NUCLEAR POWER BUSINESS UNIT
CALCULATION REVIEW AND APPROVAL

T744

Calculation #	96-0279
Number of Pages	8 + 1 attachment

Title of Calculation:
Uncertainty Associated with Instrumentation used in IT-21 & IT-22 for Charging Pumps

☒ Original Calculation ☒ QA-Scope

☐ Revised Calculation. Revision # ______

☐ Superseding Calculation. Supersedes Calculation # ______

Modification #	Description:

Other References:

Prepared B	Date: 12/20/96

This Calculation has been reviewed in accordance with NP 7.2.4. The review was accomplished by one or a combination of the following (as checked):

____ A review of a representative sample of repetitive calculations.

✓ A detailed review of the original calculation.

____ A review of the calculation against a similar calculation previously performed.

____ A review by an alternate, simplified, or approximate method of calculation.

Comments:
See the attached comment pages (2 pages)
Per note on attached sheet - all reviewer comments were resolved adequately with the preparer EJM 12/20/96

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PDR ADOCK 05000301
P PDR

	Date: 12/20/96		Date: 12/20/96

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PBF-1608
Revision 1 02/27/95

Reference(s): NP 7.2.4

Review Comments on Calculation 96-0279, Rev. 0

The following comments were made on this calculation 96-0279 and resolved with the preparer:

1. Section D.1: Per DG-I01, Section 3.3.3.15, if sufficient data is not available to perform an as-found/as-left drift analysis and there is no vendor data available, a default value of ±2% should be used for sensors and ±1% should be used for rack components. DG-I01, Section 3.3.3.12 allows use of engineering judgement where data is not available. The past calibration data discussed in this calculation adequately provides a basis for this engineering judgement.

2. Section F, General

   The general methodology in DG-I01 is to combine errors as a percent of the calibrated span (see examples in Section 3.3.1 and discussion in Section 3.3.3.5). In this calculation, percentage errors are calculated and then multiplied by the maximum flow rate to get an error in measured flow rate. This technique should yield conservative error values when considering flow rates below the maximum.

3. Section F.1:

   FE-128 - Westinghouse data sheet 1.6A lists a ±1% accuracy in range from 30 - 120 gpm and a differential pressure range of 200" H_2O. Use of this orifice error in lieu of the conversions discussed in DG-I01 Section 3.3.4.2 is conservative. The data sheet provides a reference for the 140 gpm maximum flow rate used in this calculation.

   FT-128

   a. In the calculation of the calibration errors, it should be clarified that the 10-50 mA span is the calibrated span for the transmitter per ICP-04-003.4.
   b. Reference for the FT accuracy should be noted.
   c. The adjustment of the drift to account for different calibration frequency should be done using the guidelines of DG-I01, Section 3.3.4.3. It should be noted that calibrated span and the upper range limitare the same.
   d. The static pressure effects noted here are the random portion of theses errors. As discussed in DG-I01 Sections 3.3.2.1 and 3.3.3.18 a non-random portion of the error may based on the static head differences between the header and the transmitter. In ICP-04-003.4 a pressure is applied at the transmitter during calibration. As such the impact of any differences between the header and the transmitters is not considered in the calibration. Since we are only concerned with measurement of differential pressure, this component of the error should be very small and can be excluded per DG-I01 Section 3.3.3.9.
   e. The vendor static errors are not treated exactly as noted in DG-I01. The difference in handling the static pressure will not significantly affect the results. Since the calibrated span and the upper range limit are the same, the Span Shift Bias calculation is acceptable.
   f. As discussed in the comments on FM-128, conversion of this error to a flow rate is not appropriate at this point.

   FM-128 - As shown in DG-I01 Appendix D, the output error of a non-linear device should be calculated using the input errors (i.e., the SRSS of errors for devices upstream of the non-linear device), the transfer function for the device and the errors of the device. The transfer function from DG-I01should be used in the calculation.

FI-128

a. In the discussion of the indicator accuracy you reference a telecon with Karen Depodesta. A review of select pages from reference 9 confirms that the information in the telecon is appropriate.

b. The error value allowed in ICP-04-032.1 is ±2.8 gpm and the calibrated span is 4-140 gpm. This gives ±2.8/136 = ±2.06%.

c. The terms under the square root shoulc ɔe shown squared.

4. Sections F.2:

a. The calibrated range for FI-115 and FI-116 is 20 to 198" H_2O input and 6.32 to 19.90 gpm output.

b. Errors shouid be expressed in % rather than gpm.

c. In item a, the indicator readability should be in gpm not psi.

d. Per Westinghouse data sheet accuracy of flow elements is ±1%.

5. Section G

a. In Item a, if errors for FM128 are calculated as noted above, only the error for FM128 and FI128 need to be used in the loop accuracy calculation.

6. Attachment

The calculation number and page number should be added to the attachment.

A. Purpose

The purpose of this calculation is to determine the uncertainty associated with the instrumentation used in inservice test procedures IT-21 & IT-22, for the charging pumps, (reference 2). The final uncertainty value must include a combination of the uncertainties for all the instrumentation used in the test that will have an impact on the ability to measure the IST acceptance value during the test performance for comparison to the design basis acceptance value.

B. Method

Instrument uncertainties will be calculated for the instruments used in the charging pump Inservice Test procedures, IT-21 and IT-22, (reference 2). The charging pump acceptance value will be strictly a total flow value. The charging pump total flow is determined in IT-21 and IT-22 by adjusting the pump speed to 1350 ± 10 rpm using a portable tachometer and adding the flows from three instruments, FI-128, FI-115 and FI-116. The uncertainties for these three instruments will be determined, and then combined, using a square root sum of the squares technique. The result will be added to the design basis pump performance requirement (currently defined in reference 1) to establish an IST acceptance criteria for the charging pumps that will ensure they can meet their design basis performance requirement. During the performance of IT-21 and 22, the operator will increase the charging pump flow to a value that is greater than the design basis acceptance requirement, plus instrument uncertainties. This test will show that the charging pumps are capable of satisfying their design basis requirement.

Since the charging pump design-basis acceptance value is strictly a flow value, and the charging pumps are positive displacement pumps whose flow output is nearly independent of the discharge pressure seen by the pump, it is not necessary to consider any pressure instruments in this uncertainty calculation. It is not necessary to compare the pump to a pump curve, or prove the design basis requirement can be satisfied at a particular pump speed, since the purpose is only to verify that the pump can satisfy its design basis function, which is strictly a flow value. It is not important what the rpm of the charging pump is at the time of the IST test to determine that the design basis requirement has been satisfied. The instrument uncertainties associated with the charging pump speed, and the instruments used to measure that speed, are not considered in this calculation. The pump speed remains important to ensure ASME Section XI acceptance criteria are satisfied, since these criteria are established to monitor for pump degradation.

This calculation identifies the Unit 1 instrumentation, however the calculation applies equally to the charging pumps on either unit.

C. References

1. Charging pump operability determination, 10/3/1996.
2. PBNP Inservice Test, IT-21 and IT-22, "Charging Pumps and Valves Test, (Quarterly)" Unit 1 & 2, Revision 4, April 13, 1995.
3. E-mail, Craig Neuser to Ed Mercier, Subject "Indicators", dated 12/10/1996, attached.
4. PBNP Instrumentation and Control Procedures, ICP-04.003-4, "Charging Flow Transmitter and Indicator Outage Calibration, " Rev 1, August 2, 1995.
5. PBNP Instrumentation and Control Procedures, ICP-04.003-7, "RCP A & B Seal Water And Letdown Flow Instruments Outage Calibration," Rev 3, August 27, 1996
6. Rosemount Instruction Manual MAN 4258, Model 1151HP Alphaline Differential Pressure Transmitters for High Line Pressures, January 1988.
7. DG-I01 "Instrument Setpoint Methodology", Revision 1, September 12, 1995.
8. Westinghouse Specification Sheets. Data Sheet 1.6 dated 7/18/69
9. VECTRA Calc No. PBNP-IC-07, "Westinghouse 252 Indicator Drift Calculation", Rev 0, 6/9/1995
10. Duke Engineering & Services letter to WE, "SI Pump IST Flow Test Uncertainty Evaluation", September 25, 1996.
11. WE Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance", dated 9/25/1996.
12. Foxboro Component Instruction Manual, Control #00623, Model 66A Square Root Converter, section 18-650, Feb 1969, page 1.
13. PBNP Instrumentation and Control Procedures, 1ICP-04.032-1, "Auxiliary Feedwater System and Charging Flow Electronic Outage Calibration," Rev 0, February 22, 1995.
14. Barton Component Instruction Manual, Control #001035, TFI 8.5, Model 200 Differential Pressure Indicator.
15. Westinghouse Specification Sheets for 1FE-128, Data Sheet 1.6A dated 7/30/69.

D. Assumptions

1. The temperature effect on the instrumentation will be assumed to be negligible as the transmitters are calibrated and used in essentially the same temperature environment.

2. If manufacturer's data was not located, uncertainties associated with drift of an instrument have been assumed to be the smaller of either 0.5% of full scale, or the instrument calibration tolerance. This value (0.5%) is based on engineering judgment of the maximum expected drift between calibrations for the instrumentation involved. Alternatively, the calibration accuracy is used if smaller, because instrumentation found regularly out of

calibration are typically either repaired or replaced. Reviews of past instrument calibration sheets for the instruments in this calculation have shown the drift to be less than 0.5% in nearly all cases. ✓

3. The M&TE error is assumed to be the smaller of either 0.5% of the instrument range, or the calibration tolerance, for all IST instruments. This value (0.5%) is conservative based on the research performed for Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance" (reference 11). The calibration accuracy is used if smaller because it is the practice of I&C to use a calibration instrument which is at least as accurate as the instrument being calibrated.

E. Inputs

For this calculation, the total uncertainty associated with the instrumentation used to perform the IST test must be accounted for when obtaining the minimum IST acceptance criteria Contributors to this total uncertainty include:

- Instrument (transmitter & indicator) accuracy
- Indicator readability
- Tolerance
- Drift

F. Instrument Uncertainty Determinations

1. Instrument Uncertainties for FI-128, Charging Flow. The uncertainties for the entire instrument loop, which includes the flow orifice FE-128, the flow transmitter FT-128, the I/I square root converter FM-128, and the flow instrument FI-128, will be evaluated and combined using a square root sum of the squares method.

<u>FE-128, Charging Line Flow Element</u>
Daniel Orifice Fitting Co., model #520,
The accuracy is ±1.0% (reference 15).

U128 = ± 1.0% ✓

<u>FT-128, Charging Line Flow Transmitter</u>, Rosemount, Model #1151HP5G2201 (The calibrated range is 0-200" H_2O, 10-50 mAmp). (reference 4)
FT-128 measures differential pressure, and outputs in amps. The square root conversion in the loop is done separately, in FM-128, and thus is not part of the transmitter.

a. Instrument accuracy (which includes combined effects of linearity, hysteresis, and repeatability) is ±0.25% of calibrated scale (reference 6)

b. Calibration Setting Tolerance; The as left tolerance for the instrument is ±0.2 mAdc. This represents ±0.5% of the calibrated range (0.2mA / 40 mA), (reference 4) ✓

c. Drift (transmitter stability); ±0.25% of upper range limit for 6 months. (reference 6) Based on a yearly calibration, and a 25% window on the calibration frequency:

Drift = 1.25 x 12/6 x ±0.25% = ±0.625% ✓

d. Static pressure effect
Zero Error: ±2.0% of upper range limit for 4500 psi (reference 6).
Span Error: ±0.25% of upper range limit per 1000 psi. Assuming a discharge pressure of 2000, this would be ±0.5% (reference 6).

e. M&TE Error, Minimum required M&TE tolerance is ±1.0" (reference 4), which represents an error of ±0.5% (1"/200").

$$U_{FT128} = \sqrt{(0.25\%)^2 + (0.5\%)^2 + (0.625\%)^2 + (2.0\%)^2 + (0.5\%)^2 + (0.5\%)^2}$$ ✓

$$U_{FT128} = \pm 2.28\%$$

Input errors to Square Root Converter:

$$a = \sqrt{(U_{FE128})^2 + (U_{FT128})^2}$$

$$a = \sqrt{(0.01)^2 + (0.0228)^2} = \pm 2.49\%$$ ✓

FM-128, I/I Square Root Converter for Charging Line Flow, Foxboro, Model 66AC-0. The calibrated range is 12.50 mA - 50 mA input, and 10 - 50 mA output. (reference 13)

a. Accuracy; The accuracy is ±0.5% (reference 12)

b. Calibration Setting Tolerance; The as left tolerance for the instrument is ±0.2 mAdc. (reference 13) This represents a ±0.5% input error, (0.2mA / 40mA).

