

Attachment I
Marked-up Technical Specification Page

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POWER DISTRIBUTION LIMITS

3/4.2.5 DNB PARAMETERS

LIMITING CONDITION FOR OPERATION

2. Within 24 hours of initially being within the region of prohibited operation specified on Figure 3.2-1, verify that the combination of THERMAL POWER and Reactor Coolant System total flow rate are restored to within the regions of restricted or permissible operation, or reduce THERMAL POWER to less than 5% of RATED THERMAL POWER within the next 2 hours.

SURVEILLANCE REQUIREMENTS

4.2.5.1 Each of the parameters of Table 3.2-1 shall be verified to be within their limits at least once per 12 hours.

4.2.5.2 The Reactor Coolant System total flow rate indicators shall be subjected to a CHANNEL CALIBRATION at least once per 18 months. The measurement instrumentation shall be calibrated within 7 days prior to the performance of the calorimetric flow measurement.*

4.2.5.3 The Reactor Coolant System total flow rate shall be determined by precision heat balance measurement* at least once per 18 months.

* FOR UNIT 1 CYCLE 8 ONLY, RCS FLOW SHALL BE MEASURED USING COLD LEG ELBOW TAP ΔP S, NORMALIZED TO CONSTANTS DERIVED FROM AVERAGED VALID CALORIMETRICS FROM PREVIOUS CYCLES

Attachment 2

Evaluation of Possible RCS Flow Reduction Below The Technical Specification Minimum Measured Flow Limit

The purpose of this evaluation is to demonstrate that the Catawba Unit 1 RCS flow of 379,285 gpm, as determined by a calorimetric, is acceptable for plant operation at 100% power. The Technical Specification minimum measured flow limit is 382,000 gpm, which means the RCS flow measured by the calorimetric is 0.71% below the minimum measured flow limit required for plant operation at 100% power.

The current Catawba Technical Specification flow uncertainty as given in Figure 3.2-1 is 2.2% flow. All existing Chapter 15 analyses account for this 2.2% flow uncertainty. The actual calculated flow measurement uncertainty is 1.93% flow, which means there is as much as 0.27% flow margin available in the current uncertainty allowance of 2.2% flow. Since the Catawba Unit 1 measured RCS flow is 0.71% below the Technical Specification minimum measured flow limit, and there is potentially 0.27% flow margin available, there remains a net flow reduction of between 0.71% and 0.44% flow which must be evaluated. The impact of a 0.71% flow reduction on the analyses documented in Chapter 15 of the Catawba Nuclear Station FSAR is discussed below.

Impact On DNB Limited FSAR Chapter 15 Events

The Catawba Unit 1 Cycle 8 (C1C8) reload report states that out of the total 10.7% DNB margin there is 4.6% margin available. The Instrumentation/Hardware DNB penalty reported in the C1C8 reload report is a combination of two separate penalties. The Instrumentation penalty accounts for instrumentation biases at Catawba and has a value of 2.8%. The Hardware penalty, also 2.8%, accounted for a change between the original mixing vane grid design in the Lead Test Assemblies and confirmatory CHF test section and the production grid design. A CHF testing program undertaken by B&W and DPC in 1992-1993 tested both grid designs and showed no significant difference in CHF performance. This means that the Hardware DNB penalty was in fact never required for production Mark-BW fuel. The 2.8% DNB Hardware penalty for Mark-BW fuel given in the C1C8 reload report is not required for C1C8. This conclusion was documented in late 1993, after the reload report for C1C8 was submitted. Therefore, the total Mark-BW DNB margin available for C1C8 becomes 7.4% with the removal of the 2.8% Hardware penalty.

Adequate cycle specific margin exists between the design (1.55) and statistical (1.40) DNBR limits to compensate for the DNB penalty associated with the possible reduction in flow below the Technical Specification minimum measured flow limit at full power. Of the 10.7% available Mark-BW fuel DNB margin, 7.4% currently remains unused. This available 7.4% DNB margin represents 3.3% flow margin. The small percentage flow decrease of 0.71% flow, which conservatively translates to a 1.6% DNB penalty, can be compensated for by this available margin.

