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August 30, 1988

U.S. Nuclear Regulatory Commission
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Gentlemen: ULNRC-1822

DOCKET NO. 50-483
CALLAWAY PLANT
STEAM GENERATOR LEVEL REACTOR TRIP MODIFICATION

Union Electric herewith transmits one original and one conformed copy of an application for amendment to Facility Operating License No. NPF-30 for the Callaway Plant.

The requested amendment affects the steam generator low-low level trip circuitry by adding an Environmental Allowance Modifier (EAM) and a Trip Time Delay (TTD). The EAM will distinguish between a normal and an adverse containment environment and will adjust the steam generator low-low level setpoint accordingly. The TTD will delay the trip signals during low power operations (less than or equal to 20% of rated thermal power, 3565 MWt, or 713 MWt). These changes have been developed by the Westinghouse Owners Group Trip Reduction Assessment Program as a means to reduce the frequency of unnecessary feedwater-related reactor trips. The EAM and TTD conceptual designs are documented in WCAP-11325-P-A and WCAP-11342-P-A, which were approved by NRC in January, 1988.

This submittal includes a Safety Evaluation (Attachment 1) which provides the basis for our conclusion that implementation of EAM and TTD is acceptable and that it does not involve an unreviewed safety question. Attachment 1 also provides the additional plant-specific information which the NRC requested in their SERs for WCAP-11325-P-A and WCAP-11342-P-A.

Attachment 2 describes the transient analysis performed and hardware changes associated with the implementation of EAM and TTD. This attachment contains information proprietary to Westinghouse Electric Corporation. As such, the following versions of Attachment 2 are enclosed:

1. WCAP-11883, Implementation of the Steam Generator Low Low Level Reactor Trip Time Delay and Environmental Allowance

WITH CHECK $150
#153873

CHANGE	LTR	ENCL
LPDR	1	1NP
NSIC	1	1NP
NRC PDR	1	1NP

A001
1/1

Modifier in the Callaway Plant, Westinghouse Proprietary Class 2, August 1988.

2. WCAP-11884, Implementation of the Steam Generator Low Low Level Reactor Trip Time Delay and Environmental Allowance Modifier in the Callaway Plant, Westinghouse Non-Proprietary Class 3, August 1988.

Also enclosed is a Westinghouse Application for Withholding, CAW-88-080, Proprietary Information Notice, and accompanying Affidavit AW-76-031.

As this submittal contains information proprietary to Westinghouse Electric Corporation, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph(b)(4) of Section 2.790 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations. Correspondence with respect to the proprietary aspects of the Application for Withholding or the supporting Westinghouse affidavit should reference CAW-88-080 and should be addressed to R. A. Wiesemann, Manager Regulatory and Legislative Affairs, Westinghouse Electric Corporation, P.O. Box 355, Pittsburgh, PA 15230.

Attachment 3 provides typical process control block diagrams, functional diagrams, and wiring diagrams. Attachments 4 and 5 provide the necessary Technical Specification changes and the Significant Hazards Evaluation in support of this amendment request. Attachment 6 contains the draft FSAR Chapter 7 changes, as requested by NRC in their SERs for WCAP-11325-P-A and WCAP-11342-P-A.

This request has been reviewed and approved by the Callaway Onsite Review Committee and the Nuclear Safety Review Board. It has been determined that this request does not involve any unreviewed safety questions as defined in 10CFR50.59 nor a significant hazard consideration as determined by the three factor test per 10CFR50.92.

Union Electric plans to implement these hardware changes during the Refuel 3 outage planned to begin in March, 1989. It is therefore requested that NRC approve the amendment by February 15, 1989 to allow adequate planning for the work to be performed during the refueling outage.

Enclosed is a check for the $150 application fee required by 10CFR170.21.

Very truly yours,

Donald F. Schnell

DS/GGY/jal

Attachments: 1-Safety Evaluation

2-WCAP-11883 (Proprietary Class 2)
WCAP-11884 (Non-proprietary Class 3)

3-Process Control Block Diagrams, Functional Diagrams, and Interconnecting Wiring Diagrams (for typical channel)

4-Technical Specification Changes

5-Significant Hazards Evaluation

6-Draft FSAR Chapter 7 changes

STATE OF MISSOURI)
) S S
CITY OF ST. LOUIS)

Donald F. Schnell, of lawful age, being first duly sworn upon oath says that he is Senior Vice President-Nuclear and an officer of Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Donald F. Schnell
Donald F. Schnell
Senior Vice President
Nuclear

SUBSCRIBED and sworn to before me this 29th day of August, 1988.

Barbara J. Pfaff
BARBARA J. PFAFF
NOTARY PUBLIC, STATE OF MISSOURI
MY COMMISSION EXPIRES APRIL 22, 1989
ST. LOUIS COUNTY

Attachment - 1
ULNRC-1822

SAFETY EVALUATION

STEAM GENERATOR LEVEL REACTOR TRIP MODIFICATION

I. Introduction

II. Hardware and Circuitry Description

III. Accident Analyses

  A. Trip Time Delay Analysis

  B. Environmental Allowance Modifier Analyses

  C. SG Level Reference Leg Heatup Uncertainty

  D. Setpoint Analysis

IV. SER Applicability

V. Conclusions

VI. References

I. Introduction

This Safety Evaluation supports the proposed implementation of the steam generator (SG) low-low level trip Environmental Allowance Modifier (EAM) and Trip Time Delay (TTD) at Callaway Plant. Implementation of the EAM/TTD modification will reduce the frequency of unnecessary feedwater-related trips.

The development of EAM/TTD is described in the NRC-approved topical reports WCAP-11325-P-A and WCAP-11342-P-A. The implementation of EAM/TTD at Callaway Plant will be in accordance with the requirements of the NRC-issued Safety Evaluation Reports (SERs) which approved the EAM/TTD topical reports.

Section II summarizes the hardware and circuitry modifications and protection system logic for EAM/TTD.

Section III summarizes the accident analyses and setpoint analysis which support EAM/TTD. The applicable design bases were evaluated or reanalyzed to support the SG low-low level Trip Time Delay. Containment analyses were performed to support the Environmental Allowance Modifier.

Section IV contains Callaway plant-specific responses to NRC questions specifically identified in the SERs which approved the implementation of EAM/TTD.

Section V provides concluding comments and a safety evaluation pursuant to 10CFR50.59.

II. Hardware and Circuitry Description

This section provides a brief discussion of the hardware to be used in the EAM/TTD design and the Callaway-specific changes to the basic design described in WCAP-11325-P-A and WCAP-11342-P-A. The hardware to be used in implementing the modification is Westinghouse 7300 series equipment as is currently used in Callaway's 7300 process protection cabinets. The following printed circuit cards will be used in implementing the EAM/TTD modification.