c. Drift; No information was found in the component manual, so ±0.5% was assumed. (assumption 2).

d. M&TE; ±0.5% was assumed (assumption 3).

$$U_{FM128} = \sqrt{(0.5)^2 + (0.5)^2 + (0.5)^2 + (0.5)^2}$$
$$U_{FM128} = \pm 1.0\%$$

✓

Using the transfer function from reference 7 for a square root converter:

Eq. 1 $b = \sqrt{(a / 2B)^2 + e^2}$

Where
- b = Output error from non - linear device
- a = Input error to non - linear device
- B = Point of Interest (0 - 100% of span = 0 to 1)
- e = Device Uncertainty from non - linear device

Reviewing past IST tests, a typical value for this instrument is 29 gpm. Based on this, a point of interest of 29 gpm will be used.

$$B = \frac{\text{Point of interest}}{\text{Instrument range}} = \frac{29 \text{ gpm}}{140 \text{ gpm}} = \frac{\%}{100\ \%} = .2071$$

Evaluating Equation 1.

$$b = \sqrt{(.0249 / 2*0.2071)^2 + (.01)^2}$$

✓

$$b = .0609 = 6.09\%$$

FI-128, Charging Line Flow Indicator, Westinghouse Model #252, calibrated range of 4 to 140 gpm (reference 13)

a. Indicator readability; Based on plant walkdown by Craig Neuser, the smallest divisions on the meter face are at 2 gpm intervals. (reference 3) Therefore, the instrument is read accurately to within ±1 gpm, or ±0.74% of calibrated range.

b. Indicator Accuracy; ±1.028% (reference 9) ✓
This error also includes M&TE error and drift, based on telecon on 12/17/1996 with Karen Depodesta, Duke Engineering & Services.

c. Calibration Tolerance; 2% of 140 gpm = 2.8 gpm. (reference 13)
Since the calibrated span is 4 gpm to 140 gpm:

$$\text{Calibration Tolerance} = \frac{2.8 \text{ gpm}}{136 \text{ gpm}} = .0206 = 2.06\%$$

✓

$$U_{FI128} = \sqrt{(0.0074)^2 + (0.01028)^2 + (0.0206)}$$ ✓

$$U_{FI128} = 0.0242 = 2.42\%$$

2. Instrument Uncertainties for 1-FI-115, 1P-1A seal injection flow, Barton Instruments Corporation, model 200, calibrated range of 20" H_2O to 198" H_2O input, 6.32 gpm to 19.90 gpm output. (reference 5).
   a. Indicator readability; Based on plant walkdown by Craig Neuser, the meter face has divisions of 1 gpm, 0.2 gpm, and 0.1 gpm, dependent on the range used. (reference 3) Between 4 gpm and 10 gpm, the indicator range is .2 gpm per division. Based on past completed IT-21 & 22 tests, the reading for this instrument typically falls between 6.5 gpm and 8.7 gpm. Since this is not a linear meterface, instead of using half of a division for the reading accuracy, it is assumed that the reading accuracy is equal to the smallest division, or 0.2 gpm.

$$\text{Readability (\% of calibrated range)} = \frac{\pm 0.2 \text{ gpm}}{(19.9 \text{ gpm} - 6.32 \text{ gpm})} = \pm 0.0147 = \pm 1.47\%$$ ✓

   b. Instrument accuracy, ±0.5% of full scale (20 gpm) or ±0.1 gpm (reference 14)

$$\text{Accuracy (\% of calibrated range)} = \frac{\pm 0.5\% * 200" H_2O}{(198" H_2O - 20" H_2O)} = \pm 0.00561 = \pm 0.56$$ ✓

   c. Calibration Tolerance; The as left tolerance for the instrument is ±0.1 gpm, which represents 0.5% of full scale (reference 5)

$$\text{Calibration (\% of calibrated range)} = \frac{\pm 0.5\% * 200" H_2O}{(198" H_2O - 20" H_2O)} = \pm 0.00561 = \pm 0.56\%$$ ✓

   d. Drift; assumed to be ±0.1 gpm due to calibration tolerance, which represents 0.5% of full scale. (assumption 2)

$$\text{Drift (\% of calibrated scale)} = \frac{\pm 0.5\% * 200" H_2O}{(198" H_2O - 20" H_2O)} = \pm 0.00561 = \pm 0.56\%$$ ✓

   e. M&TE (Instrumentation uncertainty due to calibration); ± 1.0" H20, (reference 5)

$$\text{M\&TE (\% of calibrated range)} = \frac{\pm 1.0" H_2O}{(198" H_2O - 20" H_2O)} = \pm 0.00561 = \pm 0.56\%$$ ✓

   f. FE-115, Daniel Orifice Fitting Co., model #520, (flow orifice associated with FT-115).
      The accuracy is ±1.0% (reference 8)

$$\text{FE - 115(\% of calibrated range)} = \frac{\pm 1.0\% * 200"}{(198" H_2O - 20" H_2O)} = \pm 0.0112 = \pm 1.12$$

Since the bellows in the indicator effectively acts as the square root converter, it is necessary to treat this instrument as a square root converter. All the above errors with the exception of the indicator readability, are treated as input errors.

Input errors:

$$a = \sqrt{(0.0056)^2 + (0.0056)^2 + (0.0056)^2 + (0.0056)^2 + (0.0112)^2}$$

$a = \pm 0.0158 = \pm 1.58\%$ ✓

Using the transfer function for a square root device from Appendix D of reference 8

Eq. 1 $b = \sqrt{(a / 2B)^2 + e^2}$

Where
- b = Output error from non - linear device
- a = Input error to non - linear device
- B = Point of Interest (0 - 100% of span = 0 to 1)
- e = Device Uncertainty from non - linear device

To determine the point of interest, it is necessary to look at Equation 1 and recognize that the smaller that B is, the greater that the output error will be. From a review of past IST data, the lowest value for this reading was 6.4 gpm

$$B = \frac{\text{Point of interest}}{\text{Instrument range}} = \frac{6.4\ \text{gpm}}{20\ \text{gpm}} = \frac{32\%}{100\ \%} = 0.32$$

Evaluating Equation 1.

$$b = \pm\sqrt{(0.0158 / 2 \cdot 0.32)^2 + (0.0147)^2}$$

$b = 0.0287 = \pm 2.87\%$ ✓

This error converted to gpm:

$b = \pm 2.87\% * 20\ \text{gpm} = \pm 0.57\ \text{gpm}$ ✓

This error also applies to FI - 116, since the instruments and calibration methods are the same.

G. Calculation

The uncertainties of the Inservice test instrumentation has been determined above, and will be combined using a systematic method established in reference 7 and reference 10. This best estimate or realistic approach combines uncertainties using the statistical square root sum of squares (SRSS) method. This uncertainty value will be added to the design basis charging pump flow requirement and this will become the IST design basis limit, and will be used as an acceptance value for the charging pumps.

a. Loop Uncertainty associated with FI-128 (see Section F.1)

$$U128 = \pm\sqrt{(U_{FM128})^2 + (U_{FI128})^2}$$

$$U128 = \pm\sqrt{(0.0609)^2 + (.0242)^2}$$

$$U128 = \pm .0655 = \pm 6.55\% \text{ of 140 gpm range} = 9.17 \text{ gpm}$$ ✓

b. Uncertainty associated with FI-115 (see Section F.2)

$$U115 = \pm 0.57 \text{ gpm}$$ ✓

c. Uncertainty associated with FI-116 (see Section F.2)

$$U116 = \pm 0.57 \text{ gpm}$$ ✓

d. Combining the uncertainties from these three flow instruments gives the following for total uncertainty:

$$Utotal = \pm\sqrt{(U128)^2 + (U115)^2 + (U116)^2}$$

$$Utotal = \pm\sqrt{(9.17 \text{ gpm})^2 + (0.57 \text{ gpm})^2 + (0.57 \text{ gpm})^2}$$

$$Utotal = \pm 9.21 \text{ gpm}$$ ✓

H. Results

The total instrument uncertainty associated with the inservice test procedure for the charging pumps is ± 9.21 gpm

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*---------------------------------------*
*     Printed For:                      *
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Date: Tuesday, 10 December 1996 9:06am CT
To:
From:
Subject: Indicators

Flow indicators FI-115/116:

0 - 4 gpm : 1 gpm divisions
4 - 10 gpm: .2 gpm divisions
10 - 20 gpm: .1 gpm divisions

Flow indicator FI-128:

0 - 140 gpm: 2 gpm divisions

If any more info is needed please let me know.

___ CR 96 - 416

OPERABILITY DETERMINATION

1. Degraded or potentially nonconforming equipment:

   Charging Pumps U1&2 P-2A P-2B P-2C

   Safety function(s) performed:

   Internal check valves provide a containment isolation pressure boundary following a LOCA.

   No safety related functions to providing flow.

   The charging pumps are needed to bring the unit to cold shutdown with the required shutdown margin at any time during core life, assuming that the most conservative control rod is stuck in the fully withdrawn position.

   Provide RCP seal flow and makeup for RCS leakage.

3. Circumstances of potential nonconformance, including possible failure mechanisms:

   Condition Report 96-416 identified a potential concern for adequacy of the IST program to ensure that pumps meet design basis as well as ASME Section XI requirements. This evaluation supports determination of operability pending completion of detailed analysis

4. Requirement or commitment established for the equipment, and why it may not be met:

   Technical Specifications Section 15.3.2 provides the design basis for CVCS control of RCS Boron inventory. The boration volume available through any flow path is sufficient to provide the required shutdown margin at cold shutdown, Xenon free conditions from any expected operating condition. The maximum volume requirement is associated with boration from just critical , hot zero or full power, peak xenon with control rods at the insertion limit , to xenon-free, cold shutdown with the highest worth control rod assembly fully withdrawn.

   FSAR 14.3.1 states that makeup flow rate from two charging pumps is typically adequate to maintain pressurizer level long enough for the operator to respond without activating the ECCS for a break through a 3/8" diameter hole.

   Generic Letter 83-28 Required Actions Based On Generic Implications Of Salem ATWS Events

   IST acceptance criteria may not be conservative when compared to design basis criteria.

5. How and when the potentially nonconforming equipment was first discovered:

   This generic concern was first identified in June 1996 as a specific concern for safety injection pump acceptance criteria from ASME Section XI versus design requirements This generic concern was first identified in June 1996

6. Basis for declaring affected equipment operable:

   A. During normal operation the charging system is required to provide 32 gpm flow per pump. Normally two pumps are in operation. 32 gpm flow per pump is based on providing sufficient flow for reactor coolant system makeup, based on the sum of the following:

   12 gpm reactor coolant pump seal leakage. This is twice the normal leakage of 3 gpm per pump. Also, reactor coolant pump operation is only allowed if reactor coolant pump seal leakage is <5 gpm per OP-4B (line 2.3.2).

   10 gpm labyrinth seal flow. A labyrinth seal flow is necessary to prevent reactor coolant from entering the seal area. 10 gpm is the sum of the normal design labyrinth seal flow from each pump (5 gpm each). (W KIM # 102, Section 5, line 5.5.7)

   10 gpm reactor coolant system leakage. This is based on Technical Specification Section 15.3.1.D.

   B. Technical Specifications Section 15.3.2 provides the design basis for CVCS control of RCS Boron inventory. The boration volume available through any flow path is sufficient to provide the required shutdown margin at cold shutdown, Xenon free conditions from any expected operating condition. The maximum volume requirement is associated with

boration from just critical , hot zero or full power, peak xenon with control rods at the insertion limit , to xenon-free, cold shutdown with the highest worth control rod assembly fully withdrawn. Calculation P-93-014 was performed to show that for a typical cycle, assuming worst case conditions, the reactor can be maintained subcritical following a reactor trip. Specifically, the amount of negative reactivity that can be inserted by one charging pump borating at a minimum speed (15gpm) using the refueling water storage tank (RWST) as the suction source is greater than the positive reactivity added from the decay of xenon. Calculation P-93-014 showed that at a rate of 15 gpm from the RWST the intent of tech spec 15.3.2 for maintaining shutdown margin has been satisfied. The calculation did not look at the capability of the boric acid storage tanks ability to provide shutdown margin. The RWST is more limiting for a minimum flow requirement than the Boric acid storage tanks because boric acid concentration is maintained higher in the boric acid storage tanks than the RWST.

