been observed in which small (< 1°F) “switches” occur in which one hot leg suddenly cools while another one becomes hotter. These switches have been attributed to effects introduced by fluid eddies in the reactor vessel.

T_{hot} is measured by three resistance temperature devices (RTDs) located 120 degrees apart in each of the four RCS loops. As expected from the above discussion, these measurements disagree. Typically, there is an RTD temperature range of roughly 12°F. The licensee averages RTD readings when calculating RCS flow rate (Reference 2).

There was less thermal streaming during Catawba's initial core loadings because there was less variation in core outlet temperature. Consequently, there is a tendency to place greater reliance on the early calorimetric data when calculating RCS flow rate. There are potential non-conservatisms that must be addressed with this approach – (1) RCP impeller smoothing that decreases developed pump head and (2) the effect of thermal streaming during the first few months of operation where there is a potential that indicated hot leg temperature is lower than actual, a situation that is the reverse of the long-term thermal streaming behavior. Conversely, RTD manifolds were used during the first cycle of operation that were eliminated during later cycles. The effect was an apparent reduction in the number of hot leg sample locations that appears to exacerbate the thermal streaming effect. We address these topics in Section 3, below.

By its Safety Evaluation Report (SER) dated March 17, 1995 (Reference 1), the staff approved a technical specification amendment to allow use of the RCS cold leg elbow differential pressure taps to determine RCS flow rate for Catawba Units 1 and 2. By a letter dated March 9, 2001 (Reference 3), as supplemented by a letter dated July 25, 2001 (Reference 2), Duke Energy Corporation requested an amendment to the Catawba Unit 2 operating license to allow revision of the elbow coefficients used in RCS flow rate determination. This request is consistent with an SER stipulation that any future changes to the elbow coefficients require prior NRC review and approval.

Table 1 lists 12 calorimetric values reported by the licensee (Reference 3).[1] Reference 1 approved determination of average coefficients based on the 11 calorimetrics performed between August 1986 and April 1993. Duke Power claims that including all of these calorimetrics results in a severe flow penalty because of the increasing bias with increasing time due to hot leg streaming. Consequently, its request is to calculate elbow coefficients using 3 calorimetrics performed between September 1986 and March 1988 to produce a new set of coefficients that contain less conservatism. It claims the new coefficients will remain conservative with respect to an analytical flow model developed to track flow changes due to RCS configuration changes.

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[1] In Reference 4, the licensee indicated there were technical problems with the Oct 90, Nov 90, and Dec 91 values, and it chose not to use these in some of its calculations.

Table 1. Calorimetric-Determined Flow Rate (Reference 5)

Date	gpm*
Jul 86	406947
Aug 86	402475
Sep 86	400477
Nov 86	399917
Mar 88	396202
Jun 89	392927
Oct 90	388268
Nov 90	390583
Jan 91	390826
Dec 91	391127
Jan 92	389611
Apr 93	390040

*Uncertainty is 2.2 percent

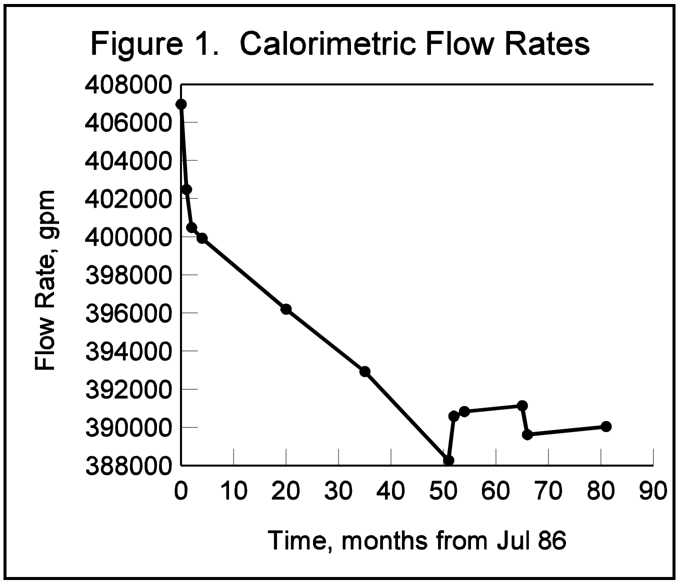
The change from using 11 calorimetrics to using 3 calorimetrics results in a predicted RCS flow rate increase of about 4000 gpm, or about 1 percent (Reference 3). The difference between the requested coefficients using 3 calorimetrics to the analytic model predictions is about 2850 gpm (0.71 percent), with the analytic model higher than the calorimetric result. We examine these values and the impact of potential perturbations in Section 3, below.