1. NCT - Channel Test Card
2. NMT - Master Test Card
3. NAL - Comparator Card (single, double, and dual comparator cards)
4. NAI - Annunciator Interface Card
5. NPL - PROM Logic Card

A detailed description of each type of card is provided in Attachment 2, Section 3.4. The reliability of 7300 series hardware has been demonstrated through field experience and the mean time between failure rates for the active cards in the EAM/TTD modification have been examined and no degradation of protection system reliability will occur. For a more detailed discussion of card reliability, see Section 3.4.2 of Attachment 2. All equipment to be used in implementing this modification was previously qualified under the Westinghouse 7300 Process Protection System equipment qualification program. Existing equipment that will interface with the new EAM/TTD hardware (i.e., containment pressure transmitters, steam generator level transmitters, RCS narrow range hot and cold leg bypass manifold RTDs, and interconnecting cable) were previously qualified under separate test programs in accordance with NUREG-0588 Category 1 requirements. A detailed discussion of the EQ program may be found in Section 3.5 of Attachment 2.

Figure 1 of Attachment 2 shows a functional diagram of the EAM/TTD modification. The following is a brief description of functional and implementation information for each part of the modification.

II.A.1 Environmental Allowance Modifier Functional Description

The EAM will distinguish between a normal or an adverse containment environment and enable a higher adverse environment steam generator low-low level trip setpoint when an adverse containment condition is sensed by elevated containment pressure. The adverse environment level setpoint will be higher due to the inclusion of instrument uncertainties related to the harsh environment. Otherwise, a lower setpoint will be used in conjunction with a normal environment. Consequently, the frequency of unnecessary steam generator low-low level trips will be decreased by increasing the operating margin, the distance between the nominal steam generator level and the normal environment low-low level trip setpoint.

II.A.2 EAM Implementation Description

The EAM will utilize an input signal from the existing containment pressure and steam generator level transmitters. A single comparator card will be added to each of the four existing containment pressure channels to enable the steam generator low-low level setpoint corresponding to an adverse environment. The EAM circuitry will have a latch-in feature that will ensure that this setpoint remains enabled once an adverse environment has been detected. In order to disable the adverse environment setpoint, containment pressure must decrease below its setpoint and the switch must be manually reset. In addition, the latch-in feature will be interlocked with the EAM comparator channel test switch as described in Section 3.1.2 of Attachment 2.

The existing steam generator low-low level comparator cards will operate with a setpoint corresponding to an adverse environment. Eight new steam generator level double comparator cards (two per protection set with each double comparator card handling two steam generators) will be added. These double comparator cards will operate with a setpoint associated with a normal environment.

II.B.1 Trip Time Delay Functional Description

The Trip Time Delay may be generally described as a system of pre-determined programmed trip delay times that are based upon the prevailing power level at the time a low-low level setpoint is reached. Section 3.2.1 of Attachment 2 refers to trip time delays based upon power level and upon the number of affected steam generators. However, the results of the Callaway-specific analyses were unaffected by the number of steam generators experiencing low level conditions. As such, the duration of trip time delays at Callaway Plant will be a function of power level only, as further discussed in Sections II.B.2 and III.A below. These delay times will be longer at low power versus high power. This correlates to the use of timers, each with a preset value, which are used to detain the actuation of the reactor trip, main feedwater isolation, and initiation of auxiliary feedwater so that steam generator level anomalies, such as shrink/swell transients, may naturally stabilize.

II.B.2 TTD Implementation Description

As shown in Figure 1 of Attachment 2, the input to the TTD circuitry is the EAM logic output and power level. In order to determine power level, the TTD will utilize the Delta-T signal from the Overtemperature and Overpower protection channels. The Delta-T signal will be processed by four new dual comparator cards (one per protection set). These dual comparator cards will enable the appropriate timer associated with the power level at the time a steam generator low-low level condition is detected.

As shown in Figure 1 of Attachment 2, once the TTD receives a low-low steam generator level signal from the EAM circuitry, all four timers will be started. The timer that determines the delay of the trip actuation signal will depend on the applicable logic fulfilled for each timer (an enabled condition). The effective time delay of the trip signal will be the shortest delay of all the enabled timers. Timer A will be the effective timer with the conditions of a low-low level signal in any one steam generator and the power level below the low power setpoint of 10% of rated thermal power. Timer B will be the effective timer with power levels between the low power (10%) and high power (20%) setpoints coincident with a low-low level signal in any one steam generator. Timer C will be the effective timer at power levels less than 10% with a low-low level signal in more than one steam generator. Finally, timer D will be the effective timer with low-low level signals in more than one steam generator coincident with the power level between 10% and 20% of rated thermal power. For power levels above the 20% power setpoint, all time delays will be bypassed, thus, the reactor trip signal will not be delayed by the EAM/TTD circuitry.

Timers, once enabled, will be latched in until all steam generator level signals in a protection set are restored to levels above the low-low level setpoint. Restoration of all steam generator levels to levels above the low-low level setpoint will terminate the timing, reset the timers to their predetermined values, and reset the trip logic signals.

In summary, timer B will be interlocked with the low power setpoint. Timer C will be interlocked with the two out of four steam generator low-low level logic and timer D will be interlocked with both the two out of four level signals as well as the low power setpoint. Moreover, above the 20% power setpoint there will be no EAM/TTD delay of the trip actuation signal.

The TTD circuitry described in WCAP-11325-P-A differs from the proposed Callaway design only in the location of the timers. At Callaway, these timers will be located in the 7300 Process Protection System cabinets rather than in the SSPS cabinets. This minor change simplifies field installation and reduces the overall impact on existing plant design.

II.C Alarms, Annunciators, Indicators, and Status Lights

Alarms, annunciators, indicators, and status lights are necessary to provide the operator with accurate, complete, and timely information pertinent to the protection system status. Status lights and control board indicators provide the operator with specific information with respect to which individual channels generated the alarm and/or trip condition. Presently, for the steam generator low-low level protection system, sixteen instrumentation channels (one per steam generator, per protection set) are provided. Each level channel is configured with a bistable trip status light which is illuminated on the control board anytime that an enabled bistable trip setpoint has been reached. An alarm and annunciator (one per steam generator) is provided to inform the operator that at least one level channel has dropped below its trip setpoint. If more than one level channel for any one steam generator has fallen below its trip setpoint, a "first out" reactor trip alarm and annunciator is provided to alert the operator that a reactor trip has occurred.

After the EAM/TTD modification has been installed, all of the alarms, annunciators, and status lights will continue to function as described. However, since these signals originate at the SSPS voting circuitry, they will not be actuated until all applicable time delays have expired.

Additional alarms and annunciators will be provided with the EAM/TTD hardware modification. These will inform the operator that an adverse environment and/or a low-low steam generator water level has been detected. A new low-low level alarm will be provided for each steam generator to signify that the water level in at least one channel has dropped below the low-low level setpoint in that steam generator. The operator may then observe the individual channel steam generator level indicators to determine appropriate actions. Finally, a common alarm and annunciator will be provided to indicate the presence of an adverse environment. The input to this window will be derived from the four containment pressure channels (one per protection set). The operator may then observe the individual channel containment pressure indicators to determine which channel(s) have the adverse steam generator low-low level setpoint enabled.