The reactor coolant pump seal leakage is not flow that can be considered to be added to the RCS. Therefore the total charging flow is required to be 15 gpm + 12 gpm = 27 gpm. The 32 gpm flow mentioned above is limiting as it envelopes the shutdown margin capability flow of 27 gpm.

C. FSAR 14.3.1 states that makeup flow rate from two charging pumps is typically adequate to maintain pressurizer level long enough for the operator to respond without activating the ECCS for a break through a 3/8" diameter hole. The original basis for capacity of the charging pumps was the ability to makeup to the RCS for normal charging system flow requirements (30 gpm), RCP seal injection flow requirements where the seal injection flow consists of the normal RCP labyrinth flow (5 gpm per pump), maximum seal flow through one RCP seal (75 gpm, assuming pumps equipped with floating ring seals which are not applicable to PBNP), and twice the nominal no. 1 seal flow in the remaining pump (6 gpm). This total of 121 gpm results in a requirement of 60.5 gpm per charging pump. Neither this requirement nor the 32 gpm limiting flow requirement stated above is related to the FSAR Chapter 14 statement relating charging system performance and a 3/8 inch reactor coolant system hole. The FSAR states that two charging pumps are typically adequate to maintain pressurizer level long enough for the operator to respond without activating the ECCS for a break through a 3/8 inch diameter hole. This statement does not mean that pressurizer level will be maintained constant or that the charging pumps will be able to meet the volume of such a leak. The statement in the FSAR concerning charging system capability is therefore only a general capability statement and not a design basis requirement. A calculation (N-90-015 Response Time for 3/8" Line Break In Reactor Coolant System) was performed to determine the amount of time available for operator action with two charging pumps available. The calculation concluded that approximately 30 minutes is available for operator action at no load conditions and 2 hours is available at full power. This calculation assumed a design flow rate of 60.5 gpm from each of two charging pumps. The maximum flow rate from a 3/8" line was determined to 17.5 lbm/sec or 126 gpm reference calc in NCR N-89-187. Note that although the 3/8" piping was upgraded to safety related and eliminated the need to include charging flow for 3/8" line break in the design basis, the statement in the FSAR is still true in that two charging pumps operating at their design maximum flow is typically adequate time for operator response. See attached response to Nonconformance Report N-89-187 for additional information.

D. Generic Letter 83-28 (Required Actions Based On Generic Implications Of Salem ATWS Events) required each licensee to submit a report describing how it meets the requirements contained within the Generic Letter. A letter from C.W. Fay Vice President Nuclear power to the NRC dtd 11/1/83 contained this report. One of the sections required to be addressed in the Generic Letter concerned post maintenance testing. The report stated that it is current practice to perform PMT on safety related pumps and valves. This testing is performed in accordance with the guidelines of ASME Section XI. The same acceptance criteria used in evaluating performance during periodic testing is used in evaluating performance after maintenance. Current practice at PBNP is to perform periodic testing in accordance with Section XI and to perform PMT to the Section XI requirements after maintenance. The charging pumps are called upon in procedure CSP S.1 "Response to Nuclear Power Generation/ATWS" as a potential boration path for ATWS. A review of the Westinghouse Owners Group Emergency response guideline for FSR S.1 does not call out any specific flow requirement for the charging pumps. It provides guidance for various means of borating the unit through emergency boration paths to the charging pumps as one of the alternatives. A review of PBNPs response to GL 83-28 did not find any flow requirements for the charging pumps. Based on the above and the fact that the charging pumps are tested in accordance with ASME Section XI the commitments concerning ATWS have been met.

E. The IST program tests the charging pump flow against normal system operating pressure. The pumps are tested at 1350 rpm plus or minus 10 rpm. This is below the maximum RPM of the pump. The most limiting pump from attached IST data provided 42.6 gpm at 1350 rpm against normal system operating pressure. <u>This is above the required limiting design basis of</u>

32 gpm and thus the charging pumps are considered operable.

Pump	Design Basis	IST Required Action Range	Actual Results
1P2A	32 gpm	41.39 - 48.95 gpm	42.8 gpm
1P2B	32 gpm	39.80 - 47.08 gpm	42.6 gpm
1P2C	32 gpm	41.10 - 48.55 gpm	43.6 gpm
2P2A	32 gpm	39.62 - 46.86 gpm	43.6 gpm
2P2B	32 gpm	40.30 - 47.60 gpm	44.8 gpm
2P2C	32 gpm	39.06 - 46.20 gpm	43.1 gpm

Prepared By: _ Date: 10/3/96

Approved By: [illegible] _ Date: 10/

Reviewed By: _ Date: 10/3/96

DCS

Charging Pump Flow Acceptance Criteria

Westinghouse used the following flows to determine the charging pump capacity (see attached DBD worksheets):

* 30 gpm (charging flow)
* 10 gpm (labyrinth flow)
* 75 gpm (maximum seal flow in one reactor coolant pump)
* 6 gpm (twice the "normal" seal flow (3 gpm) in the other pump)

This totals 121 gpm, or 60.5 gpm per pump based on two operable charging pumps (out of three total). This determination was made before mechanical seals were qualified for reactor coolant pump applications, hence the very large 75 gpm seal leakage assumption, and the charging pumps were bought on this basis. Since the PBNP reactor coolant pumps have mechanical seals, the following flows can be used to determine the current required charging pump capacity:

* 30 gpm (charging flow)
* 10 gpm (labyrinth flow)
* 12 gpm (twice the normal seal flow for both reactor coolant pumps)

This totals 52 gpm, or 26 gpm per pump. To arrive at an IST pump flow acceptance value, it is appropriate to consider only the (1) reactor coolant system inventory control and (2) boric acid addition functions of the CVCS (i.e., the "Chemical" and "Volume" control functions of the CVCS) Letdown flow does not need to be considered because it is related to RCS purification, and this RCS chemistry limits are addressed by other Technical Specifications (Section 15.3.1.C). This number can be arrived at as follows:

* 12 gpm (makeup for seal leakage - the maximum allowed by procedure is 10 gpm per pump) ←
* 10 gpm (labyrinth seal flow - labyrinth seal flow is required when maintaining seal flow)
* 10 gpm (Technical Specification 15.3.1.D allowed leakage)

This totals 32 gpm per pump. In addition to maintaining RCS inventory, this flow is considered a reasonable acceptance flow since it also envelopes the following:

(1) The boric acid transfer pumps are in-series with the changing pumps. The BATPs have an IST required flow of 8 gpm. 32 gpm envelopes this flow,
(2) It envelopes Appendix R evaluations, which assume a 20 gpm flow during fires.
(3) It also envelopes the flow required to accomodate either the assumed RCS contraction during cooldown (30 gpm) and auxiliary spray (30 gpm) flow, but not both together.

See the attachment for why the charging pump capacity does not need to be tied to providing makeup to accommodate 3/8 inch reactor coolant system line breaks.

Control Room Chilled Water Pump Flow Acceptance Criteria (P-112A, P-112B)

Control room cooling is not a safety-related function and is not directly related to any regulatory requirements (i.e. post-TMI). The control room chilled water has a design flow of 116 gpm @ 55 feet. This flow was required to accomodate removing a design room load of 580,000 Btu/hr. The latest calculations indicate that the load on the heat exchangers is about 432,000 Btu/hr. 116 gpm would be a reasonable flow to use, although a flow somewhat less would be acceptable given the actual lower-than-design room cooling load.

Cable Spreading Room Chilled Water Pump Flow Acceptance Criteria (P-111A, 111B)

Cable spreading room cooling is not a safety-related function and is not directly related to any regulatory requirements. The cabie spreading room chilled water pump has a design flow of 96 gpm @ 53 feet. This would be reasonable for to use.

FLOW TEST

Pump Flow Reference
Values and Limits

Pump#: 1P2A   IT-021   Date Established: 3/02/93
Entered By: LEH

REFERENCE VALUES

Pressure: Flow: 44.50 gpm

Vibration: Point A: .097 ips
Point B: .101 ips
Point C: .087 ips

1350 ± 10 rpm

ACCEPTABLE RANGE

Flow: 42.28 gpm to 48.95 gpm

Vibration: Point A: ≤ .243 ips
Point B: ≤ .253 ips
Point C: ≤ .217 ips

ALERT RANGE

Low Flow: 41.39 gpm to 42.28 gpm
High Flow: 48.95 gpm to 48.95 gpm

Vibration: Point A: .243 ips to .582 ips
Point B: .253 ips to .606 ips
Point C: .217 ips to .522 ips

REQUIRED ACTION RANGE

Low Flow: 41.39 gpm
High Flow: 48.95 gpm

Vibration: Point A: > .582 ips
Point B: > .606 ips
Point C: > .522 ips

COMMENT: Criteria from ASME OMb-1989, Part 6.

Pump: 1P2A

Test: 021

Flow Test

Test Date	Flow	Vibrations (ips) A	B	C	Int	Remarks
10/29/92	45.0	.100	.100	.080	LEH	ROUTINE SURVEILLANC
3/01/93	44.5	.097	.101	.087		
6/29/93	46.0	.107	.106	.083		
9/03/93	44.9	.109	.151	.077		
9/17/93	44.7	.127	.106	.092		
12/02/93		.133	.111	.086		
3/05/94	45.9	.155	.125	.097		
9/07/94	42.7	.123	.096	.086	LEH	ROUTINE SURVEILLANC
12/05/94	42.2	.096	.156	.103	LEH	ROUTINE, 2P-2A WO 9
3/05/95	43.1	.097	.095	.087	LEH	ROUTINE SURVEILLANC
6/02/95		.095	.096	.079	LRD	ROUTINE SURVEILLANC
9/06/95	45.8	.103	.099	.087	LEH	ROUTINE SURVEILLANC
12/05/95	46.0	.154	.096	.078	BAT	ROUTINE SURVEILLANC
3/07/96	45.4	.125	.098	.077	LEH	ROUTINE SURVEILLANC
6/05/96	43.7	.094	.086	.083	LRD	ROUTINE SURVEILLANC
6/15/96	42.8	.101	.095	.076	LRD	POST MAINTENANCE FO
9/05/96	42.8	.105	.088	.084	LEH	ROUTINE SURVEILLANC

FLOW TEST

Pump Flow Reference
Values and Limits

Date Established: 5/22/96

Pump#: 1P2B IT-021 Entered By: LEH

REFERENCE VALUES

Pressure: 1975.00 Flow: 42.80 gpm

Vibration: Point A: .172 ips
Point B: .101 ips
Point C: .087 ips

ACCEPTABLE RANGE

Flow: 40.70 gpm to 47.10 gpm

Vibration: Point A: ≤ .325 ips
Point B: ≤ .252 ips
Point C: ≤ .217 ips

ALERT RANGE

Low Flow: 39.80 gpm to 40.70 gpm

Vibration: Point A: .325 ips to .700 ips
Point B: .252 ips to .604 ips
Point C: .217 ips to .521 ips

REQUIRED ACTION RANGE

Low Flow: 39.80 gpm
High Flow: 47.08 gpm

Vibration: Point A: > .700 ips
Point B: > .604 ips
Point C: > .521 ips

COMMENT:

TEST DATA FOR ONE PUMP 9/06/96 Page 1

Pump: 1P2B

Test: 021

Flow Test

Test Date	Flow	Vibrations (ips) A	B	C	Int	Remarks
10/29/92	44.8	.100	.120	.080	LEH	ROUTINE SURVEILLANC
3/01/93	44.8	.100	.106	.088		
5/29/93	44.7	.127	.126	.110		
9/03/93	44.5	.125	.126	.115		
12/02/93		.116	.133	.125		
3/05/94	44.5	.128	.123	.117		
6/03/94	42.1	.198	.146	.091		
9/07/94	42.6	.131	.119	.108	LEH	ROUTINE SURVEILLANC
12/05/94	42.1	.252	.196	.087	LEH	ROUTINE, 2P-2A WO 9
2/24/95	41.3	.167	.119	.099	LEH	1P-2B, WO 9407493
2/24/95	41.3	.167	.119	.099	LEH	1P-2B, WO 9407493
2/25/95	42.9	.128	.126	.100	LEH	1P-2B, WO 9502540
3/05/95	43.0	.137	.119	.098	LEH	ROUTINE SURVEILLANC
6/02/95		.112	.112	.098	LRD	ROUTINE SURVEILLANC
9/06/95	45.5	.177	.120	.105	LEH	ROUTINE SURVEILLANC
12/05/95	45.5	.175	.115	.096	BAT	ROUTINE SURVEILLANC
3/07/96	45.2	.141	.112	.109	LEH	ROUTINE SURVEILLANC
5/22/96		.172	.101	.087	LEH	POST MAINT. P2B, WO
6/05/96	43.5	.109	.108	.105	LRD	ROUTINE SURVEILLANC
9/05/96	42.6	.126	.110	.111	LEH	ROUTINE SURVEILLANC

FLOW TEST

Pump Flow Reference
Values and Limits

Pump#: 1P2C   IT-021   Date Established: 2/28/96
Entered By: LEH

REFERENCE VALUES

Pressure: 2000.00   Flow: 44.14 gpm

1350±10rpm

Vibration: Point A: .176 ips
Point B: .138 ips
Point C: .106 ips

ACCEPTABLE RANGE

Flow: 41.90 gpm to 48.60 gpm

Vibration: Point A: ≤ .325 ips
Point B: ≤ .325 ips
Point C: ≤ .264 ips

ALERT RANGE

Low Flow: 41.10 gpm to 41.90 gpm
High Flow: 48.60 gpm to 48.55 gpm

Vibration: Point A: .325 ips to .700 ips
Point B: .325 ips to .700 ips
Point C: .264 ips to .635 ips

REQUIRED ACTION RANGE

Low Flow: 41.10 gpm
High Flow: 48.55 gpm

Vibration: Point A: > .700 ips
Point B: > .700 ips
Point C: > .635 ips

COMMENT: Criteria from ASME OMb-1989, Part 6. WO 9601306 set new reference values.

