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June 29, 2000

2CAN060014

U. S. Nuclear Regulatory Commission
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Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Supplement to Proposed Technical Specification Change Request Supporting the ANO-2 Containment Building Design Pressure Increase to 59 Psig

Gentlemen:

In a letter dated November 3, 1999 (2CAN119903), Entergy Operations, Inc. submitted a license amendment request regarding uprating the Arkansas Nuclear One, Unit 2 (ANO-2) containment building design pressure from 54 to 59 psig. Subsequent to the submittal, corrections were made to two key input assumptions used in the computer code to perform the containment analysis. A correction was made regarding the surface area assumed for an existing containment heat sink. A second correction was made regarding the time required to fill the containment spray headers, and thus the containment spray system response time. The discrepancies in the input data were discovered during reviews conducted for the replacement steam generator project. Both of these issues were traced to the original Bechtel licensing calculations performed in the early 1970's and have been addressed under the corrective action program. To offset the effects of these corrections, other input and methodology assumptions have been modified and the technical specification allowed initial containment pressure has been reduced. The net result of these changes is a slight reduction in the peak pressures and temperatures reported in the November 3, 1999, submittal.

This submittal revises two technical specification (TS) pages and several Safety Analysis Report pages submitted in the November 3, 1999, letter. For completeness, all TS pages associated with the November 3, 1999, submittal, as revised by this letter, have been included in Enclosure 1. The change required as a result of the revised input assumptions is discussed in the attachment. The attachment also addresses the withdrawal of a proposed revision to TS 6.15, "Containment Leakage Rate Testing Program." This item was discussed during a telephone conference call between the NRC and ANO-2 staffs on June 27, 2000. The

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discussions associated with the remainder of the proposed TS changes are contained in the November 3, 1999, letter. Corrected SAR pages are included in Enclosure 2.

The proposed changes have been evaluated in accordance with 10CFR50.91(a)(1) using criteria in 10CFR50.92(c) and it has been determined that the no significant hazards considerations contained in our November 3, 1999, submittal remain bounding.

Should you have any questions or comments, please contact me.

Very truly yours,

CGA/dwb
Attachment/enclosures

To the best of my knowledge and belief, the statements contained in this submittal are true.

SUBSCRIBED AND SWORN TO before me, a Notary Public in and for Pope **County and the State of Arkansas, this** 29 **day of** June **, 2000.**

Notary Public
My Commission Expires 12/15/2007

"OFFICIAL SEAL"
Andrea Pierce
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ATTACHMENT

TO

2CAN060014

PROPOSED TECHNICAL SPECIFICATION

AND

RESPECTIVE SAFETY ANALYSES

IN THE MATTER OF AMENDING

LICENSE NO. NPF-6

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

DOCKET NO. 50-368

DESCRIPTION OF PROPOSED CHANGES

The proposed changes to the Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specifications (TSs) included in our November 3, 1999, submittal are as follows:

- Technical Specification Figure 3.6-1, "Containment Internal Pressure Vs. Average Air Temperature." The region of acceptable operation has been reduced. The containment maximum pressure has been set at a uniform value of 15.5 psia.

- Technical Specification 6.15, "Containment Leakage Rate Testing Program." The phrase in the third paragraph, "which is equivalent to 0.1% of containment volume per day," proposed for addition has been withdrawn.

All TS pages associated with the November 3, 1999 submittal as revised by this letter, have been attached for completeness as Enclosure 1. Only the changes proposed by this letter are discussed below. The discussions supporting the remainder of the proposed TS changes, presented in the November 3, 1999 submittal, are not repeated in this letter.

DISCUSSION OF CHANGES

The loss of coolant accident (LOCA) and main steam line break (MSLB) containment design basis accident analyses have been revised to correct two input assumptions for the COPATTA computer code used to perform the containment analysis. A correction was made regarding the surface area assumed for an existing containment heat sink. A second correction was made regarding the time required to fill the containment spray headers, and thus the containment spray system response time.

By themselves, these changes in assumptions would have increased the calculated peak pressures and temperatures. Other input assumptions have been modified to offset the effects of these corrections. Additional containment heat sinks have been documented and incorporated in the analyses. Also, the technical specification limits on pressure in Figure 3.6-1 have been reduced to correspond with the assumptions in the containment analysis, i.e., the area of maximum initial containment pressure has been reduced. There was no change in the minimum allowable containment pressures.