II.D Surveillance Testing

The EAM/TTD steam generator level channels will be periodically tested on a monthly basis consistent with the remainder of the 7300 Process Protection System. The level channels may be tested one-at-a-time to verify one-out-of-four operation, and with various combinations of two-at-a-time to verify two-out-of-four operation. The EAM and Delta-T comparators will also be tested at this time. After the normal environment comparators have been tested, periodic surveillance of the EAM/TTD steam generator level channel is complete. Section 3.6.2.2 of Attachment 2 describes surveillances to be performed on a refueling outage (18 month) interval.

III. Accident Analyses

Analyses were performed to establish Safety Analysis Limits (SALs) for the SG low-low level trip time delays, the normal and adverse containment condition trip setpoints, and for the EAM containment pressure setpoint. The analytical methodology employed is consistent with NRC-approved methodologies for implementation of the EAM/TTD modifications.

Instrument uncertainties and environmental allowances were calculated to account for instrumentation and measurement errors and the effect of postulated post-accident environmental conditions on SG low-low level trip and EAM containment pressure setpoints. The methodologies employed are consistent with methodologies previously accepted by the NRC.

III.A. Trip Time Delay Analyses

Analyses to determine SG low-low level trip setpoint and trip time delay SALs were performed consistent with the NRC-approved methodology of WCAP-11325-P-A, "Steam Generator Low Water Level Protection System Modifications to Reduce Feedwater-Related Trips." The analyses which support the implementation of the TTD modification are described in Attachment 2.

An evaluation of the impact of the SALs for trip time delays and trip setpoints on the safety analysis design bases was performed. Both LOCA and non-LOCA design bases were considered in the evaluation.

The following design basis transients assume the actuation of automatic protection features by means of the SG low-low level trip signal and were explicitly reanalyzed to determine the impact of power-dependent trip time delays and environment-dependent trip setpoints:

1. Loss of Nonemergency AC Power to the Station Auxiliaries (FSAR Section 15.2.6),
2. Loss of Normal Feedwater Flow (FSAR Section 15.2.7),
3. Feedwater System Pipe Break (FSAR Section 15.2.8),
4. Steamline Break Mass/Energy Releases for Equipment Environmental Qualification Outside Containment (WCAP-10961-P).

Sensitivity studies were performed to assess the effects of trip time delays at low power on the equipment surface temperatures listed in Table 3.4 of Reference 1. It was concluded that these equipment surface temperatures, as given in Table 3.4 of Reference 1, remain bounding and are unaffected by the proposed EAM/TTD modification.

Other design basis transients, which do not assume automatic protection by means of the SG low-low level trip signal, are unaffected by the SG low-low level trip time delays and trip setpoints.

The evaluations and analyses of the above design basis transients justify the implementation of the following SG low-low level trip time delay and trip setpoint SALs:

Trip Setpoint	0% narrow range span
Trip Time Delay	
- 10% nominal power, 2/4 SG logic	240 seconds
- 10% nominal power, 1/4 SG logic	240 seconds
- 20% nominal power, 2/4 SG logic	130 seconds
- 20% nominal power, 1/4 SG logic	130 seconds

III.B. Environmental Allowance Modifier Analyses

The NRC has previously approved the Westinghouse topical report WCAP-11342-P-A, "Modification of the Steam Generator Low-Low Level Trip Setpoint to Reduce Feedwater-Related Trips." This WCAP proposes a design modification which can reduce the inadvertent plant trips related to low steam generator level signals by installing an Environmental Allowance Modifier which distinguishes between normal (low temperature) and adverse (high temperature) containment environmental conditions and automatically selects a low or high setpoint for the low-low level trip corresponding to normal or adverse containment conditions. These setpoints reflect the exclusion/inclusion of instrumentation uncertainties related to harsh environmental conditions. By using the two different setpoints, more operational flexibility (and fewer spurious trips) is provided during normal conditions, while adequate protection is still provided during accident/adverse conditions.

WCAP-11342-P-A discusses the measurement of containment pressure, rather than containment temperature directly, and conservatively relates pressure to a corresponding containment temperature. This is done because containment pressure is easily and accurately measured and equalizes more rapidly throughout containment during a transient than temperature.

III.B.1 Containment Temperature Defining Adverse Environment

WCAP-11342-P-A specifies a minimum containment temperature which defines an adverse environment. This temperature corresponds to the normal temperature limit for Westinghouse supplied differential pressure (level) transmitters. The Callaway-specific analyses, however, use a transmitter surface temperature of 180°F, rather than the containment atmosphere temperature, to define an adverse containment environment. This approach is consistent with the methodology accepted by the NRC for safety-related component thermal lag analysis described in NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." Environmental allowance errors associated with the transmitters themselves were calculated at 230°F, yielding a 50°F margin between the temperature utilized in the containment analysis and the temperature assumed for instrument error calculations.

Environmental allowance errors associated with SG reference leg heatup are discussed in Section III.C below.

III.B.2 Minimum Feedline Break Size

Consistent with the methodology of WCAP-11342-P-A, minimum break size was determined below which steam generator level could be maintained by the feedwater system. Break flow rates for which the feedwater system can maintain an adequate steam generator water level do not require automatic protection by tripping the reactor on low-low SG level. Adequate heat removal is assured for small feedline breaks as long as the steam generator U-tubes remain covered.

The Callaway feedwater system is comprised of two 67%-capacity turbine-driven feedwater pumps and four feedwater control valves which are designed with a range of 0-120% nominal flow. An evaluation of design and operating data has determined that, for the Callaway Plant feedwater system, break mass flow rates below 225 lbm/sec for a single steam generator are within the capacity of the feedwater system to maintain water level in the affected steam generator. In addition, for such small break flow rates, plant operators would have ample time to detect a problem from a number of plant indications, e.g., containment pressure, containment temperature, SG steam/feedwater mismatch, containment sump level, etc.

III.B.3 Break Discharge Assumptions

As described in WCAP-11342-P-A, the limiting break discharge enthalpy for large dry containments was found to be 1205 BTU/lbm. This enthalpy corresponds to the greatest enthalpy of saturated water vapor physically possible. Use of this superheated break discharge for a specified break mass flow rate maximizes containment temperature while minimizing containment pressure.

In accordance with the WCAP methodology, the above break discharge enthalpy was used in the Callaway-specific containment analyses discussed in Section III.B.4. The important SG parameters identified by Westinghouse are SG type (feedring or preheat), maximum break size, the SG pressure, the SG temperature, and the feedwater temperature. With the exception of feedwater temperature, all Callaway-specific SG parameters are bounded by those assumed in the WCAP.