For fresh Westinghouse OFA fuel, no margin is available. Catawba Unit 1 Cycle 8 contains only 9 OFA assemblies in the core and these assemblies operate at relatively low power levels. Using the sensitivity of radial peaking (F_{ΔH}) to DNB a 1.6% DNB penalty will result in a F_{ΔH} peaking penalty of 0.6%. This means that as long as the OFA fuel assemblies in C1C8 are at least 0.6% lower in peak than the most limiting Mark-BW fuel, sufficient margin is available to compensate for the possible reduction in flow without using any of the 10.7% DNB margin between the design and statistical DNBR limits. The F_{ΔH} of the highest peaked OFA fuel assembly in C1C8 is 19%

lower than the most limiting Mark-BW fuel assembly and is therefore, non-limiting with respect to DNB.

Those transients in Chapter 15 which are DNB limiting have sufficient margin available to account for this small possible reduction in RCS flow. The following DNB limiting transients will therefore not be affected by the small flow reduction below the Technical Specification minimum measured flow limit.

- 15.1.1 Reduction in Feedwater Temperature
- 15.1.2 Increase in Feedwater Flow
- 15.1.3 Excessive Increase in Secondary Steam Flow
- 15.1.4 Inadvertent Opening of a Steam Generator or Safety Valve
- 15.1.5 Steam Line Break
- 15.2.8 Feedwater Line Break
- 15.3.1 Partial Loss of Flow
- 15.3.2 Complete Loss Of Flow
- 15.3.3 Locked Rotor
- 15.3.4 Reactor Coolant Pump Shaft Break
- 15.4.1 Zero Power Bank Withdrawal
- 15.4.2 Uncontrolled Bank Withdrawal at Power
- 15.4.3 Rod Cluster Control Assembly Misoperation
- 15.4.4 Startup of an Inactive Reactor Coolant Pump
- 15.4.7 Inadvertent Loading of a Fuel Assembly In An Improper Position
- 15.4.8 Rod Ejection Accident
- 15.5.1 Inadvertent Operation of ECCS During Power Operation
- 15.6.1 Inadvertent Opening of a Pressurizer Relief Valve
- 15.6.3 Steam Generator Tube Rupture

Impact On Secondary System Peak Pressure FSAR Chapter 15 Events

The turbine trip peak secondary pressure analysis (15.2.3b) is performed with a sensitivity study on reactor coolant flow. A change of approximately 12% flow causes an increase in secondary pressure of approximately 2 psi due to increased primary to secondary heat transfer, and therefore the results of this analysis are not affected by the slight flow reduction. Furthermore, this demonstrates that the flow assumption does not sufficiently affect heat transfer to significantly affect the results of peak pressure analyses.

Impact On Primary System Peak Pressure FSAR Chapter 15 Events

As stated above, a small change in RCS flow does not significantly impact the primary to secondary heat transfer. Therefore the peak pressure analyses are not affected by the small change in RCS flow. In addition, the peak primary pressure analyses assume 15% steam generator tube plugging to decrease heat transfer. Actual tube plugging is about 8%, and the margin of 7% tube plugging more than offsets the impact of 0.71% flow deficit for the following peak primary pressure analyses:

- 15.2.2 Loss of External Load
- 15.2.3a Turbine Trip
- 15.2.4 Inadvertent Closure of Main Steam Isolation Valves
- 15.2.5 Loss of Condenser Vacuum and Events Causing Turbine Trip
- 15.2.6 Loss of Non-emergency AC Power to Station Auxiliaries
- 15.2.7 Loss of Normal Feedwater Flow
- 15.3.3 Locked Rotor
- 15.4.2 Uncontrolled Bank Withdrawal at Power

The following transients do not benefit from the steam generator tube plugging margin as discussed for the transients above. The peak pressure for these transients is reached so quickly that the heat transfer impact of steam generator tube plugging and a reduction of flow below the Technical Specification minimum measured flow limit will not affect the peak primary pressure results. In addition, significant margin to the acceptance criteria for these transients is available, the zero power bank withdrawal and rod ejection transient peak pressure margin is 48 psi and 242 psi respectively.