3.0 EVALUATION

Reference 1 approved determination of average coefficients based on 11 separate calorimetric determinations. The request to use 3 calorimetric determinations to produce a new set of coefficients that contain less conservatism requires additional justification to compensate for the reduced conservatism. That justification is addressed in the remainder of this section.

3.1 Calorimetric RCS Flow Rate

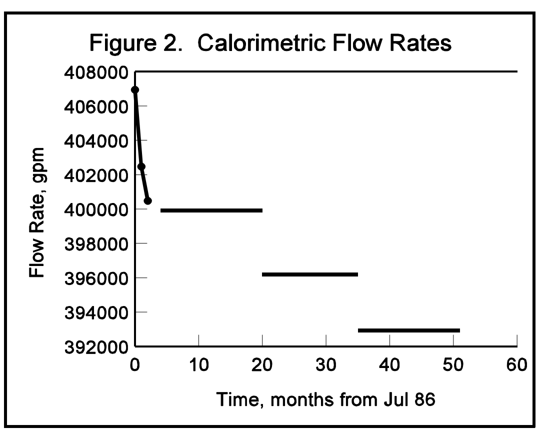
The calorimetric-determined flow rate values from Table 1 are plotted in Figure 1. The licensee excluded the July 1986 value because it was based on data obtained at 75 percent power (Reference 6), in contrast to the remaining values based on 98 percent or greater power. It used the remaining 11 values to establish its approved elbow coefficients. It proposes using the September and November 1986, and March 1988 values to establish elbow coefficients. The licensee believes the September 1986 and November 1986 values have less thermal streaming in contrast to the March 1988 value, which the licensee states “... contains a



significant amount of hot leg streaming penalty....” (Reference 3). The licensee identified RTD bypass removal prior to Cycle 2 restart in March 1988 as a candidate for some of the apparent streaming associated with the March 1988 and later calorimetric values (Reference 6). The licensee also stated that Cycles 1 and 2 “... had a much flatter radial power distribution than the later low-leakage loading patterns ... so hot leg streaming was not as significant.”

To assess these statements and their implications, we first assume the initial flow rate degradation is due to RCP impeller smoothing, as discussed in Section 3.2, below. Then we assume the later degradations are essentially due to physical changes during refueling outages and flow rate is essentially unchanged between outages. (This assumption is consistent with observed behavior.) This results in the Figure 2 representation of the early values.

We note that 46 steam generator (SG) tubes were plugged early in plant operation, although it is not clear whether these were plugged prior to the dates of the above data. Reference 5 also indicates an additional 34 tubes were plugged during the initial 4 years of operation. The



licensee's model predicts this has little effect on RCS flow rate, which substantiates our judgement that SG tube plugging has little influence on flow rate during the first few months of operation. Since SG tube plugging does not significantly affect the flow behavior illustrated in Figure 2, we conclude that the apparent step flow rate decrease of 3700 gpm at 20 months is due to a combination of core reload and RTD bypass removal.

At the end of the first cycle, each manifold was eliminated and RTDs were inserted into the flow scoops that had channeled flow to the manifold. When used with a manifold, each flow scoop sampled flow from five holes located from near the hot leg pipe wall to about 6 inches from the wall, a total of 15 sample locations for each hot leg. With the RTD located in a manifold, only two holes per scoop appear effective, with flow entering from the hole nearest the pipe wall essentially blocked by the pipe holding the RTD, and the two holes nearest the pipe centerline passing water that is not "seen" by the RTD. The change resulted in a reduction to 6 sample locations per hot leg. Further, with the manifold, the 15 samples were mixed, and then a temperature was measured. With today's RTD configuration, the three RTD indications are averaged. Although neither measurement technique is known to provide a good hot leg sample, intuitively, the 15 samples should provide a better representation.