As previously stated in Reference 2, the maximum feedwater temperature at uprated conditions with no SG tube plugging is predicted to be 446°F. The maximum feedwater temperature assumed in the WCAP analyses is 445°F for the Carroll County 1 & 2 plants. Considering the conservatisms of the WCAP methodology and the Callaway-specific analyses, this 1°F deviation is judged to have a negligible impact on both the applicability of the WCAP methodology to the Callaway Plant at uprated conditions and on the validity of the results of the Callaway-specific analyses.

III.B.4 Callaway-Specific EAM Containment Analyses

Callaway-specific EAM containment analyses were performed to assure the implementation of conservative SALs at Callaway Plant because of slight differences in the containment heat sinks and purge system modelling between what was assumed in WCAP-11342-P-A and what applies to Callaway Plant. The Callaway-specific distribution of heat sink areas is greater than that assumed in the WCAP analyses. Also, the WCAP assumes an 8-inch purge valve equivalent diameter. The nominal diameter of the Callaway Plant mini-purge valves is 18 inches with a calculated equivalent diameter ranging from a minimum of 9.3 inches to a maximum of 10.4 inches.

The WCAP methodology utilizes a single containment analysis to determine both the containment pressure and containment temperature for a given break mass flow rate. Through this single containment analysis approach, the minimum containment pressure for a specified containment temperature was calculated. With the exception described in Section III.B.1 above, the Callaway-specific EAM containment analyses were performed consistent with the methodology of WCAP-11342-P-A with the additional conservative enhancements described below to further minimize the EAM containment pressure SAL.

In the Callaway-specific analysis, for each assumed break, dual containment pressure/temperature calculations were performed: 1) A "temperature maximizing" case to maximize containment temperature and, thereby, the SG level transmitter surface temperature and 2) A "pressure-minimizing" case to minimize containment pressure. Both cases used the NRC-approved computer code COPATTA which has been previously used to perform FSAR Chapter 6 analyses to conservatively predict the Callaway Plant containment pressure/temperature response following a LOCA or MSLB.

The EAM containment pressure SAL was determined by selecting the containment pressure from the pressure-minimizing case at the time at which the SG level transmitter surface temperature reaches 180°F from the temperature-maximizing case. If the containment pressure was determined to peak prior to the time the SG level transmitter surface temperature reached 180°F, the peak pressure would be used in the determination of the EAM containment pressure SAL. The temperature-maximizing case was used to determine a minimum time for the SG level transmitter surface temperature to reach 180°F. The pressure-minimizing case was then used to determine a lower bound on containment pressure which could occur up to the time the SG level transmitter surface temperature reaches 180°F. This method assures that the EAM containment pressure setpoint will be minimized which, in turn, assures that swap-over from the normal to adverse SG low-low level setpoint will occur prior to the SG level transmitter surface temperatures reaching 180°F.

By perturbing the WCAP single-case methodology in this manner, additional assurance is obtained that the containment pressure is minimized for a specified containment temperature. As discussed in Section III.B.5 below, a comparison of the generic results in the WCAP and the Callaway-specific results demonstrates that the Callaway-specific results conservatively underpredict the EAM containment pressure SAL relative to the generic WCAP results.

III.B.4.1 Assumptions Used to Maximize Temperature Increase

To calculate the shortest time to heat up the SG level transmitters, the overall containment temperature rise was maximized. The following assumptions were used in this analysis:

- The flow coefficient of the mini-purge system open exhaust duct was minimized (a value of 0.269 was used). This is consistent with the WCAP-11342-P-A methodology.

- No containment spray was modelled. Three containment air coolers were modelled using normal operating conditions (normal fan speed) with 95°F service water.

  A sensitivity study was performed to evaluate the effect of assuming no containment coolers on the results of the analysis. The results of the sensitivity study demonstrate that, for the limiting small break cases, modelling containment coolers has no effect on the calculated EAM containment pressure SAL. For these small break cases, the containment pressure reaches a peak long before the SG level transmitter surface temperature reaches 180°F. The exclusion of the effect of containment coolers results in a minor increase in SG level transmitter surface temperature; however, it does not affect the conclusion that the calculated EAM containment pressure SAL will assure swap-over to the adverse environment setpoint prior to the SG level transmitter surface temperature reaching 180°F.

- A minimum containment free volume of 2.5E6 ft3 was used.

- Outside atmospheric conditions were initially assumed to be 95°F, 14.4 psia, and 0% relative humidity.

- Conditions inside the containment were initially assumed to be 120°F, 14.4 psia, and 100% relative humidity.

- The fraction of condensate from all heat sinks that revaporizes was assumed to be 8%, the maximum allowed under NUREG-0588, Appendix B. This is consistent with the thermal lag methodology used for EQ calculations, as discussed in FSAR Section 3.11(B).1.2.2. This methodology was approved by NRC in Section 3.11.3.3.1 of Supplement 3 to the Callaway SER.

- The Uchida heat transfer coefficient was used for heat transfer to all passive heat sinks.

- To maximize heat transfer to the SG level transmitter housing, the larger of either a condensing or forced-convection heat transfer coefficient was used. The heat transfer coefficient for condensation was four times the Uchida coefficient as specified in NUREG-0588. The heat transfer coefficient for forced convection was determined internally by COPATTA.

- Minimum calculated areas for passive heat sinks were used to maximize temperature increase.

III.B.4.2 Assumptions Used to Minimize Pressure Increase

The following assumptions were used in this analysis:

- The flow coefficient of the mini-purge system open exhaust duct was maximized (a value of 0.332 was used).

- Four containment air coolers were modelled using normal operating conditions (normal fan speed) with 33°F service water. Containment spray was not modelled since at all times the containment pressure remains below the containment pressure HI-3 setpoint (27.0 psig) for actuation of containment spray.

- A maximum containment free volume of 2.7E6 ft3 was used.

- Initial atmospheric conditions outside the containment were assumed to be -60°F, 14.4 psia, and 0% relative humidity.

- Initial conditions inside containment were assumed to be 90°F, 14.4 psia, and 100% relative humidity.

- Consistent with the ECCS backpressure analysis contained in FSAR Section 6.2.1.5, no revaporization of condensate was considered.

- The maximum calculated passive heat sink surface areas were used. This included the containment floor.

  These areas were further multiplied by 1.2 to increase the heat transfer rate in accordance with Standard Review Plan Section 6.2.1.5.

III.B.5 Containment EAM Analysis Results

Figure III-1 depicts the containment pressure and SG level transmitter surface temperature response for the limiting 140 lbm/sec break. The 140 lbm/sec break is limiting since it is the smallest analyzed break for which the EAM circuitry would detect an adverse environmental condition, thereby providing the longest SG level setpoint swap-over time and the highest SG level transmitter surface temperature at the time of swap-over. This break is characterized as the smallest break for which a setpoint change (from normal to adverse) is needed and for which the SG level transmitters come the closest to exceeding their normal operation limit (180°F) prior to enabling the setpoint change. Recall that the containment pressure curve comes from the pressure-minimizing containment model and the transmitter surface temperature curve comes from the temperature-maximizing containment model. These models are described above in Section III.B.4. Determining the containment pressure and transmitter surface temperature in this manner assures that the containment pressure is minimized for a specified transmitter surface temperature.