Pump: 1P2C

Test: 021

Flow Test

Test Date	Flow	A	B	C	Int	Remarks
		Vibrations (ips)				
10/29/92	44.9	.130	.090	.090	LEH	ROUTINE SURVEILLANC
2/09/93	45.1	.127	.102	.083		
3/01/93	45.1	.148	.131	.100		
6/29/93	46.0	.116	.101	.084		
9/03/93	44.5	.178	.105	.125		
12/02/93		.128	.102	.086		
3/05/94	45.9	.145	.109	.089		
5/27/94	42.0	.122	.111	.097		
9/07/94	42.7	.119	.097	.089	LEH	ROUTINE SURVEILLANC
12/05/94	42.8	.116	.185	.271	LEH	ROUTINE, 2P-2A WO 9
1/06/95	41.3	.125	.101	.089	LEH	INCREASED FREQUENCY
3/05/95	42.9	.112	.091	.087	LEH	ROUTINE SURVEILLANC
6/02/95		.133	.101	.090	LRD	ROUTINE SURVEILLANC
8/04/95	46.3	.141	.098	.083	LRD	POST MAIN. FOR 1P2C
9/06/95	46.0	.140	.102	.096	LEH	ROUTINE SURVEILLANC
12/05/95	45.5	.137	.106	.091	BAT	ROUTINE SURVEILLANC
2/02/96	44.3	.128	.094	.089	LEH	POST MAINT, 1P2C
2/28/96	44.1	.176	.138	.106	LEH	WO 9601306, 1P-2C
3/07/96	45.2	.184	.133	.108	LEH	ROUTINE SURVEILLANC
4/25/96	43.2	.189	.128	.105	LEH	POST MAINT. 1P2C,WO
5/24/96	43.5	.121	.128	.096	LRD	POST-MAIN. TEST FOR
6/05/96	43.7	.121	.131	.101	LRD	ROUTINE SURVEILLANC
9/05/96	43.6	.153	.122	.098	LEH	ROUTINE SURVEILLANC

FLOW TEST

Pump Flow Reference
Values and Limits

Pump#: 2P2A   IT-022   Date Established: 3/01/93
Entered By: LEH

REFERENCE VALUES

Pressure: Flow: 42.60 gpm

Vibration: Point A: .112 ips
Point B: .138 ips
Point C: .115 ips

1350±10 rpm

ACCEPTABLE RANGE

Flow: 40.47 gpm to 46.86 gpm

Vibration: Point A: ≤ .280 ips
Point B: ≤ .325 ips
Point C: ≤ .288 ips

ALERT RANGE

Low Flow: 39.62 gpm to 40.47 gpm
High Flow: 46.86 gpm to 46.86 gpm

Vibration: Point A: .280 ips to .672 ips
Point B: .325 ips to .700 ips
Point C: .288 ips to .690 ips

REQUIRED ACTION RANGE

Low Flow: 39.62 gpm
High Flow: 46.86 gpm

Vibration: Point A: > .672 ips
Point B: > .700 ips
Point C: > .690 ips

COMMENT: Criteria fom ASME OMb-1989, Part 6.

TEST DATA FOR ONE PUMP 9/09/96 Page 1

Pump: 2P2A

Test: 022

Flow Test

Vibrations (ips)

Test Date	Flow	A	B	C	Int	Remarks
11/21/92	44.7	.110	.140	.120	BAT	ROUTINE SURVEILLANC
11/21/92	25.0	.110	.140	.120	BAT	ROUTINE SURVEILLANC
1/21/93	40.7	.131	.136	.103		
3/01/93	42.6	.112	.138	.115		
6/02/93	42.3	.104	.126	.109		
9/[illegible]/93	44.2	.126	.143	.107		
12/02/93		.108	.138	.107		
2/18/94	46.1	.106	.140	.120		
3/05/94	44.8	.0[illegible]	.137	.112		
6/05/94	45.8	.098	.134	.111		
7/21/94	45.2	.152	.144	.121	KKW	ROUTINE SURVEILLANC
9/07/94	44.0	.103	.137	.108	LEH	ROUTINE SURVEILLANC
11/02/94	46.2	.117	.133	.112	LEH	2P-2A, WO 9407468,
11/02/94	46.2	.117	.133	.112	LEH	2P-2A, WO 9407468,
12/06/94	40.9	.111	.140	.110	LEH	ROUTINE SURVEILLANC
[illegible]0/95	43.0	.101	.126	.116	LEH	2P-2A WO 9501241
2/[illegible]7/95	43.1	.092	.127	.121	LEH	2P-2A, WO 9501906
3/05/95	43.2	.104	.128	.117	LEH	ROUTINE SURVEILLANC
4/28/95	42.8	.108	.126	.112	BAT	POST MAINTENANCE 2P
6/19/95	43.5	.106	.137	.107	LRD	ROUTINE, 9506129, 2P2
9/06/95	42.9	.105	.136	.109	LEH	ROUTINE SURVEILLANC
9/21/95	44.6	.128	.120	.094	LEH	WO 9508942, 2P-2A
12/04/95	42.9	.106	.136	.110	BAT	ROUTINE SURVEILLANC
3/07/96	43.5	.104	.142	.106	LEH	ROUTINE SURVEILLANC
6/03/96	44.5	.100	.136	.557	LRD	ROUTINE SURVEILLANC
6/26/96	44.1	.145	.134	.118	LRD	2P2A, 2P2B INCREASE
9/08/96	43.6	.113	.133	.109	LEH	ROUTINE SURVEILLANC

FLOW TEST

Pump Flow Reference
Values and Limits

Pump#: 2P2B   IT-022   Date Established: 6/08/96
Entered By: LEH

REFERENCE VALUES

Pressure: 1984.00   Flow: 43.30 gpm

Vibration: Point A: .123 ips
Point B: .113 ips
Point C: .114 ips

ACCEPTABLE RANGE

Flow: 41.10 gpm to 47.60 gpm

Vibration: Point A: ≤ .308 ips
Point B: ≤ .283 ips
Point C: ≤ .285 ips

ALERT RANGE

Low Flow: 40.30 gpm to 41.10 gpm

Vibration: Point A: .308 ips to .700 ips
Point B: .283 ips to .678 ips
Point C: .285 ips to .684 ips

REQUIRED ACTION RANGE

Low Flow: 40.30 gpm
High Flow: 47.60 gpm

Vibration: Point A: > .700 ips
Point B: > .678 ips
Point C: > .684 ips

COMMENT: Criteria from ASME OMb-1989, Part 6. Changed flow reference only for test dated 06/08/96.

TEST DATA FOR ONE PUMP 9/09/96 Page 1

Pump: 2P2B

Test: 022

Flow Test

		Vibrations (ips)				
Test Date	Flow	A	B	C	Int	Remarks
11/21/92	26.0	.140	.120	.140	BAT	ROUTINE SURVEILLANC
11/21/92	45.2	.140	.120	.140	BAT	ROUTINE SURVEILLANC
1/21/93	40.7	.147	.119	.141		
3/01/93	42.0	.166	.159	.152		
6/02/93	42.3	.135	.119	.132		
9/01/93	43.7	.150	.119	.131		
12/02/93		.213	.189	.127		
3/05/94	44.8	.146	.113	.129		
6/05/94	45.1	.152	.113	.129		
9/07/94	44.4	.151	.111	.132	LEH	ROUTINE SURVEILLANC
12/06/94	41.6	.148	.108	.114	LEH	ROUTINE SURVEILLANC
3/05/95	43.2	.152	.198	.130	LEH	ROUTINE SURVEILLANC
6/19/95	43.2	.150	.087	.142	LRD	ROUTINE,9506129,2P2
9/06/95	44.1	.165	.118	.160	LEH	ROUTINE SURVEILLANC
12/04/95	43.6	.157	.101	.141	BAT	ROUTINE SURVEILLANC
3/07/96	44.1	.149	.104	.123	LEH	ROUTINE SURVEILLANC
3/27/96	46.6	.123	.113	.114	LEH	POST MAINT 2P2B, WO
6/08/96	43.3	.156	.168	.421	LRD	ROUTINE SURVEILLANC
6/26/96	44.7	.179	.112	.134	LRD	2P2A, 2P2B INCREASE
9/08/96	44.8	.153	.113	.125	LEH	ROUTINE SURVEILLANC

FLOW TEST

Pump Flow Reference
Values and Limits

Pump#: 2P2C

IT-022

Date Established: 9/07/94
Entered By: LEH

REFERENCE VALUES

Pressure:

Flow: 42.00 gpm

Vibration: Point A: .122 ips
Point B: .091 ips
Point C: .097 ips

1350±10 rpm

ACCEPTABLE RANGE

Flow: 39.90 gpm to 46.20 gpm

Vibration: Point A: ≤ .305 ips
Point B: ≤ .228 ips
Point C: ≤ .243 ips

ALERT RANGE

Low Flow: 39.06 gpm to 39.90 gpm
High Flow: 46.20 gpm to 46.20 gpm

Vibration: Point A: .305 ips to .700 ips
Point B: .228 ips to .546 ips
Point C: .243 ips to .582 ips

REQUIRED ACTION RANGE

Low Flow: 39.06 gpm
High Flow: 46.20 gpm

Vibration: Point A: > .700 ips
Point B: > .546 ips
Point C: > .582 ips

COMMENT: Criteria from ASME OMb-1989, Part 6.