The RTD manifolds allowed RCS water to flow at roughly 500 gpm from the hot legs to the cross-over (cold leg) pipes between the elbow taps and the RCPs, thus bypassing the elbow tap measurement. Consequently, manifold removal would increase actual flow rate through the elbows, but would likely have little effect on actual reactor vessel flow rate. On the cold leg side, flow was from downstream of the RCPs back to the cross-over pipes upstream of the RCPs. Manifold removal would remove this reactor vessel bypass flow, thus increasing actual reactor vessel flow rate by an amount that would also be indicated by the elbow taps. The actual elbow tap indication between early in Cycle 1 and immediately upon restart in Cycle 2 shows an indicated increase rate of approximately 600 gpm, consistent with our expectation. Assuming there are no other physical changes that significantly affect RCS flow rate, this provides some substantiation that the elbow indications are correct; i.e. – actual RCS flow rate increased by about 600 gpm whereas the calorimetric indicated a fictitious decrease of 3700 gpm. We believe a significant part of the decrease was due to the actual temperature measurements, which we believe were more representative of true hot leg temperature prior to RTD manifold removal. Consequently, the licensee's inclusion of the calorimetric obtained at the beginning of Cycle 2 introduces a conservatism in its proposed elbow coefficients that is not introduced by the other two calorimetrics.

The licensee has established a trend in which thermal streaming increased during the first few years of operation. However, the licensee has not fully addressed the nature of thermal streaming during the first few months of operation, a period represented by 2 of the 3 calorimetric points it requested to include in its coefficients. The licensee's request touches on a question we raised in 1994 (Reference 7) when we asked "How do we know which, if any, of the (elbow) 'constants' (i.e., coefficients) is correct." The importance of this question is minimized when a large number of calorimetric points with detrimental streaming are included in coefficient determination. With only 3 points, we must re-examine the assumption that the initial points are realistic.

The hot leg RTDs are located 120 degrees apart with one at the top of the hot leg. Since the lower regions of the hot leg may contain cooler water from peripheral core regions, there is a possibility that the 2 lower RTDs are cooler than the true hot leg average temperature and that an average of the 3 RTDs may also be cooler than the true temperature. Such a condition would result in predicting a calorimetric flow rate that was greater than actual, a non-conservatism.

The licensee mentioned potential non-conservative streaming in Reference 8 and in effect concluded it was not a problem. The licensee's justification is not convincing and, lacking other information, we conclude there should be an allowance for this potential non-conservative effect. Further, there is a similar streaming effect in the RCS cold legs that could influence indicated cold leg temperature due to unequal SG tube lengths and the SG outlet plenum arrangement, with some residual influence remaining from the hot leg streaming. This effect is reduced via mixing in the RCP when T_{cold} is measured downstream of the RCPs. This should also be addressed when determining elbow coefficients. For assessment purposes, we will assume a 0.5 percent (2000 gpm) bias due to these effects.

In Reference 2, the licensee reported a mistake in the calculation of the September 2000 calorimetric flow rate for McGuire Unit 1 due to "The reactor coolant pump power was inadvertently subtracted in the previous calorimetrics instead of added, as it should have been." Subsequently, we recognized that the licensee assumed RCP heat is introduced into the RCS at the RCP location. This is incorrect. Only the RCP inefficiency is introduced at the RCP. The remaining energy is introduced as a pressure increase or potential energy. This is converted to thermal energy during frictional flow through the entire RCS. To assess the impact of this error, consider an overall RCS heat balance written as follows:

$$Q_{core} + Q_{RCP} - Q_{loss} = Q_{cal}$$

where: Q_{core} = nuclear heat generation rate in core

Q_{RCP}= rate of thermal energy addition to RCS by RCP

Q_{loss} = RCS thermal energy loss rate due to everything other than SGs

Q_{cal} = rate of thermal energy removal by SGs (determined calorimetrically)

and the assumed location of Q_{RCP} is unimportant in this equation.

