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February 21, 2008
LIC-08-0015

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

References:
1. Docket No. 50-285
2. Letter from OPPD (D. J. Bannister) to NRC (Document Control Desk), "Fort Calhoun Station Unit No. 1 License Amendment Request (LAR), Modifications of the Containment Spray System Actuation Logic," dated July 30, 2007 (LIC-07-0052) (ML072150293)
3. Letter from NRC (Document Control Desk) to OPPD (D. J. Bannister), "Fort Calhoun Station, Unit 1 – Request for Additional Information Regarding License Amendment Request for Proposed Technical Specification Changes for Modification of Containment Spray System Actuation Logic (TAC No. MD6204)," dated January 18, 2008 (NRC-08-0011)

SUBJECT: Response to Request for Additional Information Regarding License Amendment Request for Proposed Technical Specification Changes for Modification of Containment Spray System Actuation Logic

In Reference 2, the Omaha Public Power District (OPPD) requested changes to the Fort Calhoun Station (FCS), Unit No. 1, Operating License No. DPR-40 to modify the containment spray (CS) system actuation logic to preclude automatic start of the containment spray pumps for a loss-of-coolant accident (LOCA). The Nuclear Regulatory Commission (NRC) staff reviewed the information provided in Reference 2 and determined that additional information is needed to complete their review. Reference 3 provides the NRC's request for additional information (RAI) which was received on January 22, 2008.

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During the preparation of the responses to this RAI, it was realized that the numbering scheme used in the RAI lists questions 1-9, then 12-14. There are no questions numbered 10 and 11, therefore OPPD's responses are numbered in accordance with the RAI in Reference 3.

Attachment 1 provides OPPD's responses to the NRC's requests for additional information. There is no proprietary information included in OPPD's responses provided in Attachments 1 and 2.

This letter contains no regulatory commitments.

If you should have any questions regarding this submittal or require additional information, please contact Mr. Thomas C. Matthews at (402) 533-6938.

I declare under penalty of perjury that the foregoing is true and correct. Executed on February 21, 2008.

David J. Bannister
Vice President

DJB/dll

Attachments: 1. Response to Request for Additional Information
2. Logic Diagrams

c: E. E. Collins, NRC Regional Administrator, Region IV
M. T. Markley, NRC Senior Project Manager
J. D. Hanna, NRC Senior Resident Inspector

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST (LAR) FOR PROPOSED TECHNICAL SPECIFICATION CHANGES FOR MODIFICATION OF CONTAINMENT SPRAY SYSTEM ACTUATION LOGIC

OMAHA PUBLIC POWER DISTRICT (OPPD)

FORT CALHOUN STATION (FCS), UNIT NO. 1

DOCKET NO. 50-285

List of Acronyms

1A / 2A	Break Area - 1 & 2 Times Pipe Area
AOR	Analysis of Record
CAC	Containment Air Coolers
CCW	Component Cooling Water
C_d / Cd	Discharge Coefficient
CLPS / PS	Cold Leg Pump Suction
CS	Containment Spray
DEG	Double-Ended Guillotine Break
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
FCS	Ft. Calhoun Station
HPSI	High Pressure Safety Injection
LAR	License Amendment Request
LOCA	Loss-of-Coolant Accident
LOOP	Loss of Offsite Power
MER	Mass and Energy Release
NPSH	Net Positive Suction Head
NPSHA	Net Positive Suction Head Available
NPSHR	Net Positive Suction Head Required
NRC	Nuclear Regulatory Commission
OPPD	Omaha Public Power District
RAI	Request for Additional Information
RAS	Recirculation Actuation Signal
RCS	Reactor Coolant System
SI	Safety Injection
SIT	Safety Injection Tank
SIRWT	Safety Injection and Refueling Water Tank
UFSAR	Updated Final Safety Analysis Report

NOTE: The reference documents delineated throughout the responses to the Request for Additional Information (RAI) appear as bracketed references and are listed on page 14 of Attachment 1.

The Nuclear Regulatory Commission (NRC) staff has reviewed the OPPD license amendment request (LAR) submittal and determined that additional information is required to complete the staff's evaluation:

1. **Updated Safety Analysis Report (USAR) Section 9.7.7 for component cooling water (CCW) system states that "[t]he equipment, except for the piping inside of the containment, is accessible for inspection and maintenance at all times."**

   a. **For the safety-related CCW system piping inside the containment that supplies water to the containment coolers and is not accessible as per USAR Section 9.7.7, please explain how and at what frequency the piping is subjected to inservice inspection (ISI).**

   b. **Please justify any deviations from ISI requirements for this piping.**

   <u>OPPD Response</u>:

   a. The related piping is ASME Code Class 2. The piping is accessible during refueling outages, but is not normally accessible while the plant is operating at full power due to radiation dose restrictions. The piping is in the ISI Program Plan and several locations are designated for ISI inspections during each ASME code 10-year interval. FCS is currently in the 4th 10-year interval.

   b. There are no deviations to the code requirements because of the location of this piping.

2. **Please provide a list of all the differences between the present GOTHIC model used for containment analysis and the proposed GOTHIC containment model given in the license amendment request and list all conservatisms in the proposed model. In addition, please provide justification for any differences between the two models.**

   <u>OPPD Response</u>:

   The base model for the FCS containment analysis models used to support elimination of the automatic actuation of containment spray following a loss-of-coolant analysis (LOCA) was developed based on models used in the analyses of record (AOR) in the Updated Final Safety Analysis Report (UFSAR) [4]. Two differences from the methodology in [1] as approved in [2] and delineated in [3] are used in its application to the FCS containment analysis without containment spray: 1) duration of the mass and energy release (MER) analysis, and 2) alternate stored energy dissipation rate calculations.

   The major differences between the new containment analysis and analysis of record models are listed in Attachment 1, Table 1.

The following conservatisms remain from the analysis of record listed in [4], Section 14.16.4, which apply to the LOCA peak pressure and temperature analysis and long-term vapor temperature response:

1. An air gap between the containment steel liner and the concrete wall is included which reduces the effectiveness of the related heat sinks. This is conservative since the existence of an air gap substantially reduces heat absorption by the massive concrete wall, reducing its ability to aid in the minimization of the containment peak pressure and temperature.

2. The addition of the nitrogen cover gas of the safety injection tanks (SITs) is included in the LOCA analysis. This is conservative since the nitrogen gas would increase peak pressure by two mechanisms. The first mechanism is that it increases the non-condensable gas partial pressure by adding to the amount of non-condensable gases in the containment, and the second mechanism is via condensation degradation.

3. Uncertainties were applied to the Safety Injection and Refueling Water Tank (SIRWT) initial temperature in the mass and energy release analysis. This raises the temperature of the water supply to the Safety Injection (SI) pumps. A high temperature value for the SIRWT is more conservative due to less heat transfer capabilities of water at higher temperatures.

4. A high containment initial pressure was used.

5. The surface area between the sump and the atmosphere was conservatively assumed to be 0 ft^2 for the short-term peak pressure and temperature analysis. This is to prevent steam condensation on the surface of the relatively colder water that would collect in the sump during the accident, which would otherwise reduce containment pressure and temperature. Additionally, no heat transfer is assumed to occur between the containment building outer surface and the outside atmosphere or between piping modeled as thermal conductors and any fluid within the steel piping. The DEFAULT option was used for all other analyses consistent with [1].

6. To maximize the relative energy from the reactor coolant system (RCS) and steam generator (SG), it is assumed that the systems are cooled to 120°F. This is the original pre-accident containment operating temperature.

The following additional conservatisms have been incorporated into the LOCA containment response model for the analysis without containment spray:

1. A single train of CACs (consisting of one Containment Air Cooling and Filtering Unit and one Containment Air Cooling unit) is credited in the containment peak pressure analyses regardless of assumed single failure in the Mass and Energy (M&E) Release case.

2. The CAC heat removal rates used were set conservatively low.

3. The long term mass and energy release rates are based on conditions at the time of the recirculation actuation signal (RAS) from the RELAP5 mass and energy calculation. The associated rates of energy release at that time are maintained constant until all energy is depleted from the RCS. The depletion time was limited to 24 hours by increasing the rate of energy release. Thus the long term energy is introduced to the containment at a rate that is greater than what would be expected. This adds conservatism to the overall calculation.

It should be noted that while the conservatisms outlined above are appropriate for the evaluation of the LOCA peak containment pressure they are not all appropriate for the LOCA sump temperature analysis. The sump analysis establishes other parameters with the intention to minimize containment atmosphere pressure. The following additional conservatisms applied to the sump temperature analyses as differences from the peak pressure analysis:

1. Nominal initial pressure was used.

2. High initial humidity was used to minimize the quantity of non-condensable gases, which maintains a lower pressure compared to lower initial humidity.

3. No addition of the nitrogen cover gas of the safety injection tanks (SITs) is included in this analysis.

4. A multiplier of 1.2 was applied to the Uchida correlation after the end-of-blowdown.

5. A Revaporization Fraction of zero was used.

6. 10% of the total stored energy dissipation after code transition was placed directly into the sump liquid instead of its normal dissipation location.

3. **Please describe the method of controlling the fouling and/or crud buildup and tube plugging in the cooling coils of the containment coolers so that cooler heat transfer characteristics, such as effectiveness, is maintained above analytical values.**

<u>OPPD Response</u>:

The component cooling water (CCW) side of the coolers is a closed loop system with controlled water chemistry. The cleanliness of the CCW system was monitored as part of GL 89-13 response and it was determined that it is not a contributor to fouling of heat exchangers. In addition, a preventive maintenance procedure is performed each outage to flush the coils and to verify that post DBA flows can be achieved through the cooling coils; this ensures that plugging or other issues do not degrade cooler effectiveness.