From Figure III-1, the transmitter surface temperature reaches the 180°F limit at 539 sec. The containment pressure at 539 sec is approximately 18.2 psia (3.5 psig). However, containment pressure is 18.5 psia (3.8 psig) at 410 sec. Since the containment model for the containment pressure calculation was selected to minimize the pressure within containment, this peak pressure defines the EAM safety analysis limit. The SG level transmitter surface temperature at 410 sec is approximately 175°F.

Figure III-2 depicts the results of the containment pressure/temperature calculations for break mass flow rates of 100 lbm/sec, 140 lbm/sec and 200 lbm/sec. Specifically, Figure III-2 depicts the maximum containment pressure, up to the time that the SG level transmitter surface temperature reaches 180°F, versus break mass flow rate. It should be noted that for the 100 lbm/sec and 140 lbm/sec breaks, the pressure peaks before the SG level transmitter surface temperature reaches 180°F. For these cases, Figure III-2 depicts the peak pressure. Also depicted in Figure III-2 are two points taken from WCAP-11342-P-A. These two points represent the containment pressure at the time containment temperature reaches 180°F for a 4-loop plant with a large dry containment. The point at 140 lbm/sec is extrapolated from the WCAP results. The Callaway-specific results are seen to conservatively underpredict the containment pressure relative to the generic results of the WCAP.

The calculated EAM containment pressure SAL was calculated to be 18.5 psia (3.8 psig) for the limiting break mass flow rate of 140 lbm/sec. This limiting mass flow rate of 140 lbm/sec is well below the 225 lbm/sec limit on feedwater system capacity to maintain SG level.

III.C. SG Level Reference Leg Heatup Uncertainty

Environmental allowance errors associated with SG reference leg heatup were calculated using a methodology consistent with that utilized previously to calculate the environmental allowance due to SG reference leg heatup in an adverse containment environment (Reference 3).

The following assumptions were made in calculating the reference leg temperature due to heatup following a main feedline break. These assumptions were made to assure that the calculated reference leg temperature overpredicts the reference leg temperature which would actually follow a main feedline break. The temperature-maximizing COPATTA containment model detailed above was used with the exceptions described below:

- Conservative break discharge conditions were assumed to maximize the mass and energy transferred to the containment. The EAM containment analyses described above in Section III.B assumed constant break discharge conditions (mass flow rate and enthalpy). For the Callaway-specific SG level reference leg heatup calculations, a double-ended guillotine (DEG) break was modelled. Conservative initial conditions (SG pressure and level), break discharge flow areas, and break discharge quality were assumed in order to maximize the mass and energy transferred to the containment. The Moody model was used to calculate critical flow rates from the break.

  For break sizes greater than or equal to 200 lbm/sec, the break discharge mass flow rate and enthalpy are time-dependent and account for the depressurization of the SG during the blowdown. The contribution of feedwater from the upstream side of the break was minimized. Although the 200 lbm/sec break discharge is less than the 225 lbm/sec limit on feedwater system capacity to maintain SG level (as described above in Section III.B.2), the assumption of a time-dependent break discharge results in a higher SG level reference leg temperature than would be the case if a constant break discharge were assumed (as assumed for break sizes less than 200 lbm/sec). This higher temperature is due to the time-dependent break enthalpy, approaching 1190 Btu/lbm for saturated vapor, being much greater than the constant break enthalpy corresponding to a mixture of saturated steam and cold feedwater (593 Btu/lbm).

  For break sizes below 200 lbm/sec, the break was modelled as a DEG break with a break area less than the large break area. Modelling the break enthalpy for small breaks in this manner is conservative with respect to maximizing mass and energy transfer to containment since the break enthalpy, for small feedline breaks, would actually be equal to the enthalpy of cold feedwater. The break discharge mass flow rate and enthalpy are constant since the steam generator conditions do not change for break mass flow rates less than 225 lbm/sec.

- The reference leg is an uninsulated 3/8" stainless steel tube containing water. One-dimensional heat transfer in cylindrical coordinates was modelled.

- No resistance to heat transfer between the inner wall of the reference leg tube and the water was assumed.

- Four times the Uchida heat transfer coefficient was used for condensing heat transfer on the outer surface of the reference leg.

- No containment coolers or spray were modelled.

- Consistent with the WCAP methodology, 50°F was added to the calculated SG reference leg temperature as margin to account for temperature gradients inside the containment.

- The geometric parameters which affect SG reference leg temperature were based on as-built dimensions.

- The containment mini-purge system exhaust duct was assumed to be closed.

- The reference leg calibration conditions were assumed to be 90°F containment temperature and 1000 psia SG pressure.

- Steam generator level reference leg water temperature was assumed equal to the inside wall temperature.

Table III-1 lists the calculated SG level reference leg temperature at the time the containment pressure reaches the FAM containment pressure SAL (18.5 psia, 3.8 psig) versus break size. The limiting SG level reference leg temperature was found to be 165°F plus 50°F margin or 215°F. This value represents the maximum impact of the competing effects of large mass and energy transfer rates for large breaks and long heatup times following small breaks. The environmental allowance in the SG low-low level trip setpoint due to SG reference leg heatup to 215°F is 5.8% of span. This may be compared to the current adverse environment SG level reference leg heatup uncertainty of 9% of span corresponding to a temperature of 265°F reported to the NRC in Reference 3.

III.D. Setpoint Analysis

The nominal SG low-low level trip time delays, trip setpoints, and EAM containment pressure setpoint are determined by adjusting the corresponding SALs for instrument and measurement uncertainties.

Instrument loop uncertainty calculations were performed to confirm the necessary Technical Specification and Safety Analysis values. A detailed description of the calculations may be found in Section 4.0 of Attachment 2. The methodology used is essentially the same as that used in previous setpoint analyses for Callaway Plant. Some minor differences can be noted in the treatment of RTD and R/E uncertainties which reflect the latest methods for use of Delta-T instead of Tavg.

The use of TTD requires that two sets of Vessel Delta-T and Time Delay setpoints be noted in the Technical Specifications; one set (Power-1) for Vessel Delta-T less than or equal to the equivalent of 10% RTP and one set (Power-2) for Vessel Delta-T less than or equal to the equivalent of 20% RTP. The inclusion of the EAM results in two trip setpoints for SG Water Level - Low-Low; one for a maximum containment ambient temperature of 230°F (Normal) and one that reflects a maximum containment temperature of 320°F (Adverse). The environmental allowance in the SG low-low water level setpoint resulting from SG level reference leg heatup was calculated at a temperature of 215°F for Normal conditions and at 265°F for Adverse conditions as described above in Section III.C.

The results of the setpoint analysis are summarized in Table III-2.