Since Q_{cal} is determined from the calorimetric, and Q_{loss} and Q_{RCP} can be determined, this equation will provide Q_{core}. For discussion purposes, we will assume the thermal behavior of the four loops can be represented by a single hot leg and a single cold leg temperature, and thus a single temperature difference, ΔT, will describe the behavior. Since hot and cold leg temperature is measured, ΔT is known. Now, if we assume Q_{loss} is negligible, RCS flow rate can be described by:

$$W = (Q_{core} + Q_{RCP\Delta T}) / (C_p \Delta T)$$

where: $Q_{RCP\Delta T}$ = thermal energy generated by fluid friction due to RCS water flowing from the cold leg to the hot leg locations

C_p = RCS water heat capacity.

The licensee originally assumed RCP heat was all introduced at the RCP location, which means it incorrectly assumed $Q_{RCP\Delta T} = 0$. This means, via the above equation, that it calculated a calorimetric flow rate that was lower than actual.

We next estimate $Q_{RCP\Delta T}$. Information provided in Reference 4, Table 1, indicates that the pressure differential, ΔP, from the cold leg RTD to the hot leg RTD locations is 52.83 psi (assuming 1/4 of the hot leg and 3/4 of the cold leg contributes). Tables 6 and 11 yield an RCP ΔP of 85.41 psi. Thus, the fraction of pump potential energy imparted to the RCS water in the pump bowl that generates heat that contributes to the RCS measured cold-to-hot leg temperature increase is 52.83/85.41 = 0.619. Consequently, the RCP adds about 20 X 0.619 = 12.4 MW to the RCS water as it flows from the cold leg RTD location to the hot leg RTD location; i.e. – $Q_{RCP\Delta T} = 12.4$ MW.

Now the above RCS flow rate equation can be applied to yield:

$$W_{correct} / W_{old} = (Q_{core} + Q_{RCP\Delta T}) / Q_{core}$$

where: $W_{correct}$ = correct RCS flow rate
W_{old} = old (incorrect) RCS flow rate

If we assume $Q_{core} = 3411$ MW, then:

$$W_{correct} / W_{old} = (3411 + 12.4) / 3411 = 1.0036$$

We conclude the licensee made a 0.36 percent error in its calorimetric flow rate determination.[2] Failure to correctly account for RCP heat means the licensee under-calculated calorimetrically-determined RCS flow rate by 1450 gpm.

We believe the first four calorimetrics are the most accurate the licensee has obtained. Further, as discussed in Section 3.2, some of the flow rate decrease during this time may be an indication of RCP impeller wear-in, a non-conservatism. From this perspective, the calorimetric values support a post wear-in flow rate of 400,000 gpm. The licensee's choice of these three values yields an average RCS flow rate of 398,850 gpm; a conservative value of ~1150 gpm when compared to the 400,000 gpm.

Other aspects of the calorimetric analysis that were addressed in our previous communications with the licensee, such as Reference 1, will not be repeated here.

3.2 RCP Impeller Smoothing

The topic of RCP wear-in arose in 1994 (Reference 7) and the licensee provided the following information:

"4. Reactor coolant pump degradation will be reflected in decreased elbow tap ΔP (differential pressure) indications.

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[2]The licensee calculated the error as 0.255 percent (Reference 6) after we told licensee representatives of our calculation.

5. Elbow tap ΔP data trends agree well with analytical predictions which do not model RCP degradation.

6. No evidence of RCP degradation has been observed at McGuire or Catawba."

In the 2001 Reference 6 communication, the licensee stated:

> "The earliest calorimetric data, which has the highest derived values of flow, was not used to develop the values of the elbow tap flow coefficients currently in use or the proposed revised flow coefficients. Therefore, the issue of the earliest flow data being non-conservative due to being recorded prior to the initial breaking-in period for the pump impellers is not applicable. Also, the elbow tap based flow values for Catawba Unit 2 do not show any significant decrease in flow that can be attributed to longer-term pump wear for the past 15 years. Longer-term pump performance degradation is not evident.
>
> Westinghouse does not have a design value for pump impeller wear rate because it is considered to be insignificant."