TEST DATA FOR ONE PUMP 9/09/96 Page 1

Pump: 2P2C

Test: 022

Flow Test

Test Date	Flow	Vibrations (ips) A	B	C	Int	Remarks
11/21/92	44.7	.140	.110	.090	BAT	ROUTINE SURVEILLANC
11/21/92	25.5	.140	.110	.090	BAT	ROUTINE SURVEILLANC
1/21/93	40.7	.130	.109	.093		
3/01/93	41.6	.143	.102	.091		
6/02/93	42.8	.170	.108	.105		
9/01/93	44.7	.202	.112	.096		
12/02/93		.192	.103	.088		
1/27/94		.213	.108	.104		
1/27/94	45.0	.213	.108	.104		
3/05/94	44.8	.204	.105	.108		
6/05/94	42.5	.137	.102	.097		
7/21/94	42.5	.167	.099	.156	KKW	ROUTINE SURVEILLANC
8/18/94	42.2	.159	.100	.099	KKW	INCREASED FREQ. TES
9/07/94	42.0	.122	.091	.097	LEH	ROUTINE SURVEILLANC
10/31/94	42.7	.171	.113	.101	LEH	POST MANT. 2P-2C, W
12/06/94	37.2	.183	.105	.101	LEH	ROUTINE SURVEILLANC
12/29/94	43.9	.201	.115	.142	LEH	2P-2C Capacity test
3/05/95	43.7	.146	.098	.109	LEH	ROUTINE SURVEILLANC
6/13/95	43.7	.167	.151	.106	LRD	ROUTINE,2P2C,950623
6/19/95	43.1	.189	.154	.104	LRD	ROUTINE,9506129,2P2
7/07/95	43.6	.158	.104	.117	LRD	ROUTINE,2P-2C,95072
9/06/95	43.0	.168	.151	.115	LEH	ROUTINE SURVEILLANC
12/04/95	43.8	.144	.142	.119	BAT	ROUTINE SURVEILLANC
3/07/96	44.0	.155	.143	.118	LEH	ROUTINE SURVEILLANC
6/08/96	42.8	.148	.146	.154	LRD	ROUTINE SURVEILLANC
6/11/96	44.9	.134	.168	.112	LRD	POST MAINTENANCE PO
9/08/96	43.1	.162	.153	.126	LEH	ROUTINE SURVEILLANC

CHEMICAL AND VOLUME CONTROL (CVCS)

Safety Function:

The CVCS System serves as an alternate shutdown system by providing for reactor coolant system boration when required. (FSAR 9.2)

Components:

1-P-002 A-C (684J741)
2-P-002 A-C (685J175)
Charging Pumps

The Charging Pumps deliver concentrated boric acid solution at the rate required for RCS boration from the discharge of the RWST's or the Boric Acid Transfer Pumps to the RCS. In addition, the charging pumps are used to mitigate the effects of a small break LOCA. However, per the safety analysis, the safety injection pumps are the primary means for responding to a small break LOCA but no such credit is taken in the safety analysis. (FSAR 9.2 and 6.2.2)

Test Requirement: IWP-3000

1-P-004 A&B (684J741)
2-P-004 A&B (685J175)
Boric Acid Transfer Pumps

The Boric Acid Transfer Pumps deliver concentrated boric acid solution at the rate required for RCS boration from the Boric Acid Tanks to the suction of the Charging Pumps. (FSAR 9.2)

Test Required: IWP-3000

1-CV-00112B (684J741)
2-CV-00112B (685J175)
RWST To Charging Pump Suction Control Valves

These valves open to provide the primary (preferred) source of concentrated borated water for RCS boration.

Test Requirement: BT-O PIT

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*-----------------------------------*
*     Printed For:                  *
*-----------------------------------*
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Date: Monday, 30 September 1996 6:44pm CT
To:
From:
Subject: charging pumps

Charging pump flow rate in resolution of Non-Conformance Report N-89-187

The original problem as stated in NCR N-89-187 is a statement on Page 14.3.1-1 of the FSAR that one charging pump is capable of maintaining pressurizer pressure at 2250 psia with a 3/8 in. break in the RCS. That statement has been replaced and the FSAR now says that the makeup flow rate from two charging pumps is typically adequate to maintain pressurizer level long enough for the operator to respond without activating the ECCS for a break through a 3/8 inch diameter hole. This is a true statement supported by calculation N-90-015 assuming minimum charging pump performance. But the key change in the design basis is more clearly stated in the definition of the Reactor Coolant Pressure Boundary (RCPB). It makes clear that there is no specific flow rate requirement for make-up flow rate from the charging pumps.

The original definition of RCPB in the QA Policy Manual in effect at the time of NCR-89-187 excluded 3/8 inch piping from the RCPB. Connections 3/8 inch diameter and smaller were not considered part of the RCPB and had no QA requirements because " ... failure of these connections results in a leak rate within the capability of the normal reactor makeup water system". Therefore, the normal charging system needed to be capable of mitigating the consequences of a 3/8 inch break by itself without challenging the ECCS.

One of the recommendations in NCR N-89-187 was to make the 3/8 inch piping part of the QA program as safety related seismic class 1 components. Documentation shows that this recommendation has been implemented. DG-G06, GUIDELINES FOR SYSTEM, COMPONENT AND PART CLASSIFICATION, the current version of the QA Policy Manual, no longer excludes 3/8 inch piping from the RCPB. It includes all pipes connected to the RCS up to and including the "second of two valves normally closed during normal reactor operation in system piping that does not penetrate primary reactor containment". General criteria in DG-G06 is now that CVCS is capable of make-up due to minor leakage, not a 3/8 inch break. Green line drawing WEST 541F091 shows that the 3/8 inch piping is now QA scope. CHAMPS lists the components that were non-QA at the time on NCR N-89-187 (RC-500J, RC-500Q and RC-579) as QA scope, safety related, and seismic class 1 components. Since 3/8 inch piping is included in the QA program, a 3/8 inch break no longer needs to be considered for design of the normal makeup system.

Therefore, the requirement that charging pumps are capable of mitigating the consequences of a 3/8 inch break no longer exists and the assumption made in calculation N-90-015 for charging pump performance is no longer a design requirement for the charging pumps.

FILE NO Q3.2

NUCLEAR POWER DEPARTMENT NONCONFORMANCE REPORT

NCR # N-89-187

INITIATION

2.1.1 REFERENCES (Affected system, equipment, procedure, code, drawing, etc.)

FSAR Section - 14.3.1, page 14.3.1-1
FSAR SECTION - TECH. SPEC'S 15.4.3-2

2.1.1 NCR BASIS CATEGORY (See Attachment QP 15-1.5)

2,9 & 10

2.1.2 CONDITION DESCRIPTION:

The FSAR LOCA analysis states that; "A makeup flow rate from one charging pump is typically adequate to sustain pressurizer pressure at 2250 psia for a break through a 3/8 in. diameter hole. This break results in a loss of approximately 17.5 lb/sec." However, a quick calculation of the maximum flow available from 1 charging pump shows that only 8.32 lb/sec. is available. Therefore, slightly more than 2 charging pumps at full capacity would be required to (cont.)

2.1.3 INITIATED BY / DATE: 8/10/89

2.1.5 GROUP HEAD REVIEW / DATE:

EVALUATION

2.2 REPORTABILITY AND OPERABILITY REVIEW RESULTS:

	YES	POTENTIAL	NO
10CFR21 REPORTABLE	☐	☐	☒
10CFR50.72 REPORTABLE	☐	☒	☒
10CFR50.73 REPORTABLE	☐	☒	☒
OTHER (SEE DCS 2.1.1)	☐	☐	☒
TECH SPEC VIOLATION	☐	☐	☒
TECH SPEC LCO	☐	☐	☒
EQUIPMENT OPERABILITY IMPACT Design Basis	☐	☒	☒

2.2.3 REGULATORY REVIEW / DATE:

2.3.5 GEN. SUPT. / OPS REVIEW / DATE:

2.4.1 EVALUATION RESPONSE DUE DATE: 1-OCTOBER-1989

2.3.2 / 2.5.1 EVALUATION AND RECOMMENDED CORRECTIVE ACTION:

NSEAS analysis to evaluate basis and determine extent, if any, of problem. 8/16/89

NSEAS — Address the Equipment Operability Impact. Determine whether or not it is an issue. 8/17/89

SEE ATTACHED PAGES 3 THROUGH 10 FOR CONTINUATION OF EVALUATION AND CORRECTIVE ACTION. NOTE EVALUATION OF REPORTABILITY AND OPERABILITY BOXES CHECKED AS "POTENTIAL" HAVE BEEN CHANGED TO "NO" FOR 10CFR50.72 AND 10CFR50.73 REPORTABILITY AND EQUIPMENT OPERABILITY IMPACT. 10/9/89

NSEAS - Perform C/A #1 (see page 7)
NPERS - Perform C/A #2 (see page 7)
QAS (SQA) - Perform C/A #3 (see page 8) and C/A #4 (see page 8) 10/20/89

2.5.2 C/A ORGANIZATION(S): NSEAS; NPERS; QAS

2.5.5 EVAL GROUP HEAD APPROVAL / DATE: 10/9/89

2.6.5 QA ACCEPTANCE / DATE: 10/89

CORRECTIVE ACTION

2.7 CORRECTIVE ACTION(S) PERFORMED:

ASSIGNED TO NSEAS, NPERS & SQA FOR C/A. (See pgs. 7-8) 10/20/89

2.5.3 CORRECTIVE ACTION DUE DATE: 1-01-90

2.7 C/A COMPLETE/DATE: (GROUP HEAD) SEE ATTACHED

2.8 Q ... /19/90

2.6.4 ROOT CAUSE / TREND CODE: Z80

FILE ______

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makeup for a 3/8 in. diameter hole. Westinghouse was contacted on 8/10/89 and they agreed with this conclusion and stated that the FSAR statement was incorrect.

Charging Pump Capacity Calculation:

maximum capacity = 60 gpm
discharge pressure = 1985 psig
discharge temperature = 120 °F

$\left.\right\} \rho = 62.1 \frac{lbm}{ft^3}$

$$\text{mass flow} = 60\,gpm \times 62.1 \frac{lbm}{ft^3} \times \frac{1\,ft^3/sec.}{448\,gpm}$$

$$\Rightarrow \text{mass flow} = 8.32 \frac{lbm}{sec.}$$

$$\Rightarrow \text{Charging Pumps Required} = \frac{17.5}{8.32} = 2.1$$

JAS
8/10/89

60 × 2.1 = 126 GPM

NOTE - THIS MAY IMPACT THE BASIS FOR QA APPLICATION'S ON IMPULSE LINES CONNECTED TO THE PRIMARY SYSTEM.
WAZ

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Evaluation

The evaluation consists of three parts. The first part checks the calculations contained in the condition description section of the NCR and the numbers reported in the FSAR. The second part explores the history of the subject paragraph in the FSAR. The third part evaluates the consequences of changing the FSAR.

Part 1 - Calculations

Calculations contained in the condition description section of the NCR are correct. The maximum charging pump flow is approximately 8.3 lbm/s per pump. In addition, calculations using Crane (1980)[1], at normal operating pressure and temperature and with limiting assumptions about break geometry, show that break flow through a 3/8 in. diameter break of 17.5 lbm/s is reasonable. The obvious conclusion is that one charging pump cannot maintain pressurizer pressure and level indefinitely.

Maintaining pressurizer level does not necessarily mean that the pressurizer level remains unchanged with a small leak in the RCS. An alternative interpretation of maintaining pressurizer level is that the charging system is capable of maintaining pressurizer level long enough for the operators to identify a loss of inventory and isolate the leak or perform an orderly shutdown, cooldown and depressurization of the RCS. Operators should have sufficient time to identify and respond to a 3/8 in. diameter break without relying on the ECCS.

ECCS is initiated when pressurizer pressure falls below 1735 psig, when steam line pressure falls below 530 psig, or when containment pressure exceeds 5 psig.[2] A 3/8 inch pipe break should have little impact on steam line or containment pressures. The setpoint of concern is the pressurizer pressure. If the charging pumps can maintain pressurizer level, then the pressurizer heaters can maintain pressure and the low pressure setpoint is not reached before an orderly cooldown can be initiated.

Estimates of the time required to empty the pressurizer by removing 600 ft^3 of water are shown, as a function of the number of charging pumps running, in the following table. The table also shows the energy required to maintain normal operating

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pressure by producing steam in the pressurizer. The maximum output of the heaters is 1000 kilowatts.

ESTIMATED TIME TO REMOVE 600 FT3 OF WATER FROM PRESSURIZER

Number of Pumps Running	Volume Flow Rate Out[3] (ft3/s)	Volume Flow Rate In[4] (ft3/s)	Rate of Change of Volume (ft3/s)	Time to Remove 600ft3[5] (minutes)	Energy to Maintain Pressure[6] (kwatts)
Zero	0.4137	0.0	-0.4137	24.	1251.
One	0.4137	0.1967	-0.2170	46.	656.
Two	0.4137	0.3933	-0.0204	490.	61.7
Three	0.4137	0.5899	0.1763	-------	-------

The most probable situation is that two charging pumps are available when the break occurs. Technical Specification section 15.3.2.B.1 requires that two charging pumps be available when the reactor is taken critical. A limiting condition of operation in section 15.3.2.D.1 requires that a second pump be available within 24 hours if only one pump is available at power. The case with zero charging pumps available should never happen and the case with one charging pump running should happen infrequently.

This calculation should remove any concern that a small diameter break is a catastrophic accident which is un-analyzed due to a misstatement in the FSAR. In the most probable condition, the operators should have several hours to identify the break and take corrective action.

However, the subject paragraph in the FSAR is still misleading. It implies that one charging pump is capable of maintaining pressurizer level. Corrective action should still be to remove or revise the subject paragraph.

Part 2 - History

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The subject paragraph was added with Amendment 23 to the FSAR and documented in a letter to the NRC dated October 14, 1977. The October 14, 1977 letter references an October 27, 1976 letter to NRC reporting a revised small break loss of coolant analysis. However, neither of these letters contains the basis for adding the subject paragraph to the FSAR.