TABLE III-1

SG LEVEL REFERENCE LEG TEMPERATURE AT EAM CONTAINMENT PRESSURE SAFETY ANALYSIS LIMIT

Break Size	Reference Leg Temperature (°F) (+0°F/+50°F)
DEG* (0.89 ft^2)	130/180
¼DEG (0.22 ft^2)	146/196
200 lbm/sec (0.080 ft^2)	165/215
140 lbm/sec	145/195

*DEG - Double-Ended Guillotine

TABLE III-2

CALLAWAY PLANT EAM/TTD SETPOINT ANALYSIS

Protection Channel	Safety Analysis Limit	Nominal Trip Setpoint
SG Water Level - Low-Low (Normal)	0.0% NR span	14.8% NR span
SG Water Level - Low-Low (Adverse)	0.0% NR span	20.2% NR span
Vessel Delta-T - Power-1	19.0% RTP	10.0% RTP
Vessel Delta-T - Power-2	29.0% RTP	20.0% RTP
Trip Time Delay - Power-1	240 sec	232 sec
Trip Time Delay - Power-2	130 sec	122 sec
Containment Pressure - EAM	3.8 psig	1.5 psig

Figure III-1 (Sheet 1 of 2)

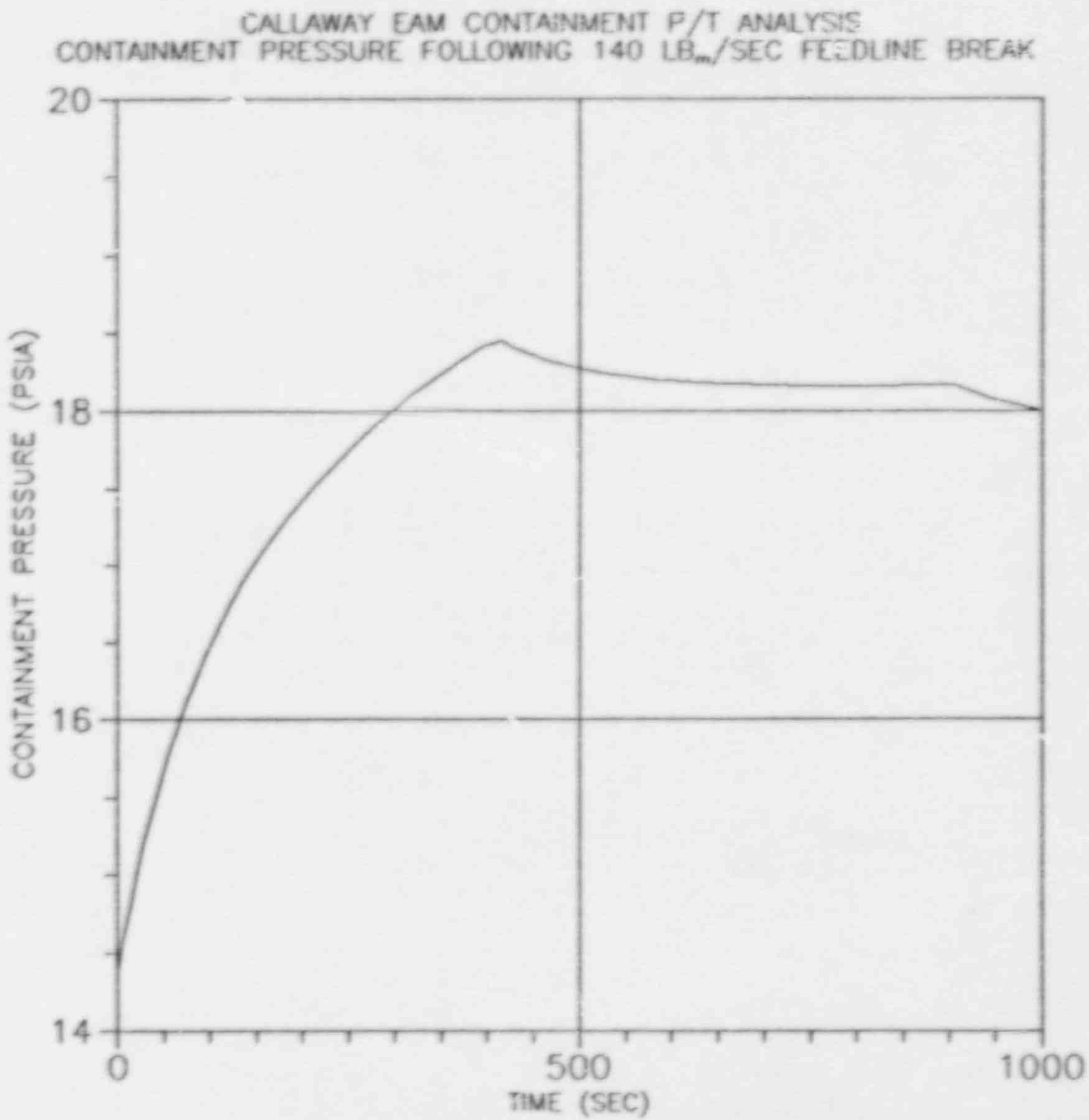


Figure III-1 (Sheet 2 of 2)