We believe these statements are correct after an initial wear-in period. However, we don't agree for the first few months of operation. Our conclusion is substantiated by Reference 9, where the leading edge flow meter (LEFM) indicated an early flow rate decrease of 0.6 to 0.8 percent, by reported observation of similar flow rate decreases at several 3-loop and 4-loop plants, and by a close examination of the licensee's data, as discussed in the following paragraphs.

Consider the flow rate degradation illustrated in Figure 3, which provides the early calorimetric values and elbow predictions.[3] The calorimetric values reflect the downward trend illustrated in Figure 1, but the elbow values are constant after the initial value. (We are interested in the trend in elbow values, not the values for purposes of this discussion since the elbow information results from coefficients obtained using 11 calorimetrics.) Neglecting potential error due to uncertainty in the values and a bias due to using 11 calorimetrics, the change in elbow value during the first 21 days of operation is about 1750 gpm, a change we believe is due to RCP impeller smoothing, as identified in Section 2, above. Further, the elbow information implies there was little smoothing after 21 days. Since some impeller smoothing will have occurred before the Figure 3 information was obtained, on this basis the total smoothing effect will be greater than 1750 gpm.

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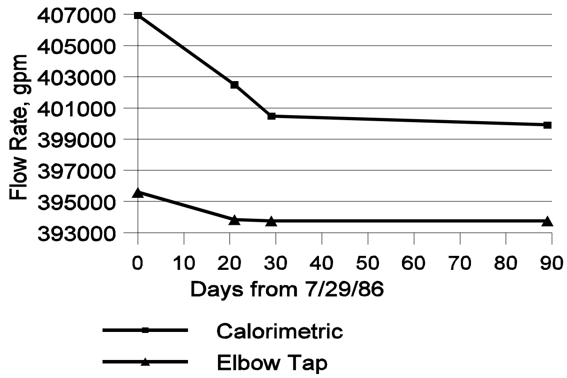
[3]According to Reference 8, the days the data were obtained were 7/29/86, 8/19/86, 8/27/86, and 11/26/86. These correspond to the Table 1 values of Jul 86, Aug 86, Sep 86, and Nov 86, respectively.

Figure 3. RCS Flow Rate



Although the first calorimetric was made at 75 percent power, we note the trend is consistent with the second and third values and there is little inconsistency between the calorimetric and elbow trends, although the magnitudes are different. If we assume the calorimetric values are correct, then the flow rate decreases by 6500 gpm during the first month and, consistent with the calorimetric, is relatively constant during the next few months.

As identified in Section 2, above, initial RCP wear-in at Prairie Island was reported to result in 0.6 to 0.8 percent flow reduction during early operation, a reduction of about 2400 to 3200 gpm. Since Prairie Island and Catawba are both equipped with Westinghouse 93AS RCPs (Reference 10), we will postulate the pumps behave similarly in the two installations.

At this point, we have three contenders for the effect of impeller smoothing, >1750 gpm, >6500 gpm, and 2400 to 3200 gpm. For assessment purposes, we will assume impeller smoothing decreases RCS flow rate by 2000 to 4000 gpm.