- 15.4.1 Zero Power Bank Withdrawal
- 15.4.8 Rod Ejection

Impact On FSAR Section 15.2.8 Feedwater Line Break Long Term Core Cooling Analysis

The Feedwater Line Break Accident, FSAR Section 15.2.8, long term core cooling case will be affected by a reduction in RCS flow below the Technical Specification minimum measured flow limit. Low flow reduces primary to secondary heat transfer, so a reduction in initial flow increases the likelihood of hot leg boiling. However, since the analysis assumes that reactor coolant pumps are tripped early in the transient (15 seconds), any penalty of the reduced flow is minimal on the long term core cooling case. In addition, the analysis assumes 15% tube plugging to degrade primary to secondary heat transfer. The actual tube plugging is less than 8%, which is a benefit for the entire duration of the event compared to the short duration of the reduced flow penalty. The lower tube plugging is also beneficial since the loop flow resistance during natural circulation is lower, which will cause a lower temperature during the long term core cooling case.

Impact On FSAR Section 15.6.3 Steam Generator Tube Rupture Dose Analysis

Reduced RCS flow may affect break flow rate slightly, but since the break flow rate is primarily dictated by the pressure difference across the break, the reduced flow effect will be small. The reduced flow will cause a reduction in the heat transfer capability and result in a decrease in secondary side pressure in order to transfer the same amount of energy. The decrease in secondary side pressure increases the break mass flowrate. However, the increase in break mass flowrate causes a more rapid depressurization of the primary, which results in an earlier reactor trip. The earlier reactor trip offsets the larger break flowrate so that the total mass transfer is essentially unchanged by the reduction in RCS flow. In addition, the reactor coolant pumps are tripped on loss of offsite power coincident with turbine trip on reactor trip. This means the post trip transient behavior will not be affected by the reduction in RCS flow. Therefore, the SGTR dose analysis

will not be affected significantly by a 0.71% reduction in RCS flow below the Technical Specification minimum measured flow limit.

Impact On FSAR Section 15.6.5 Loss of Coolant Accidents

The large and small break Loss of Coolant Accidents were evaluated by Westinghouse for a reduction in RCS flow of 1% below the Technical Specification minimum measured flow limit. The possible reduction in RCS flow will result in a Peak Clad Temperature (PCT) penalty of less than 10 °F for both the small and large break LOCA. The current Catawba Unit 1 FSAR large break LOCA PCT is 1985 °F. A 10 °F PCT penalty applied to this temperature will result in a PCT of 1995 °F. This PCT is still 205 °F below the 10CFR 50.46 acceptance criteria of 2200 °F. The Catawba Unit 1 FSAR small break LOCA PCT of 1440 °F would increase to 1450 °F which is well below the acceptance criteria of 10CFR 50.46. Recent reanalyses of the large and small break LOCAs have been performed for steam generator tube plugging percentages of 18%, and will be included in the October 1994 Catawba FSAR update. These analyses resulted in PCTs of 2022 °F for the large break LOCA and 1235 °F for the small break LOCA. A 10 °F increase in these PCTs will also remain well below acceptance criteria of 10 CFR 50.46. In addition, the effect of a 10 °F PCT increase will have a negligible effect on the other 10CFR 50.46 acceptance criteria.

Impact On FSAR Section 15.4.6 Boron Dilution Events

There is no impact on the boron dilution events. These transients are not affected by a reduction in the minimum measured flow since they do not contain a flow assumption or use flow as an input parameter.

Summary

All of the Catawba FSAR Chapter 15 events have been evaluated for a flow reduction below the Technical Specification minimum measured flow limit. Margin exists for each of these transients to account for the small RCS flow reduction and allow Catawba Unit 1 to operate at 100% power. The margins available to account for an RCS flow reduction below the Technical Specification flow limit for FSAR Chapter 15 analyses include:

- Flow uncertainty margin, up to 0.27% flow.
- DNB margin in the Catawba Unit 1 Cycle 8 reload design, 7.4% DNB.
- Steam generator tube plugging margin, (15% for analysis vs. 8% actual).
- Margins to acceptance criteria, (PCT and peak pressure)

For some FSAR Chapter 15 transients, RCS flow is not an important parameter and results in no impact due to a flow reduction below the Technical Specification minimum measured flow limit.