The air sides of the coolers are visually inspected each refueling outage (RFO) and cleaned as needed. Verification that fan cooler air flow is within surveillance acceptance criteria is performed on a refueling frequency.

4. FC07247 Table 2

a. Please verify that Table 2 applies to the high-pressure safety injection (HPSI) pumps.

b. The NRC staff would prefer to not credit a given amount of containment accident pressure (e.g., 8.99 ft) but rather to simply be assured that there is margin between the calculated containment accident pressure (conservatively minimized) and the pressure necessary to provide adequate available NPSH [net positive suction head] (calculated conservatively). Please provide curves of containment accident pressure as a function of time and the accident pressure necessary to provide adequate available NPSH.

OPPD Response:

a. The values reported in FC07247 Table 2 represent the containment conditions applicable to pumps taking suction from the containment sump after RAS, which includes the HPSI pumps. The following definitions are provided with respect to the information provided in FC07247 Table 2:

Subcooling Head (ft) = $[P_{atmosphere} - P_{sat}(T_{sump})] / \rho_{STP} * 144$
Overpressure Head (ft) = $[P_{containment} - P_{atmosphere}] / \rho_{STP} * 144$
Total Available Head (ft) = $P_{Subcooling} + P_{Overpressure}$

Where:
$P_{atmosphere}$ = 14.2 psia
ρ_{STP} = 62.4 lbm/ft^3

Note: The Subcooling and Overpressure Head for the cases presented in Figure 4 to Figure 6 were calculated using the time dependent sump liquid density using the method provided in Table 3 as opposed to the density at standard conditions (STP) used for FC07247 Table 2 listed above.

b. A comparison of the maximum NPSH deficit, calculated as NPSH Required minus NPSH Available calculated for a containment pressure of 14.2 psia, is plotted along with the available overpressure head in Figure 6. No credit for overpressure head is required for hot leg breaks. A maximum NPSH deficit of 4.15 ft was calculated for which overpressure head is required. Credit for overpressure is required for no more than 9 hours after RAS, which is available for each respective case. Note that the results presented in Figure 6 include results for additional cases analyzed since the release of calculation FC07247. Refer to OPPD Response, RAI #9 for a brief discussion of these cases.

The limiting case for peak sump liquid temperature and requirement for overpressure credit is a case with maximum ECCS (3 HPSI pumps and 2 LPSI pumps during the Safety Injection phase and 3 HPSI pumps after RAS) and minimum containment cooling (one CACF and two CACs). The overpressure credit is based on maximum allowable head loss across the strainer.

5. **USAR Section 6.2.2**

USAR Section 6.2.2 states that a preferred method of operation in the recirculation mode is to divert containment spray water to the suction of the HPSI pumps. Please verify that, under the proposed change, when the spray pumps are supplying flow to the HPSI pumps, they are not also spraying into the containment.

OPPD Response:

The system alignment for this mode of operation is currently described in Attachment 8 of the EOP/AOP Attachments "Cooled SI Flow with RAS." The steps in the attachment require that the CS valves HCV-344/345 be placed in OVERRIDE and hand-jacked closed prior to initiating the cooled SI flow. Operators are trained on these actions which are taken specifically to preclude the possibility of spraying flow into containment during this mode of operation. The above procedural guidance for this mode of operation is maintained under this proposed change.

6. **FC07247 Section 3.5**

a. **Why were the NPSH analyses performed with the time of transition at recirculating actuation signal (RAS) and the stored energy dissipation rates calculated using the existing method?**

b. **Section 3.5 states that the sump temperatures without containment spray are less than the sump temperatures at RAS from the analysis of record (AOR) with containment spray. Please explain operation of the containment spray including cooling with the shutdown coolers.**

c. **What assumptions are made of the heat transfer between the sump water and the containment atmosphere?**

OPPD Response:

a. All of the long-term analyses, including the sump temperature analysis, were run with the code transition at RAS. The selection of the energy dissipation method for the sump temperature analysis was arbitrary given the expectation that either method would produce comparable results. Calculation FC07247 [3] Figures 11 and 14 show the comparison of the different methodologies evaluated without containment spray in operation. As can be seen, there is no difference in sump liquid temperature up to the time of RAS for the cases with transition at RAS. The post-RAS containment responses are similar with pressure and temperatures slightly higher using the alternate method of calculating the stored energy dissipation rates.

Additional cases were analyzed to provide a comparison of the impact of the stored energy dissipation methodologies. Figure 1 shows the sump liquid temperature as a function of time after RAS for the analysis of record compared against comparable cases with minimum ECCS flow with stored energy dissipation calculated by the existing and alternate methods. As can be seen, the post-RAS sump temperature response is slightly higher when using the alternate method of calculating the stored energy dissipation rates. The increase in post-RAS peak temperature using the alternate method was approximately 3°F. This small difference does not warrant a change to the arbitrary selection of a stored energy dissipation method, especially given that there was a corresponding increase of overpressure head as can be seen in Figure 6 (refer to the response to RAI #4b for a brief discussion of this plot).

b. The AOR models pre-RAS CS with a constant flowrate and drop size injected into the containment vapor space. Post-RAS, the CS system suction is aligned to the containment sump with all flow passing through the SDC heat exchangers prior to being injected into the containment vapor space at a constant flowrate and drop size. The LOCA analyses without CS do not model the CS system during either pre- or post-RAS nor do they model the SDC system. Post-RAS only the available HPSI pumps are assumed to be operating injecting water into the RCS, and cooling is provided strictly by the CAC system.

Without CS operation the time to RAS is significantly longer resulting in lower decay heat and stored energy dissipation rates at RAS. This change leads to a lower temperature at which the containment cooling system will remove the energy released to containment.

c. The following parameters were set to values consistent with the AREVA NP containment analysis methodology in [1]:

1. The Minimum Heat Transfer Coefficient ([1] Section 4.6).

2. Liquid-Vapor Interface Area ([1] Section 4.0 and [1] page A-10 Item 4.2.3.2.6).

3. Revaporization Fraction ([1] Table 4-1 and [1] Section 4.2).

7. **FC07247 Section 3.6**

Why is the post-RAS peak in containment vapor temperature lower than the pre-RAS peak regardless of spray operation?

OPPD Response:

The heat load on containment is significantly higher around blowdown than after RAS, which leads to a lower peak post-RAS. The peak pressure and vapor temperature typically occur before the containment cooling systems have fully actuated, making the peak values a function of the blowdown and containment physical parameters. The magnitude of the post-RAS peak is a function of the energy release to containment (i.e., decay heat and stored energy) and containment energy removal, specifically the ability of the CACs and shutdown coolers to reject energy to the ultimate heat sink via the CCW and RW systems. For cases with containment spray in operation, the shutdown coolers are placed in service after RAS and aligned to the CS system and no credit was taken for CAC operation. For cases without CS in operation, the CACs run throughout with credit for manual starting of a second CCW pump, which increases the heat removal rate of the CACs. Post-RAS, the containment evolves to a temperature at which each containment cooling system can remove the energy release to containment, which is below that from the initial blowdown.

8. **FC07247 Section 2**

This section states that extended RELAP5 analysis performed beyond 1000 seconds could be analyzed using the reduced uncertainty in decay heat.

a. **Please explain more specifically when this reduced uncertainty would be applied or commit to specifying the uncertainty in all future FCS containment calculations.**

b. **Is the reduction in uncertainty used throughout the FC07247 Revision 0 calculations?**

OPPD Response:

a. The AREVA NP containment analysis methodology defines the transition from short-term to long-term decay heat in [1] Section 5.1.2.3.2.4 with a reduction in decay heat multiplier at the time specified therein.

b. The short-term analyses end before the reduction in uncertainty would occur. The long-term analyses for the FCS analyses without containment spray were performed with the change in decay heat uncertainty specified in the AREVA NP containment analysis methodology in [1] Section 5.1.2.3.2.4, including the mass and energy release analyses in RELAP5 and the containment analyses in GOTHIC.

9. FC07247 Section 3

Please explain why the limiting short-term cases are necessarily the limiting cases for the long term.

a. Explain why the long-term vapor pressure is lower for the "no spray" case than for the AOR case with containment spray.

b. Is the CAC modeled for the AOR case?

OPPD Response:

Containment pressure, vapor temperature and liquid temperature from the short-term cases are shown in Figure 7 to Figure 12 with the cases selected for the long-term pressure and vapor temperature analyses identified for reference. Refer to Table 2 for a brief description of each short-term hot leg and cold leg pump suction break case analyzed. The containment response for large breaks at a given location (e.g., hot leg) and single failure (e.g., diesel generator) evolve to roughly the same containment conditions. As can be seen, the plotted parameters have already started to converge at the end of the ten minutes of the short-term transient analyses and will continue to evolve to approximately the same conditions by RAS because decay heat and sensible heat release rates are similar among classes of breaks. Cases with maximum ECCS do not generate the limiting containment pressure or vapor temperature and can be eliminated for analysis of long-term containment vapor temperature.