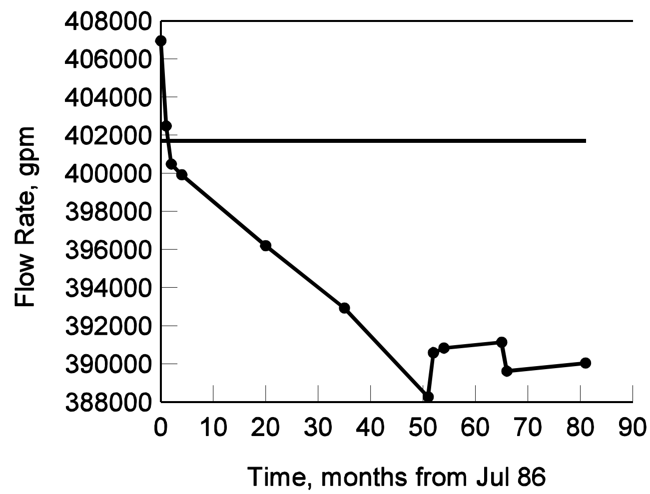
The initial flow rate decrease essential stops after about 30 days when the RCS flow rate is about 400,000 gpm. If we take this value as an accurate value, then the flow rate at the time of the first determination of RCS flow rate would have been about 400,000 + 2000 to 400,000 + 4000, or 402,000 to 404,000 gpm. (These “bounds” should not be confused with uncertainties, which the licensee reported as 2.2 percent or 8800 gpm.)

3.3 Analytic Prediction of RCS Flow Rate

In Reference 4, the licensee listed “reference” pressure drops for each contributor in the RCS for a reference flow rate. It also listed RCP head curves as a function of flow rate that it stated were developed from hot performance data, meaning for conditions corresponding to power operation. (These were apparently vendor-supplied data.) A curve was fit to the head curve and the analysis model is based on this information. It is used by assuming a flow rate, calculating pressure drops based upon the reference pressure drops and any physical changes in the flow path, and comparing the resulting total to the pump head. The process is repeated by assuming flow rates until the predicted pressure drop is equal to the pump head.

As illustrated in Figure 4 (References 2 and 5), the analytic model predicts an essentially constant RCS flow rate of ~401,700 gpm during the first few years of operation in contrast to the calorimetric determinations, which show significant variation.

Figure 4. RCS Flow Rates



There were 80 SG tubes plugged early in plant operation. The licensee's model predicts this has little effect on RCS flow rate, a reasonable prediction. However, the licensee did not address modeling changes associated with RTD bypass removal, and its model results do not reproduce the flow rate increase illustrated by the elbow response following manifold removal and as-expected from that removal. The licensee should ensure the model correctly represents these flow perturbations.

We have no information regarding pump history that underlies the RCP developed-head information provided to us in Reference 4, Table 6. Lacking such information, we will assume the tested pump or pumps were not operated for the extended time necessary to complete impeller smoothing. Consequently, we assume the analytic model uses "as-new" RCP flow characteristics. Since the analytic model predicted 401,700 gpm and the impeller smoothing effect appears to have been about 2000 to 4000 gpm, we conclude the analytic model should have predicted 399,700 to 397,700 gpm if it accounted for impeller smoothing. The greater value is essentially in agreement with the 400,000 gpm calorimetric value. The larger assumed impeller smoothing impact would mean the model underpredicted flow rate by about 2000 gpm.

3.4 Long-Term Elbow Behavior

The licensee addressed potential long-term changes in elbow indications and the staff considered this topic in its previous review (Reference 1). The requested decreased conservatism in determining elbow coefficients places an increased importance on the absence of long-term changes. Consequently, additional substantiation is needed to establish that long-term elbow coefficients are constant. Two methods that could contribute to such substantiation are:

(1) Compare elbow flow rates to analytically predicted flow rates for each physical change in the RCS that could affect flow rate. (If no RCS change is made during a refueling outage, then compare the pre-outage elbow indications to the post-outage values in conjunction with adjustments for such changes as boric acid concentration.)

(2) Compare long-term elbow flow rates to independent flow rates determined by other means.

These methods are discussed below.

3.4.1 Comparison of Analysis Predictions to Elbow Flow Rate Determinations

The licensee provided several comparisons between its analyses and elbow flow rates for Catawba and McGuire. It "... concluded that the analytical flow model is an accurate and valuable tool for use in trending RCS flow changes...." (Reference 2) We have reviewed this information and find reasonable agreement for gross trend changes, such as at McGuire Unit 1 with significant SG tube plugging or SG replacement. More subtle changes, such as those for Catawba Unit 2 with fuel changes and RTD bypass manifold removal, were not predicted by the analysis model. The "missed" changes cover a range of about 2500 gpm.