Therefore, a reduction in RCS flow of 0.71% below the current Technical Specification minimum measured flow limit will not significantly impact the current FSAR Chapter 15 safety analyses. These analyses have sufficient margin available to account for a flow reduction of 0.71% RCS flow below the flow limit and allow plant operation at 100% power. All FSAR transient analysis acceptance criteria continue to be met and the results of the analyses in the FSAR remain valid. The margin of safety as defined in the bases of the Technical Specifications will not be reduced.

Evaluation of Catawba Unit 1 Primary Loop Hydraulic Configuration Changes During the End-of-Cycle 7 Outage

Core Reload

Cycle 7 was designed with 49 Westinghouse fuel assemblies and 144 B&W fuel assemblies. Cycle 8 was designed with 9 Westinghouse fuel assemblies and 184 B&W fuel assemblies. The pressure drop across a B&W fuel assembly is 2.4% less than across a Westinghouse fuel assembly. Consequently, core flow resistance decreases in proportion to the percentage of B&W fuel in the core. With an increase of 40 B&W fuel assemblies during the outage, the pressure drop across the core at constant flow will decrease by approximately 0.11 psi. In reality, the reactor coolant pump operating point will shift to a slightly higher flow. This increase in flow will be indicated by an increase in the elbow tap ΔP indications (in absence of other hydraulic changes).

The analytical model assumed that 1/3 of the core (64 fuel assemblies) was Westinghouse fuel, whereas the actual number in Cycle 7 was 49. The analytical model also assumed that Cycle 8 was entirely B&W fuel, rather than including the 9 Westinghouse fuel assemblies. This simplifying assumption resulted in a pressure decrease across the core of 0.18 vs. 0.11 psi, which is not large in either situation.

Steam Generator Tube Plugging

The steam generator tube bundle pressure drops are affected by the number of tubes plugged and/or sleeved during each outage. Plugging and sleeving of tubes in the steam generators causes a reduction in the flow area which results in an increased pressure drop across the steam generator tubes. The number of tubes plugged and/or sleeved expressed as a percentage of steam generator tubes (4674 for Catawba Unit 1) is used to calculate the flow area through the steam generators in each loop. The calculated steam generator tube plugging percentage assumes that 18 sleeves is equivalent to 1 plugged tube.

Given below are the Catawba Unit 1 Reactor Coolant System resistance changes and corresponding pressure drop changes as calculated by the RCS flow correlation described above.

RCS Pressure Drop Changes For Changes In RCS Flow Resistance
November 1993 EOC 7 Refueling Outage

| | Loop A | Loop B | Loop C | Loop D |
|---|--------|--------|--------|--------|
| Total SG Tube Plugging, % | 6.95 | 3.47 | 11.17 | 10.06 |
| Change In SG Tube Plugging From Aug-92 Outage, % | 2.51 | 1.91 | 5.15 | 5.96 |
| SG Pressure Drop Change, psi | +1.28 | +0.94 | +2.63 | +2.91 |
| Pressure Drop Change for B&W Fuel (2/3rds to Full core), psi | -0.74 | -0.69 | -0.96 | -1.01 |
| Total Change In RCS Pressure Drop, psi | +0.54 | +0.25 | +1.67 | +1.90 |
| Change in loop flow, % | 0.32 | 0.15 | 1.00 | 1.13 |

Catawba Unit 1 Elbow Tap Tech Spec Change

NC Pumps

No work was performed on the NC Pumps that could have contributed to a reduction in flow.

Elbow Tap DP Data

Average daily data was found that goes back to 1/1/92. We plotted it on two graphs, one for cycle 6 and the other for cycle 7.

We cleaned up the data by deleting bad data and data at off power days (<99%).