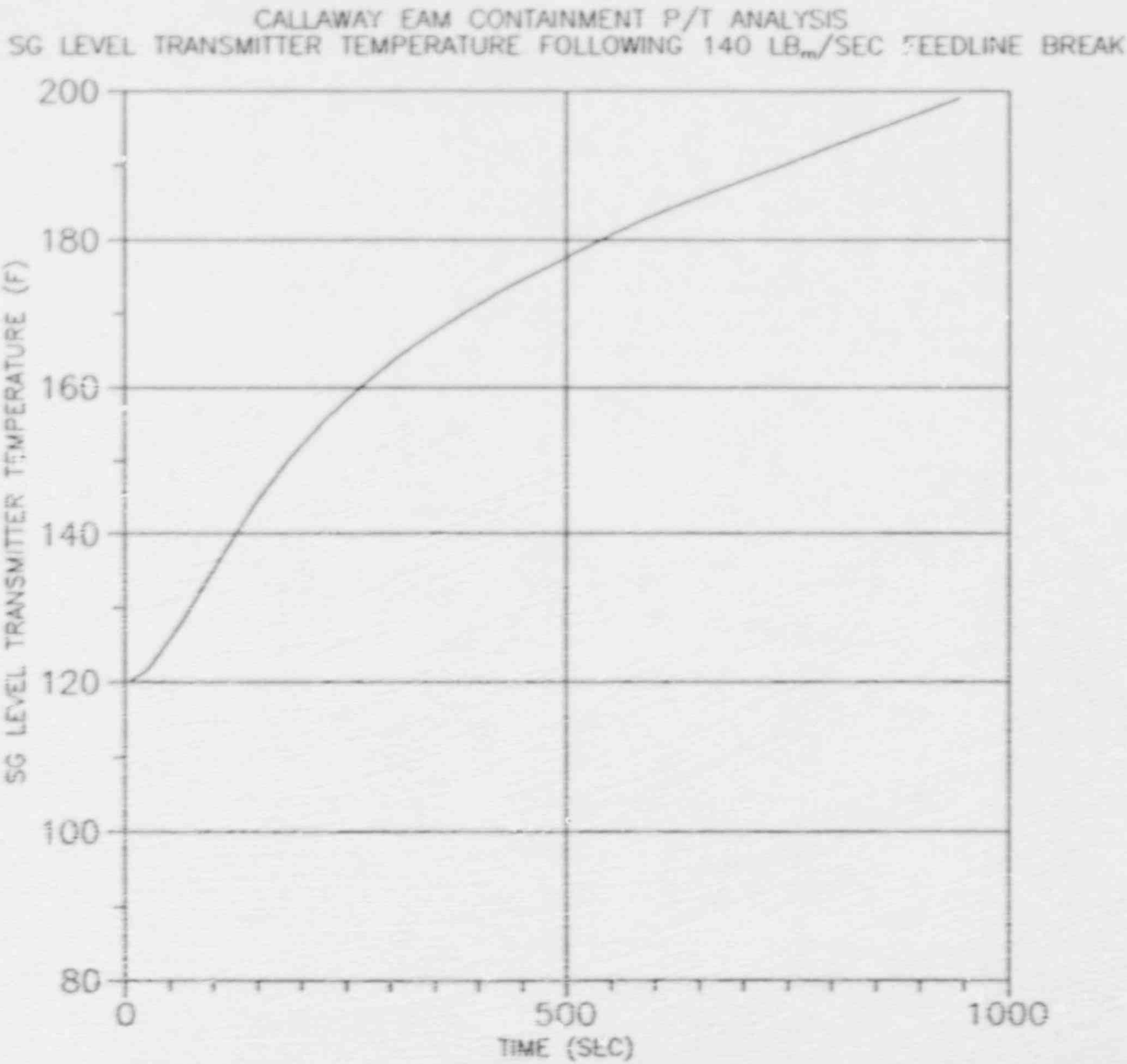
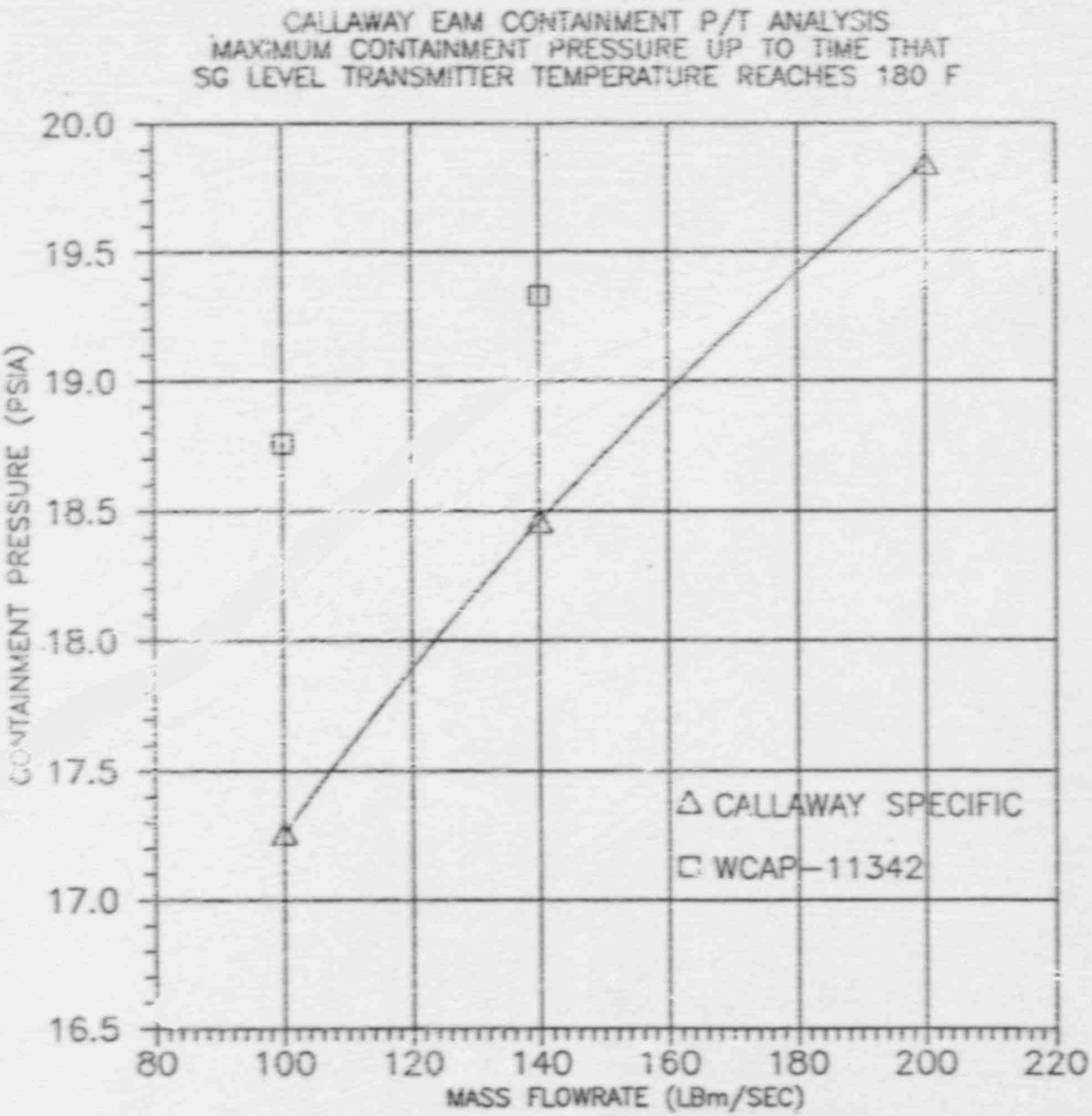


Figure III-2



CALLAWAY EAM CONTAINMENT P/T ANALYSIS
MAXIMUM CONTAINMENT PRESSURE UP TO TIME THAT
SG LEVEL TRANSMITTER TEMPERATURE REACHES 180 F
CONTAINMENT PRESSURE (PSIA)
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
80
100
120
140
160
180
200
220
MASS FLOWRATE (LBm/SEC)
△ CALLAWAY SPECIFIC
□ WCAP-11342

IV. SER Applicability

This section is provided in order to address the items the NRC specifically identified in the SERs on WCAP-11325-P-A and WCAP-11342-P-A. The SER items will be addressed either directly or by reference to the section of this report which provides the required response. This section will be presented in a format which introduces each SER discussion topic followed by our response.

Trip Time Delay SER (WCAP-11325-P-A)

(1) Plant-specific protection system logic diagrams accompanied by proposed revisions to Chapter 7 of the FSAR including compliance statements with the applicable, plant-specific safety criteria (General Design Criteria, Regulatory Guides, IEEE STD 279, etc.) covering the design modification.