Westinghouse usually provides replacement pages for the FSAR as part of a revised LOCA analysis. The subject paragraph appears once in our correspondence with Westinghouse in a letter from J. S. Taylor, W, to G. A. Reed, WE, dated July 2, 1974. The July 2 letter enclosed a draft write-up of the ECCS analysis in a generic format with specific plant dependent results left blank. Four blanks appear in the subject paragraph. They are for normal pressure, sustained pressure, hole diameter, and break flow rate.

In June of 1975, eleven months after receipt of the subject paragraph in generic format, WE submitted a re-evaluation of ECCS cooling performance and Amendment 16 to the FSAR. Amendment 16 does not include the subject paragraph.

It is not until more than three years after our receipt of the subject paragraph in generic format that it is submitted, with blanks filled in, as part of Amendment 23 to the FSAR. Nothing has been found in our records to support the addition of the subject paragraph to section 14.3.1 of the FSAR.

Part 3 - Consequences

If the subject FSAR paragraph is removed or revised, then the QA Policy Manual must be revised. The QA Policy Manual defines the Reactor Coolant Pressure Boundary (RCPB) as the pressure-containing components such as pressure vessels, piping, pumps and valves and connections to the Reactor Coolant System (RCS) greater than 3/8 inches inside diameter. Connections 3/8 inches or smaller are not considered part of the RCPB.

The basis for not including 3/8 inch or smaller connections in the RCPB is stated in Item 1, Section One of Appendix B to the Quality Assurance Policy Manual as follows:

> "...not QA-scope because failure of these connections results in a leak rate within the capability of the normal reactor makeup water systems."

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No reference is cited in Appendix B to support the statement, but Mr. Heiden, of QAS, suspects that the basis for the statement is the subject paragraph from the FSAR. If no other justification can be found, then the QA Policy Manual must be revised.

There are two ways that the QA Policy Manual could be revised. The first way is to remove the exclusion of 3/8 inch or smaller connections from the RCPB. One obvious result is that the green-line drawings of the RCS in the QA Policy Manual would need to be revised and appropriate parts upgraded to QA-scope. Information from the FSAR and from Westinghouse Systems Engineering personnel indicates that adding small diameter piping to the QA-scope equipment list may not be an impossible task.

Section 4 of the FSAR describes the RCS pressure boundary and the codes and standards used in the design and maintenance of the boundary. There is nothing that differentiates 3/8 in. piping from the remainder of the pressure boundary.

Mr. Jim Schlonsky (412-374-4258, spelling uncertain) of Westinghouse is familiar with the subject statement in the FSAR. However, he was quick to point out that the statement should only be applied to plants with higher capacity centrifugal charging pumps. The statement is inappropriate for a plant with positive displacement charging pumps because the pump is obviously incapable of maintaining RCS inventory. He stated that Westinghouse would never have put a statement like that into our FSAR because it is not necessary.

The Point Beach plant was apparently built prior to the requirement to classify RCS pressure boundary piping as is done today. Newer plants are required to show that a small diameter pipe break will not challenge the engineered safety features because the small diameter piping was not, or could not, be built to the same standards as the large diameter piping.

The second way to revise the QA Policy Manual is to clarify the statement that a break in a 3/8 inch diameter pipe results in a leak rate within the capability of the normal reactor makeup water system. Clarification should state that the basis for excluding small diameter piping from the RCPB is the time available for operator response to a break.

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Suggested text for the clarification of Item 1 in the list of Systems and Equipment Covered by the Quality Assurance Program is as follows:

1. The Reactor Coolant Pressure Boundary (RCPB) as defined above. (Connections to the reactor coolant system (RCS) greater than 3/8 inch inside diameter are considered part of the RCPB, including branch outlet nozzles or nipples, instrument wells, reservoirs, studs and fasteners in flange joints between pressure parts, traps, strainers, and orifices. Connections 3/8 inch inside diameter or smaller are not considered part of the RCPB and are therefore not QA-scope. Failure of a connection 3/8 inch diameter or smaller results in a loss of RCS inventory to which the operator can respond without activating the ECCS. In the most likely condition, with at least two charging pumps available, the operator has several hours to identify and respond to the break.)

The QA Policy Manual should reference a formal calculation of the time available for operator response under a variety of conditions as was estimated in part 1 of the evaluation.

Corrective Action

The recommended corrective action includes four activities as tabulated below:

	Date Due	Group	Activity
C/A #1	12/1/89	NSEAS	Perform a formal calculation of the time available for operator response to a break in a 3/8 inch inside diameter or smaller hole in the RCS.
C/A #2	7/3./90	NPERS	Revise FSAR section 14.3.1 paragraph 2 as follows: The maximum break size for which the normal makeup system can maintain the pressurizer level is obtained by comparing the calculated flow from the reactor coolant system through

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the postulated break against the charging pump makeup flow at normal reactor coolant system pressure, i.e.,2250 psia. A makeup flow rate from two ~~one~~ charging pumps is typically adequate ~~to sustain pressurizer pressure at 2250 psia~~ to maintain pressurizer level long enough (i.e several hours) for the operator to respond without activating the ECCS for a break through a 3/8 inch inside ~~in.~~ diameter hole. ~~This break results in a loss of approximately 17.5 lb/sec.~~

CA #3 12/1/89 QAS — As an interim corrective action, the basis for excluding small diameter piping from the RCPB in the QA Policy Manual should be changed as follows:

Connections 3/8 inch inside diameter or smaller are not considered part of the RCPB and are therefore not QA-scope. ~~because f~~ Failure of these connections results in a leak rate ~~within the capability of the normal reactor makeup water systems~~ to which the operator can respond without activating the ECCS. In the most likely condition, with at least two charging pumps available, the operator has several hours to identify and respond to the break.[1]

Where reference [1] is the calculation created as the first corrective action.

CA #4 12/1/89 QAS — Investigate the effort required to remove the exclusion of small diameter connections to the RCS from the definition of RCPB in the QA Policy Manual, add the small diameter connections to the QA-Scope green-line drawings, and upgrade appropriate equipment to QA scope. Determine final corrective action for QA Policy Manual based on results of investigation.

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ENDNOTES

1. Crane, Flow of Fluids, Technical Paper No. 410, 1980

2. Point Beach Nuclear Plant, Setpoint Document, STPT 2.1, MAJOR, Revision 1 06-14-89

3. Vout = Mout * v

   where Vout = Volume flow rate out of RCS

   v = 0.02364(ft3/lbm) - specific volume of saturated water at 600 degf.

   Mout = 17.5(lbm/s) - break mass flow rate from FSAR

4. Vin = N * G * C1 * C2 * v / v'

   where Vin = Volume flow rate into the RCS

   N = number of operating charging pumps

   G = 60.5(gpm) - the volume flow rate per pump

   C1 = 0.13368(ft3/gal) - conversion factor

   C2 = 1(min)/60(sec) - conversion factor

   v = .02365(ft3/lbm) - specific volume of saturated water at 600 degf

   v' = 0.016204(ft3/lbm) - specific volume of saturated water at 120 degf.

5. T = V * C2 / [Vout - Vin]

   where T = Time to Remove 600ft3

   V = 600(ft3) - liquid volume of pressurizer from FSAR

6. E = [Vin - Vout] * hfg * C3 / vfg

   where E = energy required to maintain pressure (kwatts)

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hfg = 466.2 (btu/lbm) - heat of vaporization at 2000 psia

C3 = 1.0548 (watts/btu/s) - conversion factor

vfg = 0.16266 (ft3/lbm) - change in specific volume for vaporization

- 10/4/89

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CALCULATION REVIEW AND APPROVAL
NUCLEAR POWER DEPARTMENT

Calculation #	N-90-015
Number of pages	15

Title of Calculation:
RESPONSE TIME FOR 3/8 INCH BREAK IN REACTOR COOLANT SYSTEM

☒ Original calculation

☐ Revised calculation. Revision #____

☐ Superseding calculation. Supersedes calculation #________

Modification #	Description:

Other References: NCR # N-89-187

Prepared By:	Date: APRIL 23, 90

This calculation has been reviewed in accordance with QP 3-6. The review was accomplished by one or a combination of the following (as checked):

____ A review of a representative sample of repetitive calculcations

____ A detailed review of the original calculation

____ A review of the calculation against a similar calculation previously performed

____ A review by an alternate, simplified or approximate method of calculation

Comments:

Reviewed By:	Date:	Approved By:	Date:
. 4	4/25/90		4/27/90

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PURPOSE: — DETERMINE THE AMOUNT OF TIME AVAILABLE FOR OPERATOR RESPONSE TO A BREAK OF 3/8 INCHES INSIDE DIAMETER OR SMALLER IN THE REACTOR COOLANT SYSTEM.

ASSUMPTIONS:

1. PRESSURIZER HEATERS POWERED FROM SAFEGUARDS BUSES ARE AVAILABLE. ✓

2. RCS AVERAGE TEMPERATURE REMAINS CONSTANT DURING THE 3/8" BREAK. ✓

3. OPERATION AT 2250 PSIA HAS A NEGLIGIBLE IMPACT ON BREAK FLOW RATE (i.e. APPROXIMATELY 6%) ✓

4. THE BREAK DISCHARGES TO AN ENVIRONMENT AT A CONSTANT PRESSURE OF 15 PSIA. ✓

5. FLOW THROUGH THE BREAK IS SINGLE PHASE. ✓

REFERENCES:

1. CRANE, FLOW OF FLUIDS, TECHNICAL PAPER NO. 410, 1980
2. POINT BEACH NUCLEAR PLANT, SETPOINT DOCUMENT, STPT 2.1, MAJOR, REVISION 1 06-14-89
3. POINT BEACH NUCLEAR PLANT, TECHNICAL SPECIFICATION, REV 56, FEB 23, 1990
4. POINT BEACH NUCLEAR PLANT, CHAMPS EQUIPMENT LIST, ON-LINE, FEBRUARY 12, 1990
5. POINT BEACH NUCLEAR PLANT, FINAL SAFETY ANALYSIS REPORT, NOVEMBER, 1989
6. 1967 ASME STEAM TABLES
7. WESTINGHOUSE, CONTROLLED LEAKAGE SEAL REACTOR COOLANT PUMP MODEL V11001-A1, TFI 03060000, REVISED BY PBCI-88-263 DATED NOV 12, 1988.
8. BECHTEL DRAWING # 6118, E-98, SHT 21, REV 2
9. PRESSURIZER TECHNICAL MANUAL, TABLE 1-2,
10. MASTER DATA BOOK, AUGUST 1, 1989

INPUTS:

1.	CHARGING PUMP CAPACITY	60.5 GPM	REF 4 ✓
2.	PRZR LEVEL AT FULL LOAD TAVG	45.8%	REF 2 ✓
3.	OPERATING PRESSURE	2000.0 PSIA	REF 3 CH 15.3
4.	AVERAGE RCS TEMP.	578.0 °F	REF 3 CH 15.3.
5.	COOLANT RETURN TEMP.	127.0 °F	REF 5 CH 9 ✓
6.	COOLANT RETURN PRESS.	15.0 PSI	REF 5 CH 9 ✓
7.	RCP SEAL LEAKAGE	3.0 GPM/PUMP	REF 7, Pg 3-1
8	PRESSURIZER VOLUME	1000 ft^3	REF 5, CH 4 ✓
9.	PRESSURIZER HEATER OUTPUT	12.82 KW/HTR	REF 9 ✓
10.	MINIMUM HEATERS/BANK	15	REF 8 ✓
11.	HEATER BANKS ON SAFEGAURDS	3	REF 10 ✓
12.	HEATER CUTOUT ON LOW-LOW LEVEL	12%	REF 2 ✓
13.	PRZR LEVEL AT NO LOAD TAVG	20%	REF 2 ✓
14	LOW PRZR PRESSURE TRIP	1790 PSIG	REF 2 ✓

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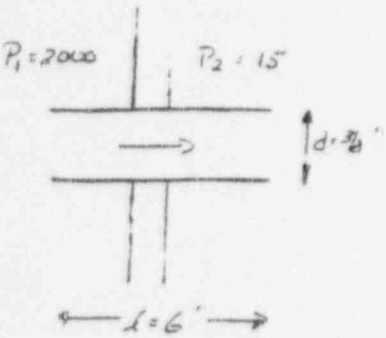
CALCULATION: CONTINUED