Channels A1, C2, and C3 had drift problems during this period. They have been replaced in the last outage.

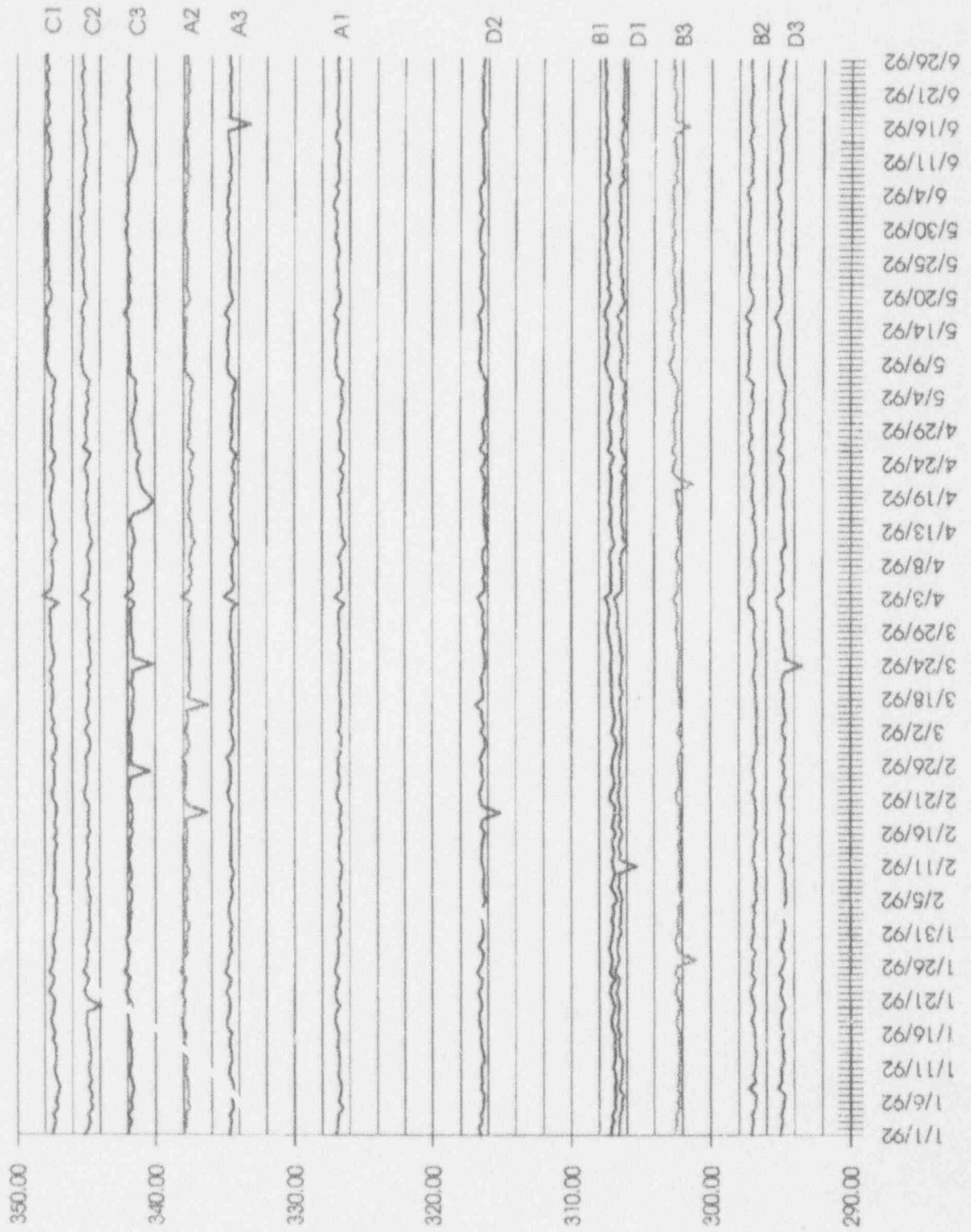
On 8/5/93 all the trends go down by about 0.3%. The OAC scanner was recalibrated that day and it was out of calibration a small amount.