Since the release of calculation FC07247, additional long-term cases were performed to further evaluate the long-term sump temperature response. From the short-term analyses, as shown in Figure 12, the sump liquid temperature results from the maximum ECCS cases appear to be divergent with some cases above and others below those of the minimum ECCS cases. Those cases that generated sump liquid temperatures below the minimum ECCS cases were said to evolve to a non-limiting condition because the sump temperature was colder. Cases PS1C-CASJ_NS and PS1CLPR-CJMH_NS are cold leg pump suction breaks that were analyzed without loss-of-offsite power (LOOP) that once the RCPs are tripped the sump temperature will quickly evolve to their comparable LOOP cases because of phase separation in the RCS and lower stored energy dissipation. Because of the potential that higher ECCS flow could result in higher stored energy dissipation rates after the end of the short-term analysis additional cases were performed to evaluate the long-term effect on sump liquid temperature with maximum ECCS flow. The results of these additional cases show that by RAS the higher ECCS flow causes a higher stored energy dissipation rate as compared with minimum ECCS flow. As can be seen in Figure 2 and Figure 3, the sump liquid temperature at RAS is higher for cases with maximum ECCS leading to higher post-RAS temperatures and lower subcooling head as shown in Figure 4 and Figure 5. The shorter time to RAS leads to higher decay heat levels and higher stored energy dissipation that lead to a higher temperature at which the CACs will remove the energy released to containment.

a. The differences between the two cases (spray and no spray) represented by containment vapor temperature response shown in FC07247 Figures 15 and 16 are listed in Table 1. Of those, the two major differences are 1) the change in RAS time and 2) the change in the stored energy dissipation methodology. For the first, the time to RAS is significantly longer without CS operation resulting in lower decay heat and stored energy dissipation rates at RAS. This change leads to a lower temperature at which the containment cooling system will remove the energy released to containment. For the second, the alternate methodology reapportions the stored energy dissipation, which results in a lower vapor pressure and temperature.

b. The AOR does not credit CAC operation.

10. [*No Question #10 in the RAI*]

11. [*No Question #11 in the RAI*]

12. <u>Attachment 1 to OPPD letter dated July 30, 2007</u>

a. Please explain why the current analysis with containment spray remains bounding for equipment qualification (EQ).

b. Why is the safety injection pump room current calculation bounding?

c. Attachment 1 Page 26 states that the final EQ analyses will be completed by October 1, 2007. Please provide any changes from the discussion in the July 30, 2007 letter.

<u>OPPD Response</u>:

a. The analysis of record and new analysis without containment spray credit different equipment for containment cooling as discussed in the response to RAI #7. A very conservative containment vapor temperature analysis was created in the analysis of record that included the combination of early code-to-code transition and overly-conservative stored energy dissipation (high heat rates applied as a constant over the long-term). Applying the transition at RAS and the alternate stored energy dissipation, removed some of the overly-conservative assumptions for cases without containment spray. The current equipment qualification is based on a bounding curve enveloping the containment analysis of record. The results of the long-term containment response shown in FC07247 Figures 15 and 16 demonstrate that the containment vapor temperature is lower than the AOR in the major areas of concern, including the short term and post-RAS peaks. The minor deviations are insignificant in magnitude and duration and are overwhelmed by the significant difference post-RAS. Therefore, elimination of the automatic containment spray actuation following a LOCA has no effect on the existing equipment qualification.

The existing calculations were reviewed to assess the impact of containment spray removal on the Containment EQ dose. The gamma radiation dose values used in these calculations are based on the methodology in IE Bulletin 79-01 B, "Environmental Qualification of Class IE Equipment." Based on a review of the methodology in IEB 79-01 B and a review of subsequent clarifications of the Bulletin in Supplements 1 and 2, it was determined that the procedure presented in IEB 79-01 B and used by FCS is applicable whether spray removal is considered or not. The calculated doses bound the plant's equipment qualification design basis without containment sprays

b. The SI Pump Room Heat-up Calculation was revised to address the impact of eliminating automatic actuation of containment spray for LOCA. As a result of this change the time to the containment sump recirculation actuation signal (RAS) is longer. This changes the post-LOCA containment sump temperature. For times up to about 6000 seconds following RAS, the previous containment sump temperature result was higher. For times after about 6000 seconds following RAS, the revised containment sump temperature was higher. Since some of the pipes traversing the SI pump rooms contain sump water, this increases the post-LOCA heat load to the rooms. However, following implementation of the proposed modification, containment spray pumps will no longer be used following a LOCA. This reduces the heat load into the rooms by reducing the number of operating pumps. Furthermore, the low pressure safety injection pumps are administratively limited to 450 gpm when used following the RAS. Running the pumps at a lower flow rate reduces the motor heat load.

   The applicable GOTHIC analysis cases were rerun with these and other minor modeling changes. The number of pumps allowed to be operating in each room is also administratively controlled as needed to ensure that the room heat-up calculations remain bounding. The results show that the rooms remain below the current EQ room temperature qualification limit.

c. The final calculation confirming EQ analysis are bounding was completed on October 31, 2007.

13. <u>Technical Specification 3.6(3)e</u>

a. Please explain why a pressure drop of 2 inches of water was selected.

b. What method will be used to measure the pressure drop?

<u>OPPD Response</u>:

a. The Maintenance and Instruction Manual for AAF Designed Nuclear Ventilation and Cooling Equipment states that the filter should be replaced when the pressure drop across the bank is between 2 inches water gauge (WG) and 3 inches WG. The design basis document for the Containment HVAC system states that the HEPA filters were designed to have a maximum initial resistance of 1" WG at the rated flow. Research of original FCS construction documents show that the HEPA filter acceptance tests (conducted in accordance with the standards in effect at the time) meet the requirements of acceptance tests described in ANSI/ASME N509-1980 and ANSI/ASME N510-1980. Specifically, the FCS HEPA filter design specifications required that the clean HEPA filter pressure drop be less than 1" WG at rated flow, then pass a standard dust loading test without exceeding 2" WG, strength test and then successfully pass the DOP penetration test. The 2" value was chosen based on these inputs. In addition, the calculation used to support a 50% HEPA filter efficiency, estimates the maximum potential bypass leakage based on an assumed 2" WG at the beginning of the accident.

b. The Pressure Drop across the filter banks is measured using surveillance test IC-ST-VA-0013. It is performed by connecting a manometer across the unit.

14. Regarding setpoint changes, please explain why the loop uncertainty for this new engineered safety features function has not been affected. Please provide diagrams and supporting discussion for the new containment spray actuation logic.

<u>OPPD Response</u>:

A new Engineered Safety Features interlock is being added to accommodate the change in the auto-start logic for the Containment Spray (CS) pumps. This interlock will take an existing Steam Generator Low pressure Signal (SGLS) contact from the SGLS matrix and input it to the existing CS pump auto-start logic. With the addition of this interlock, the CS auto-start logic will change from starting on a Pressurizer Pressure Low Signal (PPLS) and Containment Pressure High Signal (CPHS), as shown in Attachment 2, Page 3, to starting on a PPLS and CPHS coincident with an SGLS, as shown in Attachment 2, Page 4.

The SGLS signal used for the new interlock is taken from the SGLS logic matrix. This signal is derived from the same logic as the existing Steam Generator Isolation Signal (SGIS) contact output from the SGLS matrix (see Attachment 2, Pages 1 and 2). Because the interlock is taken from an existing contact output from the SGLS matrix, no analog components are affected and no new analog equipment has been added. The SGLS trip bi-stables and associated analog instrument loops are unaffected by this change. Thus, the loop uncertainty is not affected by this logic change.

The following reference documents are delineated throughout the responses to the Request for Additional Information (RAI) and appear as bracketed references.

References

[1] AREVA NP Document 43-10252PA-00, "Analysis of Containment Response to Postulated Pipe Ruptures Using GOTHIC"

[2] Letter from NRC (M. C. Thadani) to Framatome ANP (R. E. Gardner), "Correction to Letter Forwarding the Final Safety Evaluation for Framatome ANP Topical Report BAW-10252(P), Revision 0, "Analysis of Containment Response to Postulated Pipe Ruptures Using GOTHIC" (TAC No. MC3783)" (ML052450297)

[3] AREVA NP Document 77-9051353P-001, "Summary of FCS Containment Analysis without Containment Spray" (FCS Calculation FC07247)

[4] Fort Calhoun Station Updated Final Safety Analysis Report (UFSAR), Chapter 14.16, Revision 11

Table 1: FCS Containment Analysis Model Differences

Parameter	Analyses of Record	Analyses w/o CS	Discussion[1]
Code Version	GOTHIC 7.0	GOTHIC 7.2a	The latest version of the GOTHIC computer code, version 7.2a, was used from the start of the FCS containment analyses with no containment spray (CS). The selection of the latest code version allows credit for correction of code deficiencies, which have minimal affect on the transient analysis results. No credit was taken for additional code options or capabilities beyond those approved in [1].
Containment Spray	Active	Disabled	The purpose of the new FCS containment analyses was to eliminate the automatic actuation of CS following a LOCA.
Containment Air Coolers (CACs)	No Credit	Active	Given elimination of the automatic actuation of CS following a LOCA, credit for CACs was required for containment energy removal.
Shutdown Coolers	Active	No Credit	No credit was taken for the shutdown coolers in the containment without containment spray.
Operator Action	None	Start second CCW pump at 30 minutes	Taking credit for this operator action increased CAC heat removal by providing additional CCW flow through the secondary side of the CACs.
Mass & Energy Release (MER)	Short-term (beyond core quench)	[discussed in [3] Section 3.3.4]	The MER analyses for the cases without CS were performed with RELAP5/MOD2-B&W as discussed in [3] Section 3.3.4.
Stored Energy Dissipation	[discussed in [3] Section 3.3.2]	[discussed in [3] Section 3.3.3]	An evaluation of using the proposed alternate method of calculating the energy dissipation rates is included in [3] Section 3.3.4.
Phase Separation	Break Upstream Pressure	[discussed in [1] Section 4.1]	Phase separation for the containment analyses for the cases without CS were performed in accordance with the AREVA NP containment analysis methodology as delineated in the last paragraph of [1] Section 4.1.
Revaporization Fraction	0	[discussed in [1] Section 4.2]	Revaporization fraction for the containment analyses for the cases without CS was set to the AREVA NP containment analysis methodology as delineated in the second paragraph of [1] Section 4.2.
Forced Entrainment Drop Diameter	0	DEFAULT	Forced Entrainment Drop Diameter fraction for the containment analyses for the cases without CS was set to the AREVA NP containment analysis methodology as delineated in refer to [1] Section 4.8.
Liquid-Vapor Interface Area	0	[see discussion]	<u>Short-term containment analyses</u>: Liquid-Vapor Interface Area was maintained consistent with the AOR based on the discussion in AREVA NP containment analysis methodology in [1] Page A-10. <u>Long-term containment analyses</u>: Liquid-Vapor Interface Area was set consistent with the AREVA NP containment analysis methodology as discussed in [1] Section 4.0 and [1] Page A-10 item 4.2.3.2.6.
Tagami Initial Value	0	[specified in [1] Table 4-1]	Tagami Initial for the containment analyses for the cases without CS was set to the AREVA NP containment analysis methodology as delineated in [1] Table 4-1).