PART 1 - FLOW RATE THROUGH 3/8" HOLE

A. DARCY'S FORMULA, INCOMPRESSIBLE FLOW, 6" PIPE

$$w = 0.525\, d^2 \left(\frac{\Delta P \rho}{K}\right)^{1/2}$$ ✓ REF 1 EQ 3-19

WHERE



$K = K_{ENTRANCE} + K_{EXIT} + f\frac{l}{d}$ ✓

$K_{ENTRANCE} = 0.78$ REF 1 Pg A-29
- FOR AN INWARD PROJECTING SHARP EDGED PIPE ENTRANCE

$K_{EXIT} = 1.0$ REF 1 Pg A-29
- FOR A PROJECTING PIPE EXIT

$f \doteq 0.027$ (FOR 1/2" DIA) REF 1 Pg F-26
- ASSUME TURBULENT FLOW

$l = 6''$

$d = 3/8''$

$K = 0.78 + 1.0 + 0.027(6/3/8) = 2.21$

$\Delta P = (2000 - 15)$ PSIA

$\rho = (1/0.0227)\ lbm/ft^3$ REF 6

$\Delta P \rho = 87400$

$$w = 0.525\,(3/8)^2 \left(\frac{87400}{2.21}\right)^{1/2} = 14.7\ lbm/s$$ ✓

$R_e = 6.31 \frac{W}{d\mu} = (6.31)(3600)\frac{w}{d\mu}$

$\mu = 0.091$ cp REF 1 Pg A-2

$R_e = (6.31)(3600)\frac{14.68}{(3/8)(0.091)}$

NCR # N-87-187 $R_e = 9.8 \times 10^6$ ✓
- TURBULENT FLOW ASSUMPTION IS VALID

CALCULATION – CONTINUED

PART I – FLOW RATE THROUGH 3/8" HOLE

B. DARCY'S FORMULA, COMPRESSIBLE FLOW, 6" DIA

$\omega = 0.525\, Y d^2 (\Delta P / K \bar{V}_1)^{1/2}$ ✓ REF 1, EQ. 3-2C

WHERE:

$K = 2.21$

$\Delta P = (2000 - 15)$ PSIA

$\bar{V}_1 = 0.02271$

$d = 3/8"$

$Y = 0.640 \quad (k = 1.3, K = 2.21)$ REF 1, PG A-22

– FLOW REACHES THE SONIC VELOCITY

$\Delta P / P_1' = 0.603$ REF 1, PG A-22

– CALCULATE NEW ΔP

$\Delta P = 0.603 (1985) = 1197$

$\omega = (0.525)(.640)(3/8)^2 \left[\frac{1197}{(2.21)(0.02271)} \right]^{1/2}$ ✓

$\omega = 7.30$ lbm/s ✓

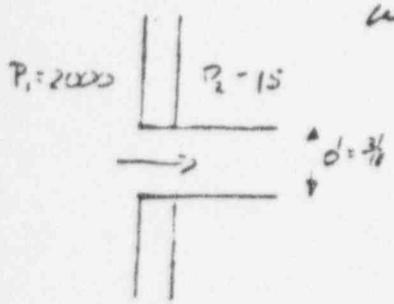
CALCULATION CONTINUED

PART I - FLOW RATE THROUGH 3/16" HOLE

C. DARCY'S FORMULA, INCOMPRESSIBLE FLOW, 6" SMOOTH PIPE

$$w = 0.525\, d^2 \left(\frac{\Delta P \rho}{K}\right)^{1/2}$$ ✓

WHERE



$K = K_{ENTRANCE} + K_{EXIT}$ ✓

$K_{ENTRANCE} = 0.50$ — REF 1, p A-29
- FOR A SHARP-EDGED ENTRANCE

$K_{EXIT} = 1.0$

$K = 1.5$

$w = 0.525(3/16)^2(87400/1.50)^{1/2} = 17.8$ lbm/s ✓

D. DARCY'S FORMULA, COMPRESSIBLE FLOW, 6" SMOOTH PIPE

$$w = 0.525\, Y d^2 \left(\Delta P / K \bar{V}_1\right)^{1/2}$$ ✓

WHERE

$K = 1.50$

$Y(k = 1.3, K = 1.5) = 0.631$ — REF 1, p A 22

$\Delta P/P' = 0.550$

$\Delta P = 0.550(1985) = 1092$

$w = (0.525)(0.631)(3/16)^2\left[1092/(1.50)(0.02271)\right]^{1/2}$ ✓

$w = 8.34$ lbm/s ✓

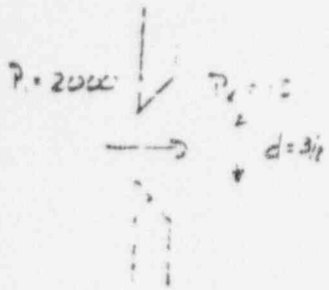
CALCULATION: CONTINUED

PART I - FLOW RATE THROUGH 3/8" HOLE

E. DARCY'S FORMULA, INCOMPRESSIBLE FLOW, ORIFICE

$$\omega = 0.525\, d^2\, C\, (\Delta P \rho)^{1/2}$$ ✓ REF 1, EQN 3-…

WHERE



$\Delta P = (2000 - 15)$ PSIA

$\rho = (1/0.02271)$ lbm/ft³ REF 6

$d = 3/8$"

$C = 0.7$ for $\beta \approx 0$ REF 1, A-21
- SELECT FLOW COEFFICIENT TO MAXIMIZE FLOW

$$\omega = 0.525(3/8)^2(0.7)\left((2000-15)/0.02271\right)^{1/2} = 15.3 \text{ lbm/s}$$ ✓

F. DARCY'S FORMULA, COMPRESSIBLE FLOW, ORIFICE

$$\omega = 0.525\, Y\, d_1^2\, C\, (\Delta P / \bar{V}_1)^{1/2}$$ ✓ REF 1, EQN 3-22

WHERE

$\bar{V}_1 = 0.02271$ ft³/lbm

$Y(k=1.3, \beta=0, \Delta P/P = 0.6) = 0.81$ REF 1, Pg A-21

$r_c = P_2/P_1 (k=1.3, \beta=0) = 0.545$

$\Delta P = P_1 - r_c P_1 = 2000(1-.545) = 910$

$$\omega = (0.525)(0.81)(3/8)^2(0.7)(910/0.02271)^{1/2} = 8.38 \text{ lbm/s}$$ ✓

CALCULATION: CONTINUED

PART 2 - RESPONSE TIME

A. VOLUME FLOW RATE OUT OF BREAK

$V_{OUT} = v_{RCS} * W_{OUT}$ ✓

WHERE

v_{RCS} (P=PSAT, T=578°F) = 0.02271 ft^3/lbm REF 6.

W_{OUT} = 17.8 lbm/s PART 1

V_{OUT} = 0.404 ft^3/s ✓

B. VOLUME FLOW RATE IN FROM CHARGING PUMPS

$V_{IN} = [(N * G) - 2 * C_1] * (v_{RCS} / v_{CRT}) * C_2 * C_3$ ✓

WHERE N = NUMBER OF PUMPS OPERATING

G = 60.5 GPM I1

C_1 = 3.0 GPM I7

v_{CRT} (P=PSAT, T=127°) = 0.016234 ft^3/lbm REF 6

C_2 = 0.13368 ft^3/GAL. REF 6

C_3 = 1 MIN / 60 SEC

V_{IN} (N=1) = 0.170 ft^3/s ✓

V_{IN} (N=2) = 0.358 ft^3/s ✓

V_{IN} (N=3) = 0.547 ft^3/s ✓

CALCULATION: CONTINUED

PART 2 - RESPONSE TIME

C. RATE OF CHANGE OF VOLUME

$\dot{V}$ = VOUT - VIN

$\dot{V}$(N=0) = 0.404 - 0.0 = 0.404 ✓

$\dot{V}$(N=1) = 0.404 - 0.170 = 0.234 ✓

$\dot{V}$(N=2) = 0.404 - 0.358 = 0.046 ✓

$\dot{V}$(N=3) = 0.404 - 0.547 = -0.143 ✓

D. ENERGY TO MAINTAIN PRESSURE

$E = \dot{V} * h_{fg} * C_4 / v_{fg}$ ✓

WHERE

h_{fg} (P=2000PSIA) = 466.2 Btu/lbm — REF 6

C_4 = 1.0548 KWATTS/Btu/s — REF 6

v_{fg} (P=2000PSIA) = 0.16266 ft³/lbm — REF 6

E(N=0) = (0.404)(466.2)(1.0548)/(0.16266)

= 1221 KWATTS ✓

E(N=1) = 707 KWATTS ✓

E(N=2) = 139 KWATTS ✓

E(N=3) = -432 KWATTS ✓

AT LEAST 100KW OF PRESSURIZER HEATERS IS AVAILABLE PER TECHNICAL SPECIFICATION ✓ — REF 3 Pg 15.3.1-3

CALCULATION: - CONTINUED

PART 2 - RESPONSE TIME

D. - CONTINUED

ONE BANK OF HEATERS CONTAINS AT LEAST 15 HEATERS. THE MINIMUM OUTPUT FROM ONE BANK IS:

$E_{MIN} = 15\ HTR \times 12.82\ KW/HTR = 192\ KW$ ✓ REF 8.9.K

ESTIMATE THE RATE OF PRESSURE DECREASE WITH ONE BANK OF HEATERS AVAILABLE ASSUMING STEAM BEHAVES AS A PERFECT GAS.

$P = nRT/V$ ✓

- ASSUME GAS MASS AND TEMPERATURE CONSTANT FOR TIME Δt

$\frac{\Delta P}{\Delta t} \propto \frac{\Delta(1/V)}{\Delta t}$ ✓

- CHANGE IN PRESSURE INVERSELY PROPORTIONAL TO CHANGE IN GAS VOLUME

$\frac{\Delta V(N)}{V} = \frac{(E(N) - E_{MIN})\ ^{v_g}/C_f \cdot h_{fg}}{(1000 - 458)}$ ✓

$\frac{\Delta V(N=0)}{V} = \frac{(1221 - 192)(0.16266)/(1.0548)(466.2)}{(1000 - 458)}$

$= 6.3 \times 10^{-4} = 0.06\%/SEC.$

$\Delta V(N=1)/V = 3.1 \times 10^{-4} = 0.03\%/SEC.$ SWD 4/25/90

$\Delta V(N=2)/V = -3.2 \times 10^{-5} = —$

$\Delta P/\Delta t = (\Delta V/V)(2000\ PSIA)$

$\Delta P(N=0)/\Delta t = (6.3 \times 10^{-4})(2000) = 1.3\ PSI/S = 78\ PSI/MIN$ ✓

$\Delta P(N=1)/\Delta t = (3.1 \times 10^{-4})(2000) = 0.62\ PSI/S = 37\ PSI/MIN$ ✓

TIME TO REACH LOW PZR PRESSURE SETPOINT

$T(N=0) = (2000 - 1805)/78 = 2.5\ MIN.$ ✓

$T(N=1) = (2000 - 1805)/37 = 5.2\ MIN.$ ✓

CALCULATION: CONTINUED

PART 2 - RESPONSE TIME

E. MINIMUM PRESSURIZER LIQUID VOLUME AVAILABLE WHILE HEATERS ARE OPERATING

	NO-LOAD	FULL LOAD	
PROGRAMED PZR LEVEL	20%	45.8%	✓
HEATER CUTOUT LEVEL	12%	12.0%	✓
CHANGE IN LEVEL	8%	33.8%	✓
LIQUID VOLUME AVAILABLE	$80 ft^3$	$338 ft^3$	✓

F. TIME TO REMOVE $80 ft^3$

$T = 80 ft^3 / \dot{V}$

T(N=0) = 80/.404 = 198 s = 3.3 MIN ✓
T(N=1) = 80/.234 = 342 s = 5.7 MIN ✓
T(N=2) = 80/.046 = 1739 s = 29.0 MIN ✓
T(N=3) = 80/-.143 = —

G. TIME TO REMOVE $338 ft^3$

T(N=0) = 338/.404 = 837 s = 13.9 MIN ✓
T(N=1) = 338/.234 = 1440 s = 24.1 MIN ✓
T(N=2) = 338/.046 = 7350 s = 122 MIN ✓
T(N=3) = 338/-.142 = —