Not all bad data was removed. The small dips you see in the negative direction were due to bad averaging. Occasionally a point will read invalid by the computer and this will be recorded as a zero reading for the 5 minute period in question. This will cause the daily average for that day to read low a slight amount.

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| Time | A1 | A2 | A3 | B1 | B2 | B3 | C1 | C2 | C3 | D1 | D2 | D3 |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 10/12/93 | 321.99 | 335.05 | 339.20 | 307.81 | 297.02 | 304.33 | 345.22 | 341.06 | 337.07 | 306.88 | 317.24 | 294.11 |
| 10/13/93 | 315.11 | 331.70 | 328.12 | 304.45 | 295.20 | 300.99 | 340.07 | 335.88 | 335.98 | 305.60 | 314.71 | 292.76 |
| 10/14/93 | 321.70 | 335.09 | 339.26 | 307.85 | 297.06 | 304.40 | 345.20 | 341.10 | 337.07 | 306.86 | 317.18 | 294.04 |
| 10/15/93 | 321.25 | 334.95 | 339.13 | 307.81 | 297.03 | 304.34 | 345.24 | 341.16 | 336.99 | 306.96 | 317.23 | 294.07 |
| 10/16/93 | 321.79 | 334.95 | 339.11 | 307.71 | 296.97 | 304.21 | 345.18 | 341.05 | 336.91 | 306.83 | 317.08 | 293.95 |
| 10/17/93 | 321.60 | 334.89 | 339.06 | 307.75 | 297.06 | 304.28 | 345.12 | 341.05 | 336.97 | 306.82 | 317.09 | 293.90 |
| 10/18/93 | 321.86 | 335.01 | 339.20 | 307.86 | 297.07 | 304.33 | 345.34 | 341.24 | 337.12 | 306.90 | 317.16 | 293.96 |
| 10/19/93 | 321.90 | 334.97 | 339.16 | 307.79 | 297.05 | 304.28 | 345.17 | 341.14 | 337.08 | 306.87 | 317.16 | 294.00 |
| 10/20/93 | 321.59 | 335.06 | 339.25 | 307.71 | 297.11 | 304.23 | 345.32 | 341.22 | 337.09 | 306.85 | 317.15 | 294.00 |
| 10/21/93 | 321.88 | 334.97 | 339.16 | 307.73 | 297.06 | 304.20 | 345.35 | 341.32 | 337.08 | 306.86 | 317.11 | 293.94 |
| 10/22/93 | 321.87 | 335.08 | 339.28 | 307.86 | 297.19 | 304.33 | 345.37 | 341.32 | 337.22 | 306.93 | 317.18 | 294.03 |
| 10/23/93 | 322.11 | 335.37 | 339.55 | 308.11 | 297.32 | 304.59 | 345.68 | 341.83 | 337.46 | 307.22 | 317.46 | 294.27 |
| 10/24/93 | 322.44 | 335.48 | 339.82 | 308.18 | 297.43 | 304.84 | 345.83 | 341.77 | 337.85 | 307.31 | 317.46 | 294.24 |
| 10/25/93 | 322.38 | 335.45 | 339.64 | 308.14 | 297.33 | 304.64 | 345.80 | 341.72 | 337.71 | 307.36 | 317.50 | 294.25 |
| 10/26/93 | 322.34 | 335.52 | 339.71 | 308.30 | 297.53 | 304.83 | 345.93 | 340.71 | 337.71 | 307.42 | 317.68 | 294.43 |
| 10/27/93 | 322.58 | 335.70 | 339.91 | 308.57 | 297.74 | 305.03 | 346.10 | 341.98 | 337.80 | 307.57 | 317.86 | 294.63 |
| 10/28/93 | 322.62 | 335.79 | 334.00 | 308.45 | 297.75 | 304.91 | 346.07 | 341.98 | 338.16 | 307.73 | 317.78 | 294.50 |

Catawba Unit 1 Elbow Tap DP (1/1/92 to EOC6)



Catawba Unit 1 Elbow Tap DP (Cycle 7)