The licensee discussed several of these inconsistencies. A change to Babcock & Wilcox fuel caused an indicated flow rate increase that was not reflected by the model. The licensee stated this was a deliberate effect since it did not want to credit too high a flow rate in its prediction and then later find it had predicted a non-conservative flow rate. In changing to W fuel at the beginning of 2000, the licensee stated it wanted to "...accurately predict or slightly over predict the effects of the higher pressure drop fuel since it was important to know when the reactor coolant flow would approach the Technical Specification minimum measured flow limit." Although these examples are reasonable for ensuring acceptable operation with respect to requirements, the approach is undesirable for comparisons between the model and elbow behavior.

In Reference 2, the licensee stated "The elbow tap method of measuring flow ... is also affected by smaller affects such as transmitter and rack component drift and streaming effects in the cold leg and it's effect on the density calculation. These effects result in small variations in the elbow tap ΔP flow indication which will not be present in the analytical flow model prediction of flow." We believe realistic model predictions could be an important aspect of recognizing such elbow "malfunctions." This is less likely to be recognized when "conservative" values are provided into the analytic model.

A key aspect of justifying that elbow coefficients remain constant is a comparison between elbow - derived flow rates and the analytic model. For this purpose, realistic information should be input to the model, comparisons should be made with the elbow information, and differences should be evaluated. We consider it undesirable to perform such comparisons with deliberate unrealistic input into the model.

3.4.2 Substantiation of Long-Term Elbow Flow Rate Determinations by Alternate Flow Measurement Techniques

Table 2 provides LEFM and elbow flow rate information obtained from Table 4-1 of Reference 9. The percent difference between the LEFM and elbow indications are as follows:

DATE	LOOP A	LOOP B
7/81	0.37	0.51
7/81*	0.17	0.51
8/91	0.17	-0.07**
*Assumes the 7/81 flow rates for full power apply for two loop operation when comparing with the one loop operation via the flow ratios. **LEFM is smaller than Elbow.		

Table 2. RCS FLOW MEASUREMENT COMPARISONS AT FULL POWER gpm/loop				
LOOP METER	A LEFM	A ELBOW	B LEFM	B ELBOW
DATE				
Feb 1980	97519	*	97950	*
Jul 1981	98673	98309	97763	97267
Aug 1991	98724	98557	97543	97607
RATIO OF FLOW WITH 1 PUMP OPERATING TO FLOW WITH 2 PUMPS OPERATING				
Dec 1974	1.0819	1.0777	1.0852	1.0875
Jul 1981	1.0794	1.0816	1.0820	1.0820
*Normalized to LEFM Flow				

Since this information is based upon a February 1980 “calibration” of the elbow indications, only a year and a half of potential degradation is covered. The Prairie Island tests covered 11 years of operation but data were obtained sporadically. The licensee is pursuing what additional data are available that could be used to confirm long-term elbow behavior.

The licensee has previously provided qualitative discussions covering long-term behavior, Reference 9 states that “The 11 year flow comparison (at Prairie Island) showed that the average difference between elbow taps and LEFMs was less than 0.3% flow,” and we obtained similar differences in the above comparison. On this basis, and with consideration of the above information, we conclude that the elbow coefficients can be assumed constant for the operating cycle scheduled to begin in October 2001.

4.0 SUMMARY

We previously approved determination of average coefficients based on 11 separate calorimetric determinations (Reference 1). The licensee request addressed here is based on 3 calorimetric determinations to produce a new set of coefficients that contain less conservatism. Therefore, we performed a more precise audit than previously conducted to supplement the previous review and to evaluate the requested change. We discovered several errors in the licensee's submittals and we found several aspects where we disagree with the licensee's conclusions. Although these errors and disagreements affect some of the quantitative aspects of the licensee's request, they do not lead to a conclusion that the licensee's request is unjustified. On the contrary, we find the licensee's request is reasonable and we find it acceptable for the upcoming reload Cycle 12.