RESULTS

PAR-1 - FLOW RATE THROUGH 3/8" HOLE

SUMMARY OF CALCULATIONS

CASE	GEOMETRY	COMPRESSIBLE	FLOW RATE lbm/s
A	6" PIPE	NO	14.7
B	6" PIPE	YES	7.30
C	SMOOTH PIPE	NO	17.8
D	SMOOTH PIPE	YES	8.34
E	ORIFICE	NO	15.3
F	ORIFICE	YES	8.38

RESULTS: CONTINUED

PART 2 - RESPONSE TIME

SUMMARY OF CALCULATIONS

# of Pumps	V_{OUT} (ft^3/s)	V_{IN} (ft^3/s)	$\dot{V}$ (ft^3/s)	Time to Low Pzr Press. (min)	Time to Heater Cutoff Minimum (min)	Maximum (min)
0	0.404	0.0	0.404	2.5	3.3	13.9 ✓
1	0.404	0.170	0.234	5.2	5.7	24.1 ✓
2	0.404	0.358	0.046	—	29.0	122.0 ✓
3	0.404	0.547	-0.143	—	—	—

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CONCLUSIONS

1. FLOW THROUGH A 3/4 INCH ID BREAK IS A MAXIMUM OF 17.8 lbm/s CONSIDERING THREE BREAK GEOMETRIES AND TWO SOLUTION METHODS. ✓

2. THE TIME AVAILABLE FOR OPERATOR RESPONSE TO PRECLUDE SAFETY INJECTION DUE TO LOW PRESSURIZER PRESSURE WITH ONE CHARGING PUMP AVAILABLE IS APPROXIMATLY FIVE MINUTES AT NO-LOAD CONDITIONS AND 24 MINUTES AT FULL POWER CONDITIONS. ONE BANK OF HEATERS' INABILITY TO MAINTAIN PRESSURE AND THE LOSS OF INVENTORY BOTH CAUSE PROBLEMS 5 MINUTES AFTER A BREAK AT NO-LOAD CONDITIONS. AT FULL POWER, ADDITIONAL PRESSURIZER LIQUID INVENTORY PROVIDES MORE TIME FOR OPERATOR RESPONSE ✓

3. WITH TWO CHARGING PUMPS AVAILABLE, THE OPERATOR HAS APPROXIMATLY 30 MINUTES TO RESPOND AND PRECLUDE SAFETY INJECTION AT NO-LOAD CONDITIONS. ONE BANK OF HEATERS IS CAPABLE OF MAINTAINING PRESSURE AND LIQUID INVENTORY IS ADEQUATE FOR APPROXIMATLY 30 MINUTES. AT FULL POWER, PRESSURIZER LIQUID INVENTORY ALLOWS UP TO 2 HOURS FOR OPERATOR RESPONSE. ✓

Quality Engineer
PBNP

NUCLEAR POWER DEPARTMENT
NCR CONTINUATION SHEET

ATTACHMENT TO NCR # N-89-187

THIS PAGE IS A CONTINUATION OF THE INDICATED SECTION:
☐ 2.1.2 – Condition Description ☐ 2.3.2/2.5.1 – Evaluation
☐ 2.2 – Reportability/Operability ☒ 2.7 – Corrective Action

INITIAL AND DATE ALL ENTRIES

- FSAR Section 14.3.1 paragraph 2 is changed to address the nonconformance in accordance with Corrective Action #2. DDS

- A copy of the changed FSAR page 14.3.1-1 is attached. The FSAR update will be issued about July 21, 1990. DDS 7/6/90

Approved by ____________ 7/6/90

Form QP 15-1.2
Rev. 0

14.3 PRIMARY SYSTEM PIPE RUPTURES

14.3.1 Loss Of Reactor Coolant From Small Ruptured Pipes Or From Cracks In Large Pipes Which Actuates Emergency Core Cooling System

Identification of Causes and Accident Description

A loss of coolant accident is defined as a rupture of the reactor coolant system piping or of any line connected to the system up to the first closed valve. Ruptures of small cross section will cause loss of the coolant at a rate which can be accommodated by the charging pumps which would maintain an operational water level in the pressurizer permitting the operator to execute an orderly shutdown. A moderate quantity of coolant containing such radioactive impurities as would normally be present in the coolant, would be released to the containment.

The maximum break size for which the normal makeup system can maintain the pressurizer level is obtained by comparing the calculated flow from the reactor coolant system through the postulated break against the charging pump makeup flow at normal reactor coolant system pressure, i.e., 2250 psia. A makeup flow rate from two charging pumps is typically adequate to maintain pressurizer level long enough for the operator to respond without activating the ECCS for a break through a 3/8 inch diameter hole.

Should a larger break occur, depressurization of the reactor coolant system causes fluid to flow to the reactor coolant system from the pressurizer resulting in a pressure and level decrease in the pressurizer. Reactor trip occurs when the pressurizer low pressure trip setpoint is reached. The consequences of the accident are limited in two ways:

1. Reactor trip and borated water injection complement void formation in causing rapid reduction of nuclear powe[illegible] residual level corresponding to the delayed fission and [illegible]oduct decay.

2. Injection of borated water ensures suff[illegible] flooding of the core to prevent excessive cladding temperatures.

NCR # N

[illegible]GE 28 OF 35

NUCLEAR POWER DEPARTMENT
NONCONFORMANCE REPORT

2.4 NCR # N - 89 - 187

THIS PAGE IS A CONTINUATION OF THE INDICATED SECTION:

- [ ] 2.1.2 - Condition Description
- [ ] 2.2 - Reportability/Operability
- [ ] 2.5.1 - Evaluation
- [x] 2.7 - Corrective Action

(Initial and Date all Entries)

Recommended corrective actions #3 and #4 on page 8 of NCR N-89-187 were assigned to SQA. Upon investigation, it was determined that the proposed revision to the QA Policy Manual given in recommended corrective action #3 was inappropriate. The issue was discussed with the MSS (MSSM 90-06) and with the NCR evaluator (see attached memo) and a modified revision to the QA Policy Manual was agreed upon. This revision is contained in QA Policy Manual Appendix B Rev. 3, dated 5/25/90. The issuance of this revision on 7/2/90 completes recommended corrective action #3. As discussed in the attached memo, an investigation of small diameter connections to the RCS indicates that all existing connections meet the requirements of QA Policy Manual Appendix B Rev. 3. This completes recommended corrective action #4.

7/2/90

7/2/90

For REH

2.6.5 / 2.8 QA REVIEW

Form QP 15-1.2
Rev. 1

WE Internal Correspondence

TO:

FROM:

DATE: APRIL 28, 1990

SUBJECT: NCR N-89-187

NCR N-89-187 addresses a discrepancy in the FSAR LOCA analysis regarding the ability of the CVCS charging system to maintain RCS inventory following a break through a 3/8" diameter hole. In your evaluation of this NCR (attachment A) you recommended that QAS perform the following actions:

1) Revise the QA Policy Manual in the interim to give a more accurate basis for excluding small diameter piping from being QA-scope.

2) Investigate the effort required to remove the small diameter piping exclusion from the Policy Manual.

In the course of completing these corrective actions, I have come to the following conclusions:

1) I do not agree with the proposed Policy Manual wording that "connections 3/8" ID or smaller are not considered part of the RCPB..." This is not consistent with the 10CFR50.2 definition of reactor coolant pressure boundary. However, I believe 10CFR50.55a(c)(2) (attachment B) provides a legitimate regulatory basis for excluding certain RCPB components from code requirements, and, therefore, from being QA-scope.

2) The only instances I identified in which the 3/8" exclusion was used were associated with impulse tubing to the LT-447 and LT-447A reactor vessel water level transmitters. Specifically, tubing and valves beyond the following root isolation valves was installed non-QA: RC-500J, RC-500Q, and RC-579. Note that all of these valves are normally closed during reactor operation. (Various instrument impulse lines shown as non-QA on the green line diagrams were determined to have been installed and maintained QA-scope. Corrections will be made to the affected green line diagrams.)

I presented the above conclusions to the MSS in March, and based on the response I received (attachment C), I propose to revise the wording in the QA Policy Manual as shown on attachment D. Please advise me whether you feel this is acceptable. If so, I will consider QAS' portion of the corrective action for NCR N-89-187 to be completed upon issuance of the revised QA Policy Manual Appendix B.

Wisconsin Electric
POWER COMPANY

231 W. Michigan, P.O. Box 2046, Milwaukee, WI 53201

(414) 221-2345

APPENDIX B	
SYSTEMS AND EQUIPMENT COVERED BY THE QUALITY ASSURANCE PROGRAM	Rev: 3 Date: 7/2/90 Pages: 6
Prepared by... 5/7/90	Approved by:... 5/15/90

This appendix provides the general criteria for the determination of QA-scope hardware at Point Beach Nuclear Plant (PBNP). The PBNP Q-List, contained in the CHAMPS equipment data base, identifies all systems, structures, and components which fall under the scope of these criteria. Items identified by the Q-List as being QA-scope are assigned QA Codes in CHAMPS. These QA Code numbers correspond to the applicable QA criterion numbers in this appendix. Used in conjunction with the Part III color-coded diagrams and other Part II appendices, this appendix provides the background used in determining the QA scoping of equipment listed in CHAMPS, as well as a reference for determining QA applicability for new equipment.

Refer to the CHAMPS equipment data base, or the hard-copy CHAMPS "Q-List" printouts, to determine if particular systems, structures or components are considered QA-scope.

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SYSTEMS AND EQUIPMENT COVERED BY THE QUALITY ASSURANCE PROGRAM

APPENDIX B

DEFINITIONS

Safety-Related - Safety-related structures, systems, and components are those that are relied upon to remain functional during the following design basis events to ensure:

1. The integrity of the reactor coolant boundary,
2. The capability to shut down the reactor and maintain it in a safe shutdown condition, and,
3. The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guidelines of 10 CFR Part 100.

Augmented Quality - Non-safety related items for which Wisconsin Electric (WE) has made a regulatory or design basis commitment; or, for plant availability reasons, Wisconsin Electric has implemented special controls to assure reliability.

QA-Scope - All safety related (SR) or augmented quality (AQ) items are said to be within "QA Scope" and are controlled under the QA program described in section I of this manual (or as modified in other Appendices of this manual).

Reactor Coolant Pressure Boundary (RCPB) - Reactor Coolant Pressure Boundary (per 10CFR50.2) means all those pressure-containing components such as pressure vessels, piping, pumps, and valves, which are:

1. Part of the reactor coolant system, or
2. Connected to the reactor coolant system, up to and including the following:
   a. The outermost containment isolation valve in system piping which penetrates primary reactor containment;
   b. The second of two valves normally closed during normal reactor operation in system piping which does not penetrate primary reactor containment;
   c. The reactor coolant system safety and relief valves.

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QA-SCOPE ITEM DETERMINATION CRITERIA

The following criteria define those items required to be considered " QA-scope". Criteria that define "safety-related" are identified with a "Y" in the left hand column under "SR?". Augmented Quality criteria have an "N" in this column. QA-scope criteria that could apply to either safety-related or augmented quality have an asterisk in the column. (The criteria are not listed in any particular order).

SR?		
Y	1.	The reactor coolant pressure boundary (RCPB) as defined above. (NOTE: 10CFR50.55a(c)(2) exempts certain components connected to the reactor coolant system from code requirements if, following a postulated failure of the component during normal reactor operation, the reactor can be shut down and cooled down in an orderly manner. Consequently, piping and components of 3/8 inch outer diameter and smaller, beyond a first-off isolation valve normally closed during reactor operation, may be exempted from being QA-scope).
Y	2.	The reactor core and reactor vessel internals (including fuel and fuel assemblies).
Y	3.	Those items required to function in order to provide overpressure protection for the reactor coolant system during reactor operation, as required by various safety analyses (i.e., pressurizer safety valves).
Y	4.	Systems or portions of systems necessary to provide emergency core cooling when required to mitigate the consequences of an accident.
Y	5.	Portions of the main steam system required to remain intact and functional following a steam generator tube rupture or main steam line break in order to (1) isolate a ruptured steam generator, (2) provide redundant protection against blowdown of more than a single steam generator, or (3) allow continued core residual heat removal using the unaffected steam generator.
*	6.	Systems or portions of systems which provide cooling water for other QA-scope equipment and components that are required for (1) emergency core cooling, (2) core residual heat removal, (3) post-accident containment heat removal, or (4) spent fuel pool cooling.
Y	7.	The emergency diesel generators and systems or portions of systems necessary to support the operation of the emergency diesel generators (fuel oil systems, air starting systems, service water, diesel room ventilation, etc.)

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