Note:

1. Except as noted, the Analyses without CS were performed in accordance with the AREVA NP containment analysis methodology in [1], including the requested changes to the methodology. A brief justification is provided for any difference from the methodology.

Table 2: FCS Short-Term Case Matrix					
Case Name	Break	ECCS[1]	Back Press	Single Failure[2]	LOOP
hl1a-BTQC_NS	HL – DEG	Max	High	GOTHIC	No
hl1alp-BYWR_NS	HL – DEG	Max	Low	GOTHIC	No
hl1blp-CTLI_NS	HL – DEG	Max	Low	GOTHIC	Yes
hl2alp-BAEC_NS	HL – DEG	Min	Low	EDG #1	Yes
hl2blp-BEKS_NS	HL – DEG	Min	Low	EDG #2	Yes
hl3a-BWER_NS	HL - DEG, Cd=0.8	Min	Low	EDG #1	Yes
hl3a1-CMND_NS	HL - DEG, Cd=0.6	Min	Low	EDG #1	Yes
hl3a2-BWVF_NS	HL - DEG, Cd=0.4	Min	Low	EDG #1	Yes
hl3b-brkr-CRDR_NS	HL - 2A Split	Min	Low	EDG #1	Yes
ps1c-CASJ_NS	CLPS – DEG	Max	High	GOTHIC	No
ps1clpr-CJMH_NS	CLPS – DEG	Max	Low	GOTHIC	No
ps1d-CYVA_NS	CLPS – DEG	Max	High	GOTHIC	Yes
ps1dlpr-BPYI_NS	CLPS – DEG	Max	Low	GOTHIC	Yes
Ps2clp-CBWR_NS	CLPS – DEG	Min	Low	EDG #1	Yes
Ps2dlp-BYLG_NS	CLPS – DEG	Min	Low	EDG #2	Yes
Ps3c-CFSP_NS	CLPS - DEG, C_d=0.8	Min	Low	EDG #1	Yes
Ps3dar1-BRGD_NS	CLPS - DEG, C_d=0.6	Min	Low	EDG #1	Yes
Ps3ebr1-BNIG_NS	CLPS - 2A Split	Min	Low	EDG #1	Yes
Ps3far-BYXC_NS	CLPS - 1A Split	Min	Low	EDG #1	Yes

Notes:
1. Maximum ECCS: 3 HPSI pumps, 2 LPSI pumps. Minimum ECCS: 1 HPSI pump, 1 LPSI pump.
2. A single failure specified as GOTHIC means that no single failure was taken in the MER analysis and the single failure would be taken in the containment analysis, if required.

Table 3: Explanation of Figure Terms	
Term	Description
Existing	Existing Stored Energy Dissipation Method
Alternate	Alternate Stored Energy Dissipation Method
Min ECCS	Pre-RAS: 1 HPSI, 1 LPSI Post-RAS: 1 HPSI, 0 LPSI
Max ECCS	Pre-RAS: 3 HPSI, 2 LPSI Post-RAS: 3 HPSI, 0 LPSI
Min Cool	< 30 min: 1 CCW pump ≥ 30 min: 2 CCW pumps Min ECCS (EDG Failure): 1 CAC / 1 CACF Max ECCS (Single Failure - CACF): 2 CAC / 1 CACF
Max Cool	3 CCW pumps 2 CAC / 2 CACF
Subcooling Head (ft)[1]	$= [P_{atmosphere} - P_{sat}(T_{sump})] / \rho_{Sump} * 144$ $P_{atmosphere}$ = 14.2 psia
Overpressure Head (ft)[1]	$= [P_{containment} - P_{atmosphere}] / \rho_{Sump} * 144$ $P_{atmosphere}$ = 14.2 psia
NPSH Deficit (ft)	= NPSHR - NPSHA(@14.2 psia)

Note:
1. The Subcooling and Overpressure Head for the cases presented in Figure 4 to Figure 6 were calculated using the time dependent sump liquid density using the method provided in Table 3 as opposed to the density at standard conditions (STP) used for FC07247 Table 2 listed in the response to RAI #4.