Reference 6 states that the upcoming reload Cycle 12 core thermal-hydraulic and updated final safety analysis report Chapter 15 analyses have at least a 1 percent margin in core flow rate. It further states that there is an additional 4.9 percent departure-from-nucleate boiling ratio (DNBR) margin for all DNBR-related analyses. It makes these statements on the basis of its determinations. As discussed in Section 2, we do not agree with all of the licensee's determinations. The quantitative differences with respect to the elbow tap flow coefficient determinations are as follows (+ is a conservative difference):

+1150 gpm Flow rate resulting from the 3 calorimetric values when contrasted to our estimate of the realistic flow rate

-2000 gpm Allowance for bias due to potential non-conservative streaming reflected in the initial calorimetrics

+1450 gpm RCP thermal energy error

0 RCP impeller smoothing (occurs prior to the values used for the elbow coefficient determinations

0 RTD manifold removal impact (Included in the above +1150 gpm via the licensee's choice of calorimetric values used for elbow coefficient determinations

On the basis of these and other considerations, as discussed in Sections 2 and 3 of this SER, we find that the licensee's choice of the basis for the proposed elbow tap coefficients is conservative and acceptable.

The analytic model represents an important aspect of long-term confirmation of elbow tap response since, when correctly configured and applied, it can lead to identification of unrecognized problems or inaccuracies. Our audit of the licensee's analytic model identified weaknesses and errors. We expect the licensee to revise its analytic model to correct these weaknesses and errors when applying the proposed elbow tap coefficients to determination of RCS flow rate in reload Cycle 13 and later cycles.

5.0 STATE CONSULTATION

In accordance with the Commission's regulations, the South Carolina State official was notified of the proposed issuance of the amendments. The State official had no comments.

6.0 ENVIRONMENTAL CONSIDERATION

The amendment changes requirements with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding [66 FR 34281]. Accordingly, the amendment meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

7.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

8.0 REFERENCES

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2. Peterson, Gary R., “Duke Energy Corporation, Catawba Nuclear Station, Unit 2, Docket Number 50-414, Response to Request for Additional Information for Revision of Unit 2 Reactor Coolant System Cold Leg Elbow Tap Flow Coefficients,” Letter from Vice President, Catawba Nuclear Station, Duke Power to USNRC, July 25, 2001.

3. Peterson, Gary R., “Duke Energy Corporation, Catawba Nuclear Station, Unit 2, Docket Number 50-414, Proposed License Amendment, Revision of Unit 2 Reactor Coolant System Cold Leg Elbow Tap Flow Coefficients,” Letter from Vice President, Catawba Nuclear Station, Duke Power to USNRC, March 9, 2001.

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5. Martin, Robert E., "Summary of February 10, 1994, Meeting with Duke Power Company on RCS Flow Measurement Methodology," USNRC, April 13, 1994.

6. Peterson, Gary R., "Duke Energy Corporation, Catawba Nuclear Station, Unit 2, Docket Number 50-414, Response to Request for Additional Information for Revision of Unit 2 Reactor Coolant System Cold Leg Elbow Tap Flow Coefficients," Letter from Vice President, Catawba Nuclear Station, Duke Power to USNRC, September 10, 2001.

7. Martin, Robert E., "Summary of March 16, 1994, Meeting with Duke Power Company on RCS Flow Measurement Methodology," USNRC, April 6, 1994.

8. Peterson, Gary R., "Duke Energy Corporation, Catawba Nuclear Station, Unit 2, Docket Number 50-414, Response to Request for Additional Information for Revision of Unit 2 Reactor Coolant System Cold Leg Elbow Tap Flow Coefficients," Letter from Vice President, Catawba Nuclear Station, Duke Power to USNRC, September 13, 2001.

9. "RCS Flow Verification Using Elbow Taps at Westinghouse 3-Loop PWRs," Westinghouse Electric Company, LLC, WCAP-14754-NP-A, Revision 1, September 1999.

10. "Reactor Coolant Pump Thermal Barrier Cracking," Westinghouse Electric Company Technical Bulletin, W-TB-99-03, April 26, 1999.

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