Plant-specific logic diagrams are provided in Attachment 3. Proposed FSAR Chapter 7 revisions are provided in Attachment 6. Since the EAM/TTD hardware will be installed in the 7300 process protection cabinets, all applicable codes and standards discussed in Chapter 7 will remain valid. For additional discussion, see Section 3.7 of Attachment 2.

(2) Proposed changes to the plant-specific Technical Specifications with an accompanying Significant Hazards Evaluation, covering any new response time values for reactor trip and auxiliary feedwater actuation on a low-low steam generator water level signal, the adjustment for the time delays (setpoint and allowable value accounting for calibration accuracy, drift, etc.) as part of the operability/surveillance requirements of the automatic actuation logic and new setpoint and allowable values for the P-8 and/or other interlocks utilized.

The proposed Technical Specification changes, including trip time delays and operability/surveillance requirements are included in Attachment 4 with the Significant Hazards Evaluation covering EAM/TTD given in Attachment 5. The interlock setpoint and allowable values are part of the Technical Specification changes and are discussed in more detail in Section III.D of this Safety Evaluation and in Section 4.0 of Attachment 2.

(3) Detailed electrical schematics covering the design modification with a discussion of the proposed periodic testing to be performed on the modified hardware installed.

The marked-up electrical schematics are provided in Attachment 3. Surveillance testing is discussed in Section 3.6 of Attachment 2.

(4) Discussion of the environmental qualification of equipment (sensors, timers, etc.) related to the design modification.

Environmental qualification of the equipment to be used is addressed in Section 3.5 of Attachment 2.

(5) Discussion of the total instrumentation uncertainties (calibration, drift, etc.) for the plant-specific power interlocks utilized and their impact upon the selection of the corresponding time delays.

The setpoint study performed to support this modification may be found in Attachment 2, Section 4.0.

(6) Plant-specific changes to the operator procedures resulting from delay of reactor trip and auxiliary feedwater initiation.

No normal operating procedure changes are required to support the Trip Time Delay modification. The TTD is not intended to modify the operators' actions but simply to provide more response time in which to take the actions currently outlined to restore Steam Generator level.

(7) Plant-specific human factors analyses for any additional displays in the control room.

The only additions to the control room will be annunciators; these will be added consistent with the human factors philosophy established during the SNUPPS Detailed Control Room Design Review.

Environmental Allowance Modifier SER (WCAP-11342-P-A)

(1) Plant-specific protection system logic diagrams accompanied by proposed revisions to Chapter 7 of the FSAR including compliance statements with the applicable, existing plant-specific safety criteria (GDC's, RG's, IEEE STD 279, etc.) covering the plant design modifications.

Plant-specific logic diagrams are provided in Attachment 3. Proposed FSAR Chapter 7 revisions are provided in Attachment 6. Since the EAM/TTD hardware will be installed in the 7300 process protection cabinets, all applicable codes and standards discussed in Chapter 7 remain valid. For additional discussion, see Section 3.7 of Attachment 2.

(2) Proposed changes to the plant-specific Technical Specifications with accompanying Significant Hazards Evaluation covering the EAM installation. This shall include new setpoints and allowable values for the

steam generator low-low level trip and the new containment pressure bistables as part of their operability/surveillance requirements for the EAM circuitry. Also, a discussion of the applicability of the WCAP methodology should be provided including a determination of the pressure setpoint.

The proposed Technical Specification changes, including new setpoints and allowable values, are found in Attachment 4 with the Significant Hazards Evaluation covering EAM/TTD given in Attachment 5. The pressure setpoint was determined by the plant-specific containment analysis presented in Section III of this attachment and the setpoint methodology presented in Section 4.0 of Attachment 2. A discussion of the applicability of the WCAP-11342-P-A methodology is included in Section 2.0 of Attachment 2.

(3) Proposed changes to the plant-specific Technical Specifications with accompanying Significant Hazards Evaluation covering any changes related to operation of containment systems, if required, to ensure acceptability of the EAM installation.

The containment pressure/temperature analysis was performed assuming the mini-purge valves were open, therefore no Technical Specification changes concerning containment operations are required.

(4) Plant-specific changes to the operator procedures to cover the use of the EAM reset controls.

Plant procedures (I&C and annunciator response) will be changed prior to operation with this modification installed. The procedure changes will require a review of plant conditions causing the EAM activation to ensure adverse temperature conditions were not observed prior to reset. Surveillance testing will not require a review prior to reset.

(5) Detailed electrical schematics covering the design modification.

These drawings are provided in Attachment 3.

(6) Plant-specific human factor analyses for any hardware modification to the control room.

The only additions to the control room for this modification will be annunciators. Human factors will be considered in their inclusion, consistent with the philosophy established in the SNUPPS Detailed Control Room Design Review.

(7) The EAM conceptual design provides for testing of the associated instrument channels in the bypass mode. Since the licensing basis for a typical Westinghouse plant provides for testing with the channel under test in the trip mode, a discussion of the acceptability for testing in bypass (reference to an applicable, approved WCAP such as WCAP-10271 is acceptable) should be provided.

Testing will be performed as discussed in Section 3.6 of Attachment 2.

V. <u>Conclusions</u>

This safety evaluation and supporting documentation demonstrate that the implementation of the Environmental Allowance Modifier and Trip Time Delay modification at Callaway Plant will not reduce any safety margins and does not involve an unreviewed safety question as defined by 10CFR50.59. Callaway Plant remains in compliance with applicable criteria and safety limits and will be operated safely and reliably provided the plant is operated in accordance with the proposed Technical Specification changes. The evaluation has verified the following:

1. The probability of an accident previously evaluated in the FSAR will not be increased.

2. The consequences of an accident previously evaluated in the FSAR will not be increased.

3. The possibility of an accident which is different than any already evaluated in the FSAR will not be created.

4. The probability of a malfunction of equipment important to safety previously evaluated in the FSAR will not be increased.

5. The consequences of a malfunction of equipment important to safety previously evaluated in the FSAR will not be increased.

6. The possibility of a malfunction different from any already evaluated in the FSAR of equipment important to safety will not be created.

7. The margin of safety as defined in the bases to any Technical Specification will not be reduced.

VI. References

1. ULNRC-1473 dated 3/24/87

2. ULNRC-1471 dated 3/31/87

3. SLNRC 81-115 dated 10/2/81

WCAP-11883 (Proprietary Class 2)
WCAP-11884 (Non-proprietary Class 3)

Attachment -2
ULNRC-1822

IMPLEMENTATION OF THE STEAM GENERATOR LOW LOW LEVEL REACTOR TRIP TIME DELAY AND ENVIRONMENTAL ALLOWANCE MODIFIER IN THE CALLAWAY PLANT

STEAM GENERATOR LEVEL REACTOR TRIP MODIFICATION

- Westinghouse Application for Withholding Proprietary Information from Public Disclosure
- Proprietary Information Notice
- Affidavit AW-76-31
- WCAP-11883 (Proprietary) and WCAP-11884 (Non-proprietary)