Figure 1 - FCS Sump Temperature With and Without Spray

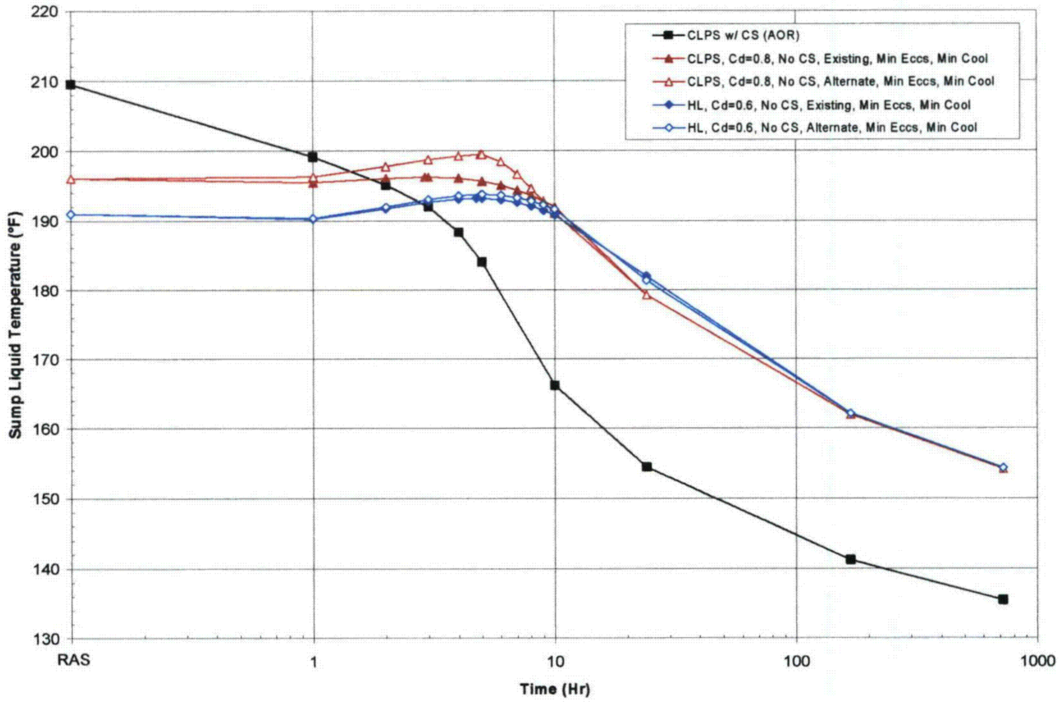


Figure 2 - FCS Sump Temperature Without Spray - CLPS Breaks

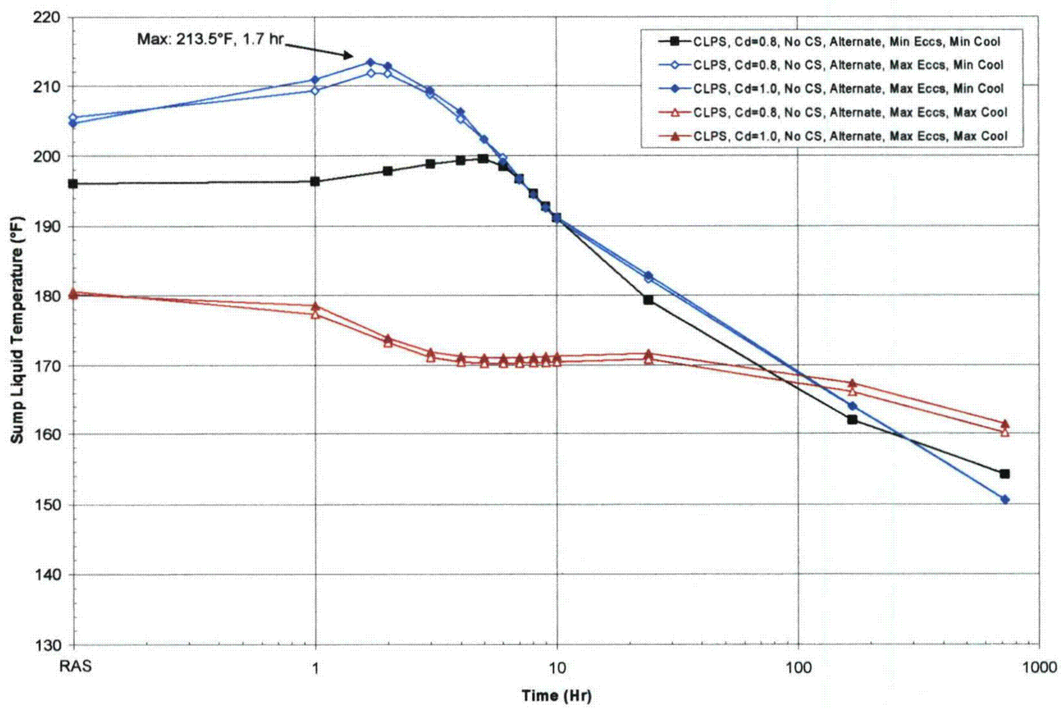


Figure 3 - FCS Sump Temperature Without Spray - HL Breaks

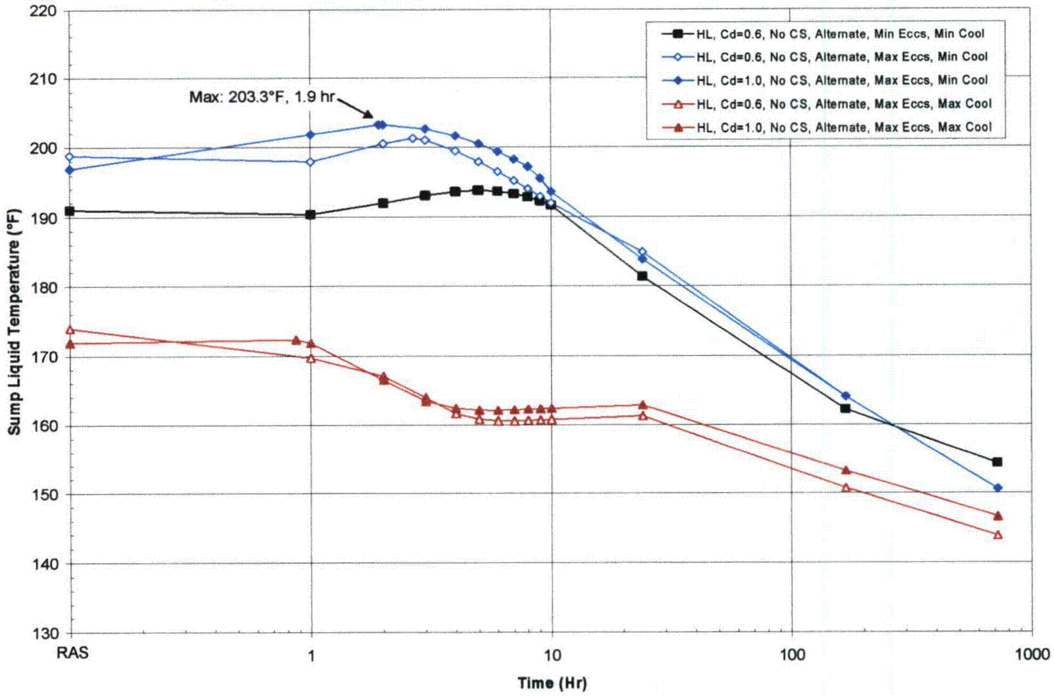


Figure 4 - FCS Subcooling Head Without Spray - CLPS Breaks

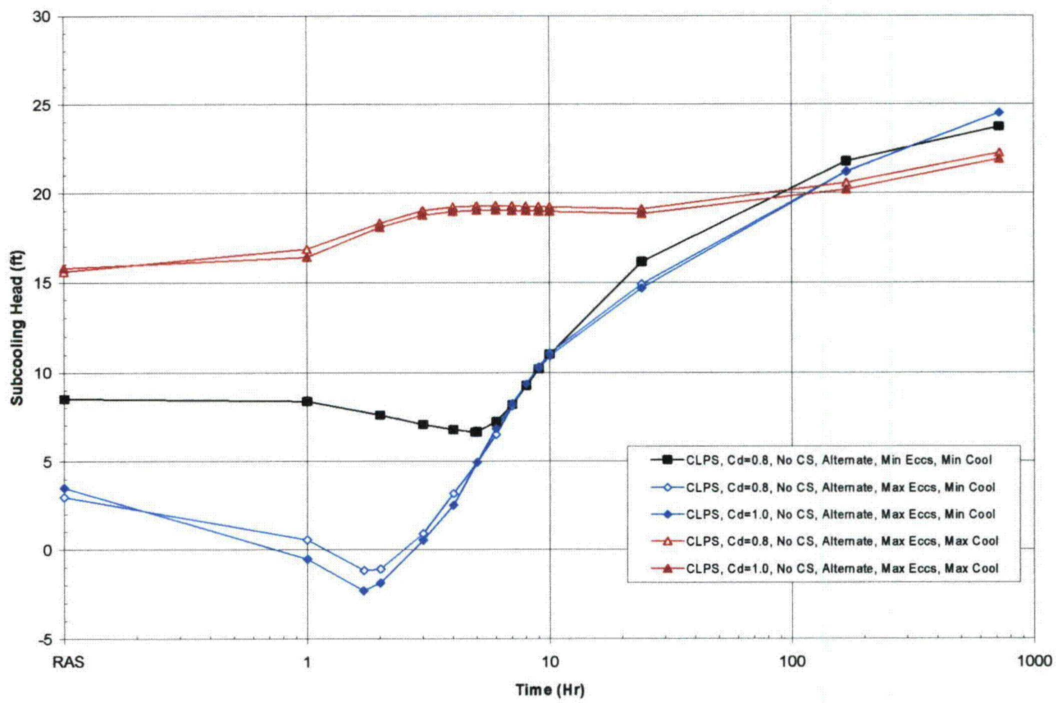


Figure 5 - FCS Subcooling Head Without Spray - HL Breaks

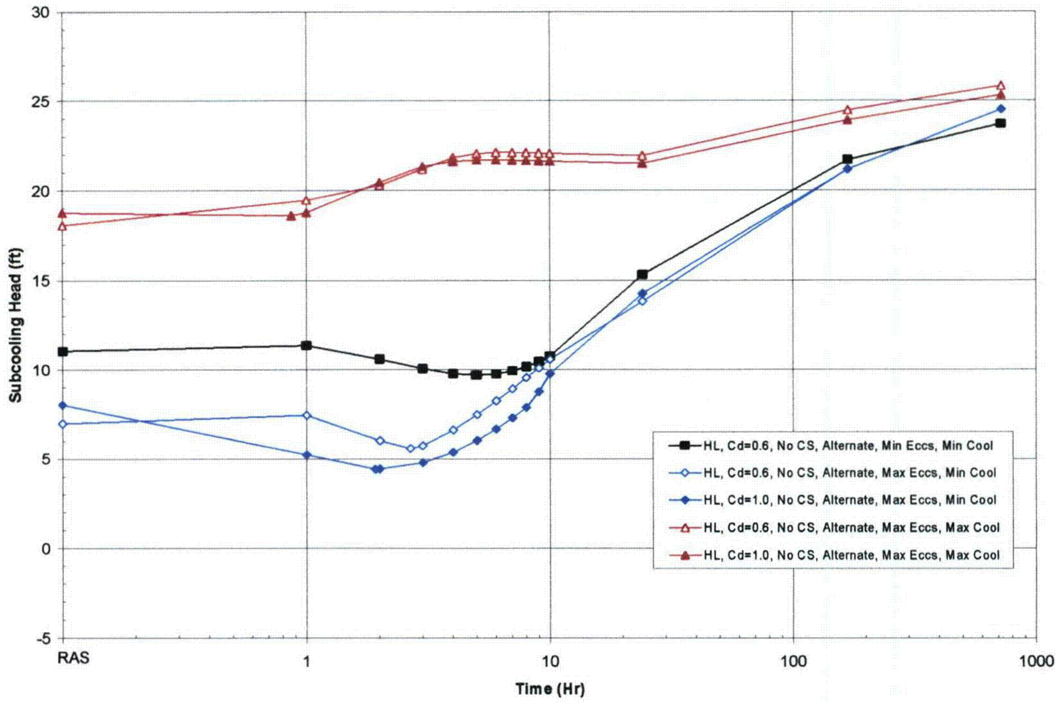


Figure 6 - FCS NPSH Evaluation Without Spray - Limiting Breaks

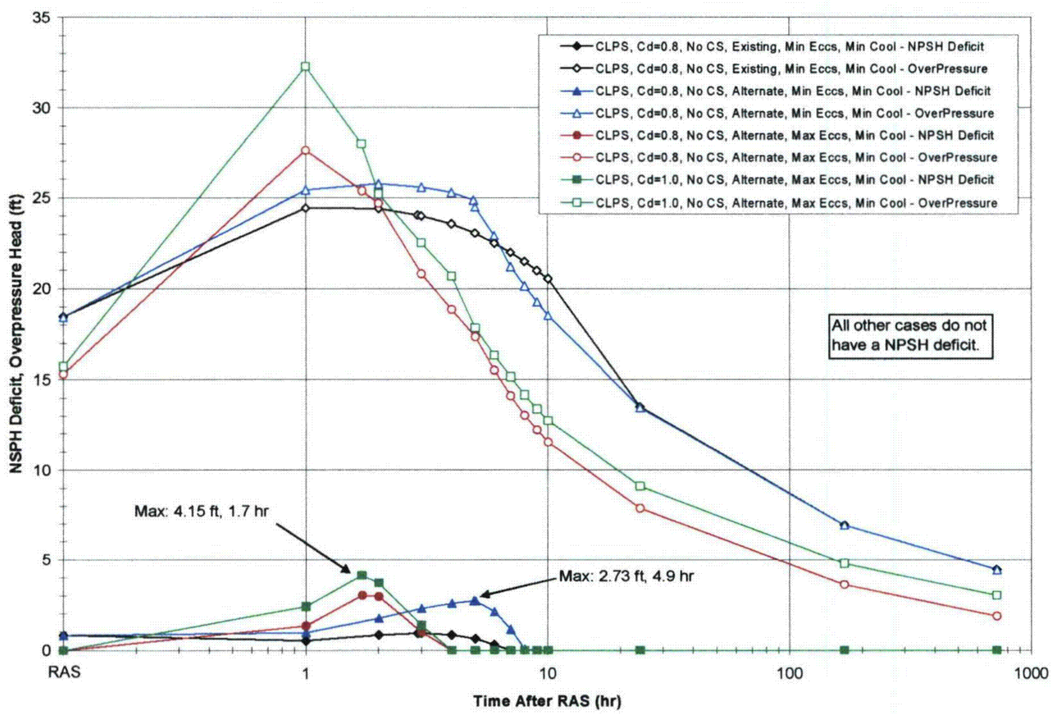


Figure 7 - FCS Short-Term Results - Hot Leg Break - Pressure

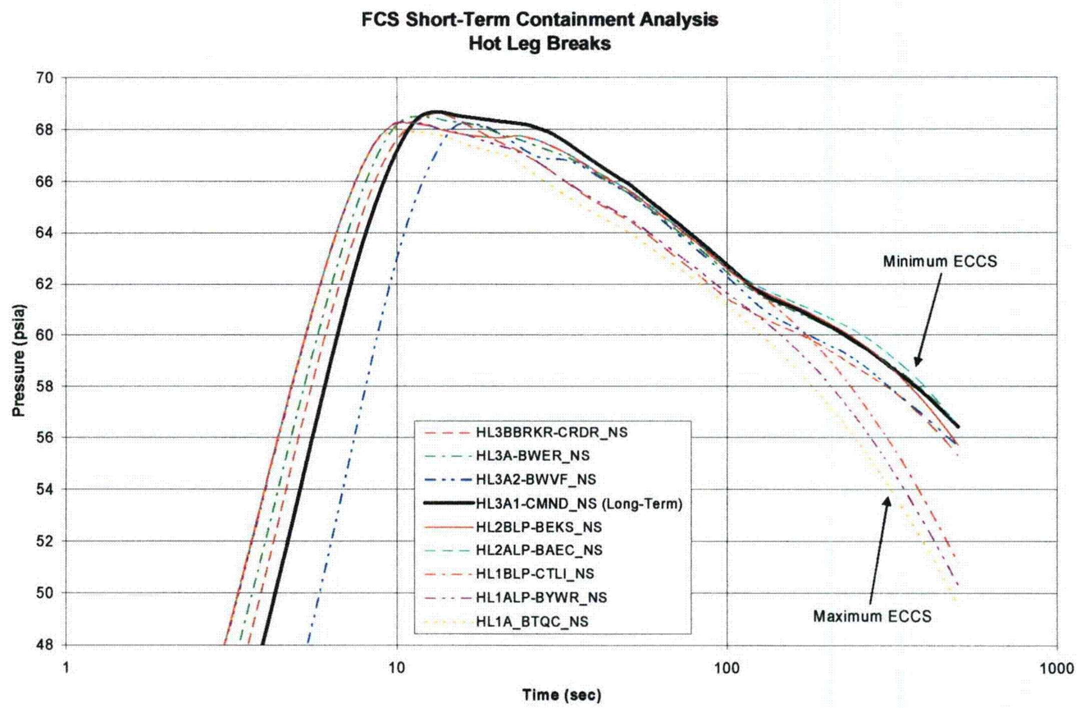


Figure 8 - FCS Short-Term Results - Cold Leg Pump Suction Break - Pressure

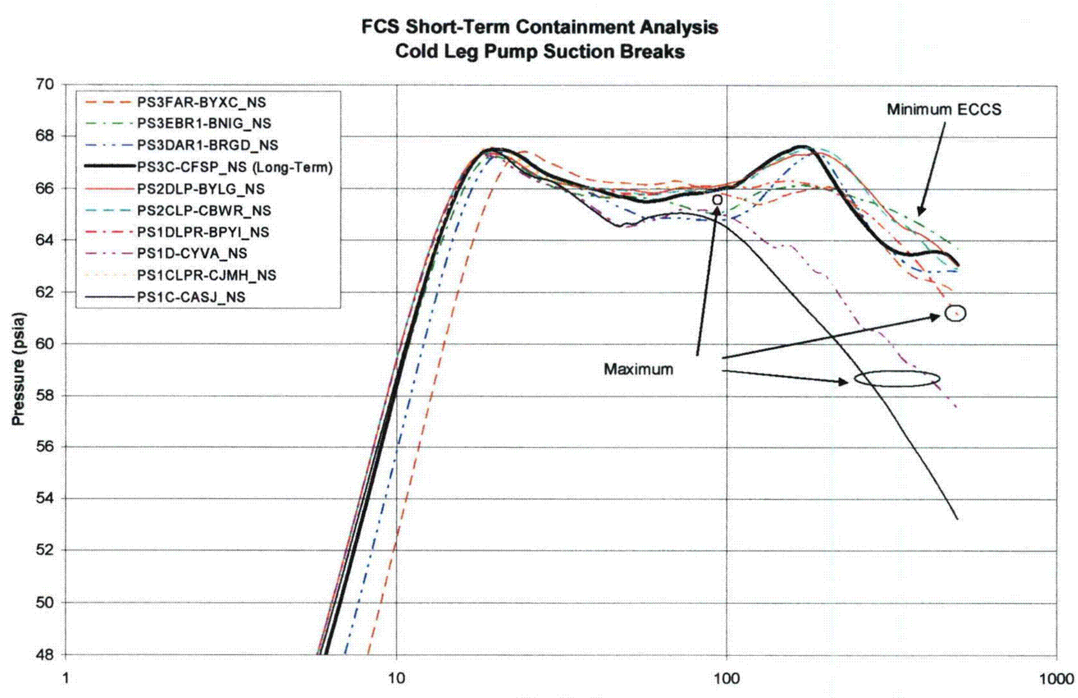


Figure 9 - FCS Short-Term Results - Hot Leg Break - Vapor Temperature

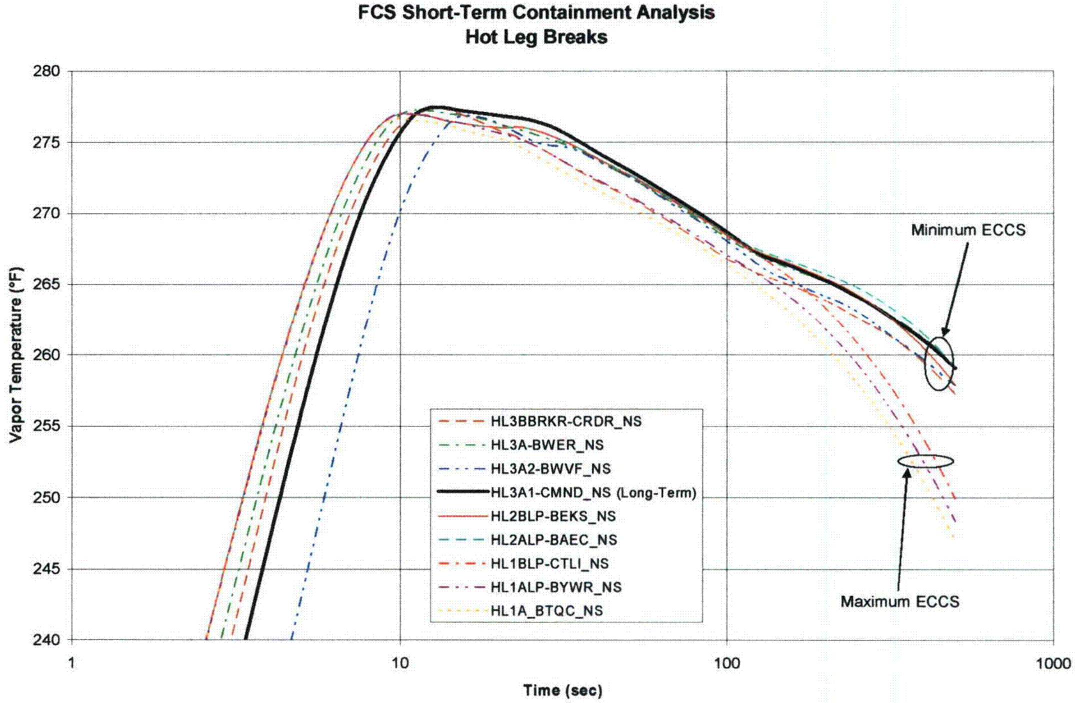


Figure 10 - FCS Short-Term Results - Cold Leg Pump Suction Break - Vapor Temperature

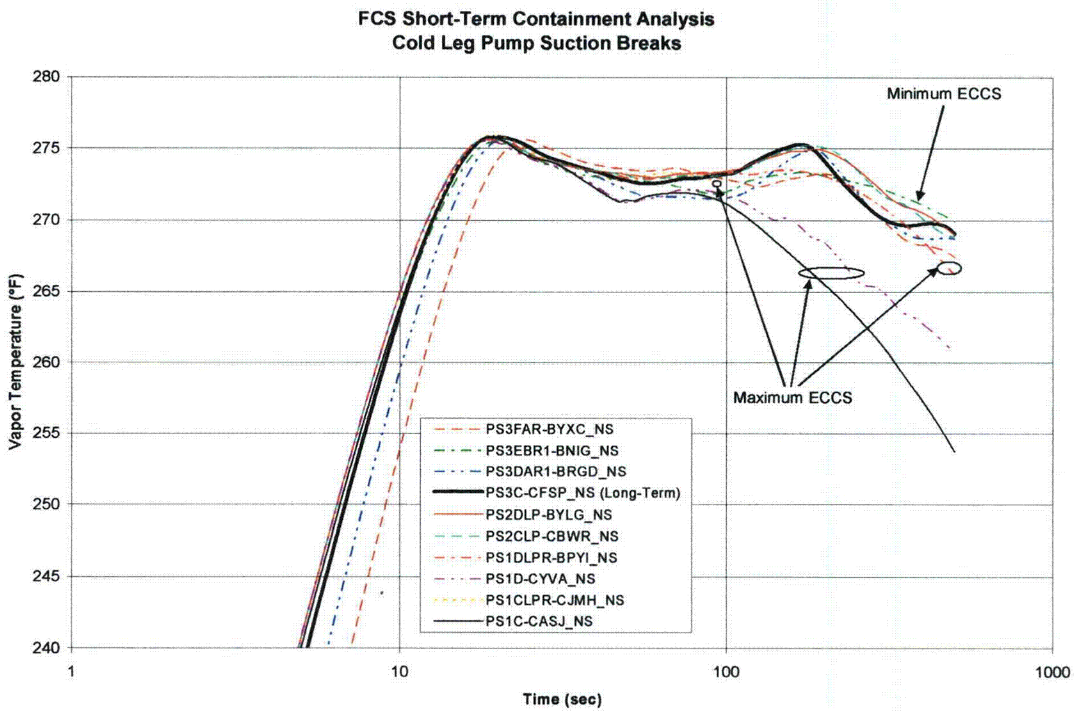


Figure 11 - FCS Short-Term Results - Hot Leg Break - Liquid Temperature

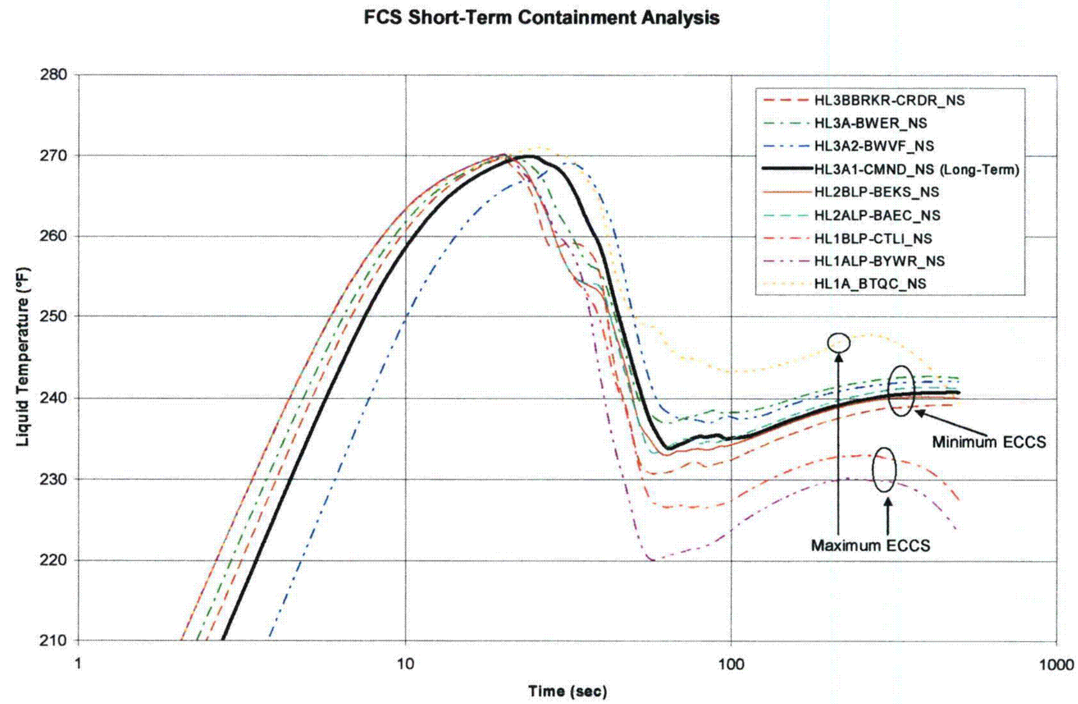
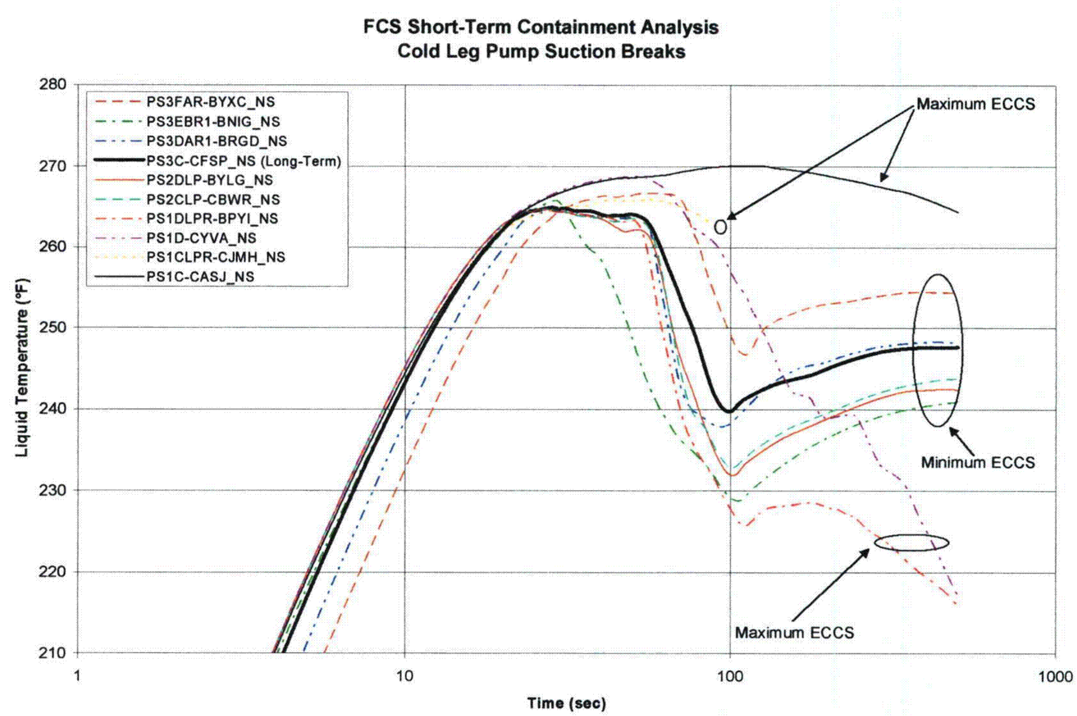
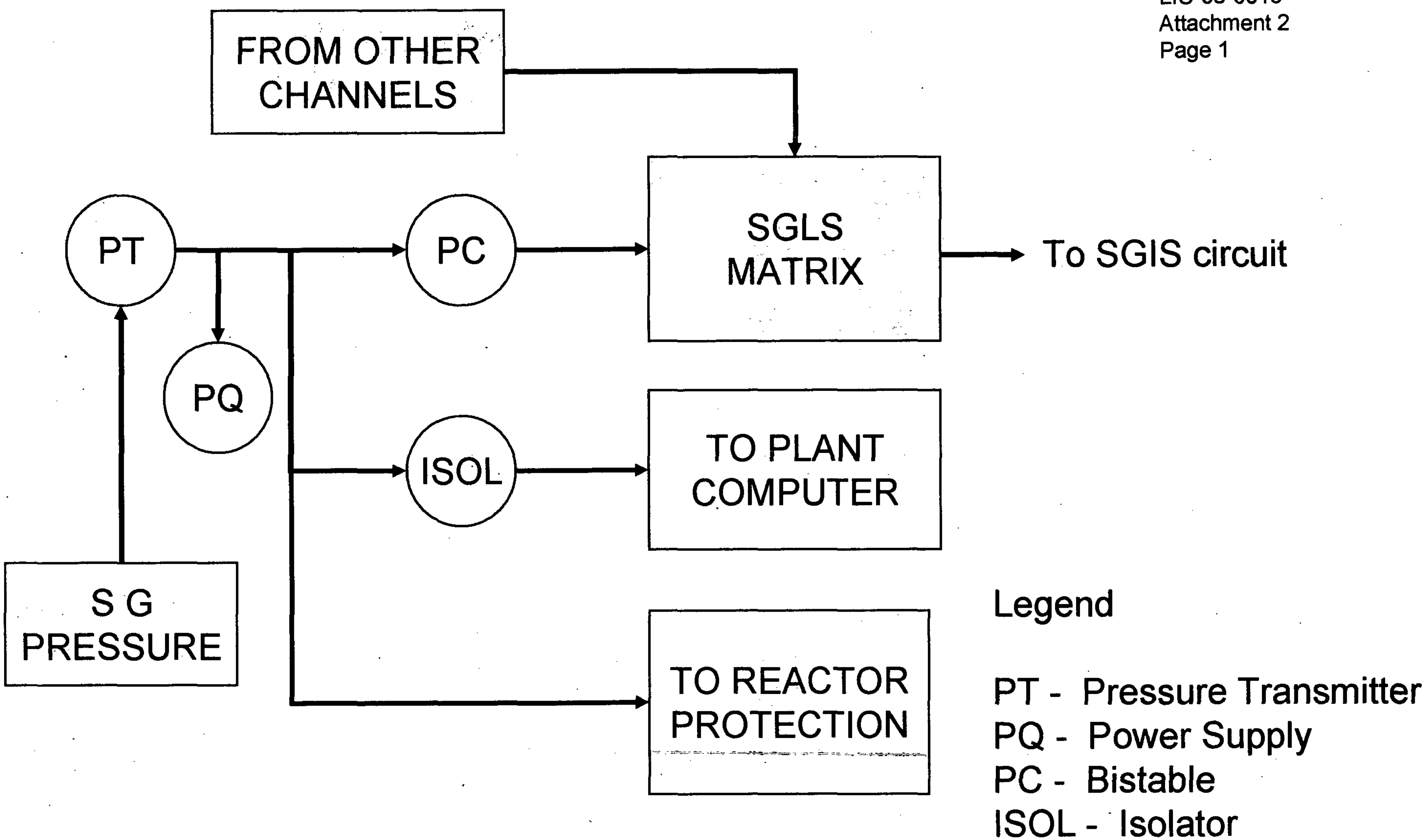
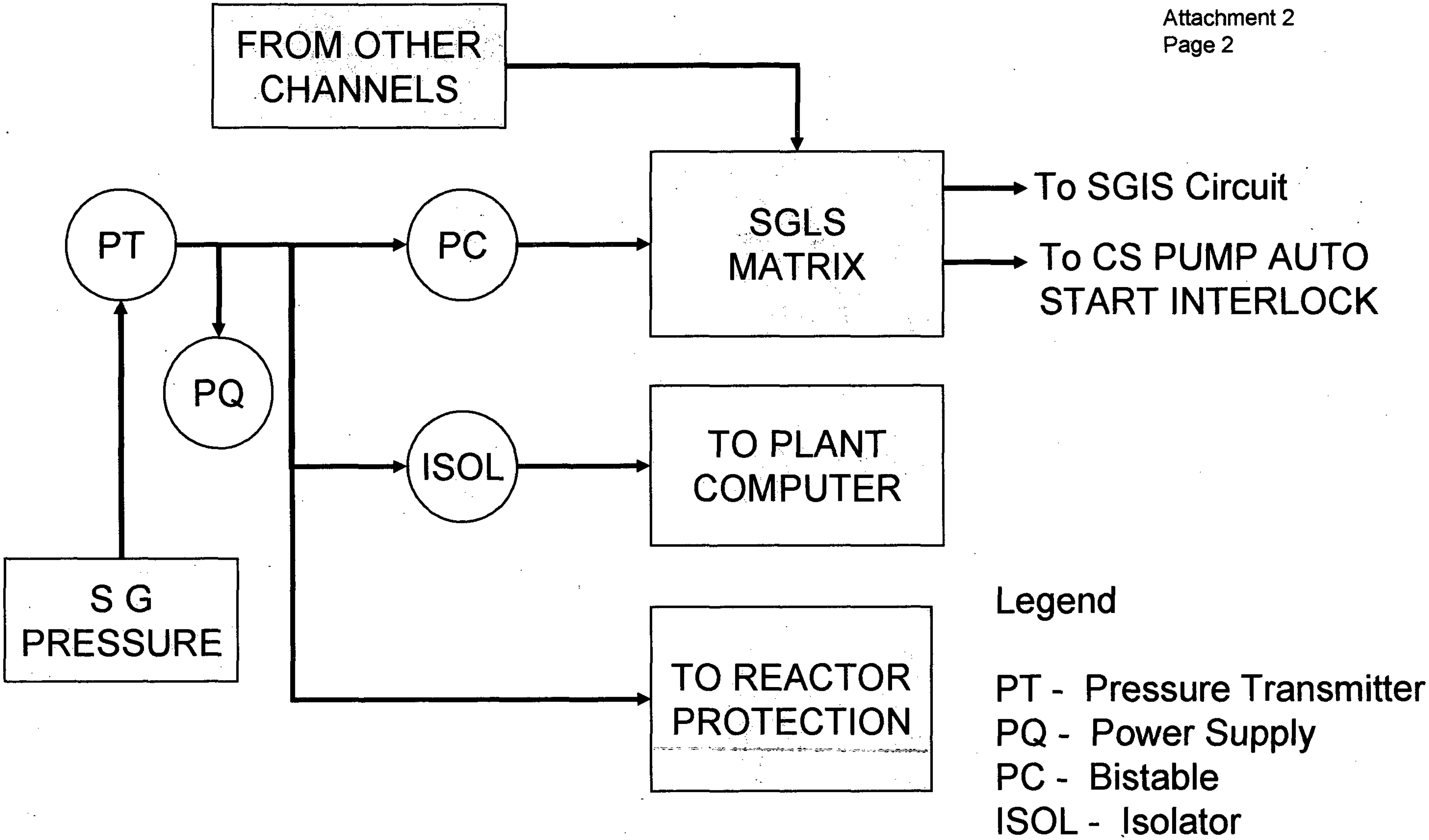


Figure 12 - FCS Short-Term Results - Cold Leg Pump Suction Break - Liquid Temperature

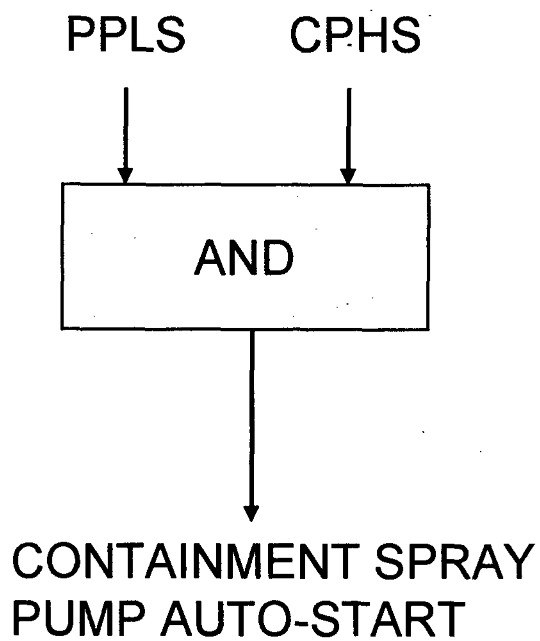




TYPICAL SG PRESSURE CHANNEL
(BEFORE)



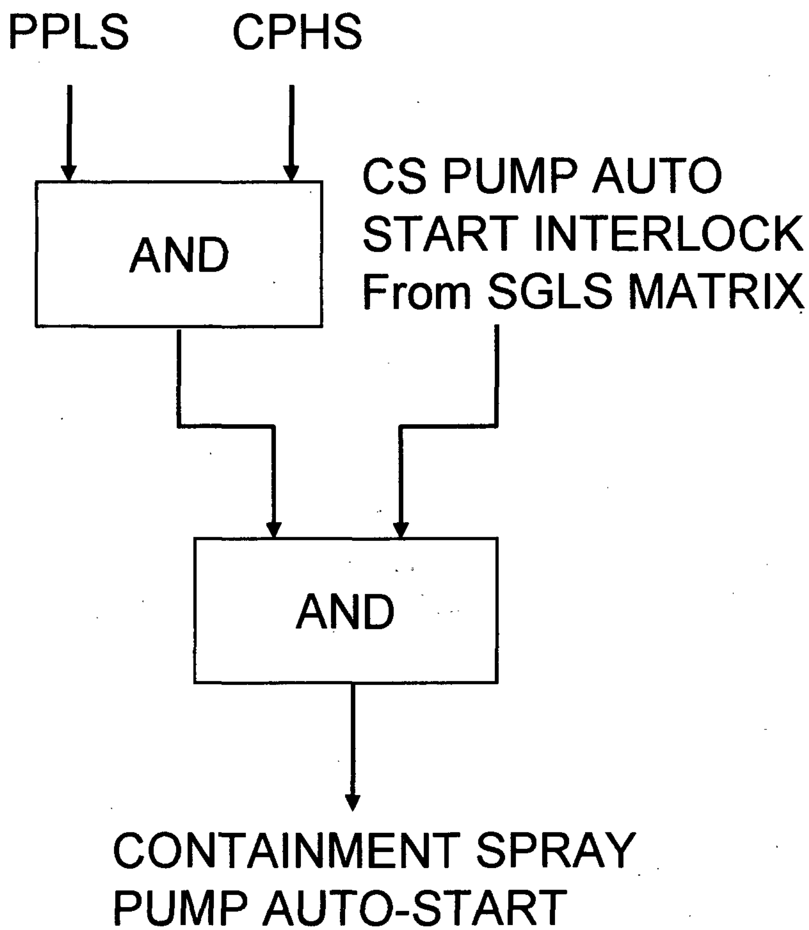
TYPICAL SG PRESSURE CHANNEL
(AFTER)



SIGNALS

PPLS - Pressurizer Pressure Low Signal
CPHS – Containment Pressure High Signal

CONTAINMENT SPRAY PUMP AUTO START (BEFORE)



SIGNALS

PPLS - Pressurizer Pressure Low Signal
CPHS – Containment Pressure High Signal
SGLS – Steam Generator Low Pressure Signal

CONTAINMENT SPRAY PUMP AUTO START (AFTER)