The net result of these changes is a slight reduction in the peak containment pressures reported in the November 3, 1999, submittal (from 57.7 to 57.6 psig). The peak accident pressure, P_a, remains rounded to 58 psig. The previously reported containment analysis results are discussed in Section G of Enclosure 3, and the proposed changes to SAR Sections 6.2.1.1.3.1.2.2 and 6.2.1.1.3.2.2.2, and SAR Tables 6.2-8G, 6.2-8J and 6.2-9C of the November 3, 1999, submittal.

The revised analyses have one other methodology assumption change which has no impact on peak pressure calculations, but provides more realistic peak temperature results. In the process of revising the analyses, the peak temperatures in the LOCA analyses were re-

evaluated. The peak temperatures previously reported (typically in excess of 290°F) were the result of superheat conditions predicted by the COPATTA computer code for the brief period just before the start of containment spray. A significant contributing factor to the prediction of superheat is the very conservative treatment, by COPATTA, of the condensed steam cooled by the containment heat sinks. As it has been configured in the ANO-2 analyses, all condensate was assumed to be instantaneously deposited in the sump. The relatively cool condensate was assumed to absorb no additional heat from the superheated steam in the containment atmosphere.

As described in Section 1.b of Appendix B to NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," December 1979, a maximum of 8% of the condensate formed on heat sinks may be assumed to remain in the vapor region (i.e., be revaporized) rather than be transferred directly to the sump during periods of superheat conditions. The COPATTA code supports the use of this assumption. Consequently, the revised containment analyses for both LOCA and MSLB events have included an assumption of 8% revaporization.

For the LOCA analyses, with the assumption of revaporization, the superheat conditions prior to the start of spray were reduced sufficiently such that the peak event temperature shifted to the saturation temperature at the time of the peak pressure. Similar temperature reductions during the superheat period prior to spray activation were predicted for each LOCA case analyzed; consequently, the peak temperature for all LOCA events is 285°F. For the MSLB analyses with the assumption of revaporization similar reductions in temperature during the superheat period were obtained.

Comparisons of analysis results with and without the revaporization assumption show that peak pressures are unaffected by the assumption. Peak pressures for the more limiting cases of both the LOCA and MSLB analyses occur after spray has initiated and the containment atmosphere is effectively at saturated conditions. Since the revaporization assumption affects only limited portions of the analyses, and does not affect peak pressure results, the revaporization assumption was uniformly applied to all of the containment analyses.

The revised analyses affect the proposed changes to the SAR pages included in the November 3, 1999 submittal. Attached, as Enclosure 2, are the corrected SAR pages affected by the changes to input assumptions, methodology descriptions, and analysis results.

Technical Specification 6.15, "Containment Leakage Rate Testing Program," is revised based on a June 27, 2000, telephone conference call involving members of the NRC and ANO-2 staffs. The proposed phrase in the third paragraph, "which is equivalent to 0.1% of containment volume per day," has been withdrawn. The TS page has been revised accordingly and is included in Enclosure 1. The shaded text on the marked up page will be deleted.

ENCLOSURE 1

PROPOSED TECHNICAL SPECIFICATION CHANGES

TABLE 3.3-3

ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION

FUNCTIONAL UNIT	TOTAL NO. OF CHANNELS	CHANNELS TO TRIP	MINIMUM CHANNELS OPERABLE	APPLICABLE MODES	ACTION
1. SAFETY INJECTION (SIAS)					
a. Manual (Trip Buttons)	2 sets of 2	1 set of 2	2 sets of 2	1, 2, 3, 4	9
b. Containment Pressure - High	4	2	3	1, 2, 3	10,11
c. Pressurizer Pressure - Low	4	2	3	1, 2, 3(a)	10,11
d. ESFAS Logic					
1. Matrix Logic	6	1	3	1, 2, 3	12
2. Initiation Logic	4	2	4	1, 2, 3, 4	9
e. Automatic Actuation Logic	2	1	2	1, 2, 3, 4	13
2. CONTAINMENT SPRAY, MAIN STEAM, AND MAIN FEEDWATER ISOLATION (CSAS)					
a. Manual (Trip Buttons)	2 sets of 2	1 set of 2	2 sets of 2	1, 2, 3, 4	9
b. Containment Pressure -- High - High	4	2(b)	3	1, 2, 3	10,11
c. ESFAS Logic					
1. Matrix Logic	6	1	3	1, 2, 3	12
2. Initiation Logic	4	2	4	1, 2, 3, 4	9
d. Automatic Actuation Logic	2	1	2	1, 2, 3, 4	13

INTERNAL PRESSURE AND AIR TEMPERATURE

LIMITING CONDITION FOR OPERATION

3.6.1.4 The combination of containment internal pressure and average air temperature shall be maintained within the region of acceptable operation shown on Figure 3.6-1.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

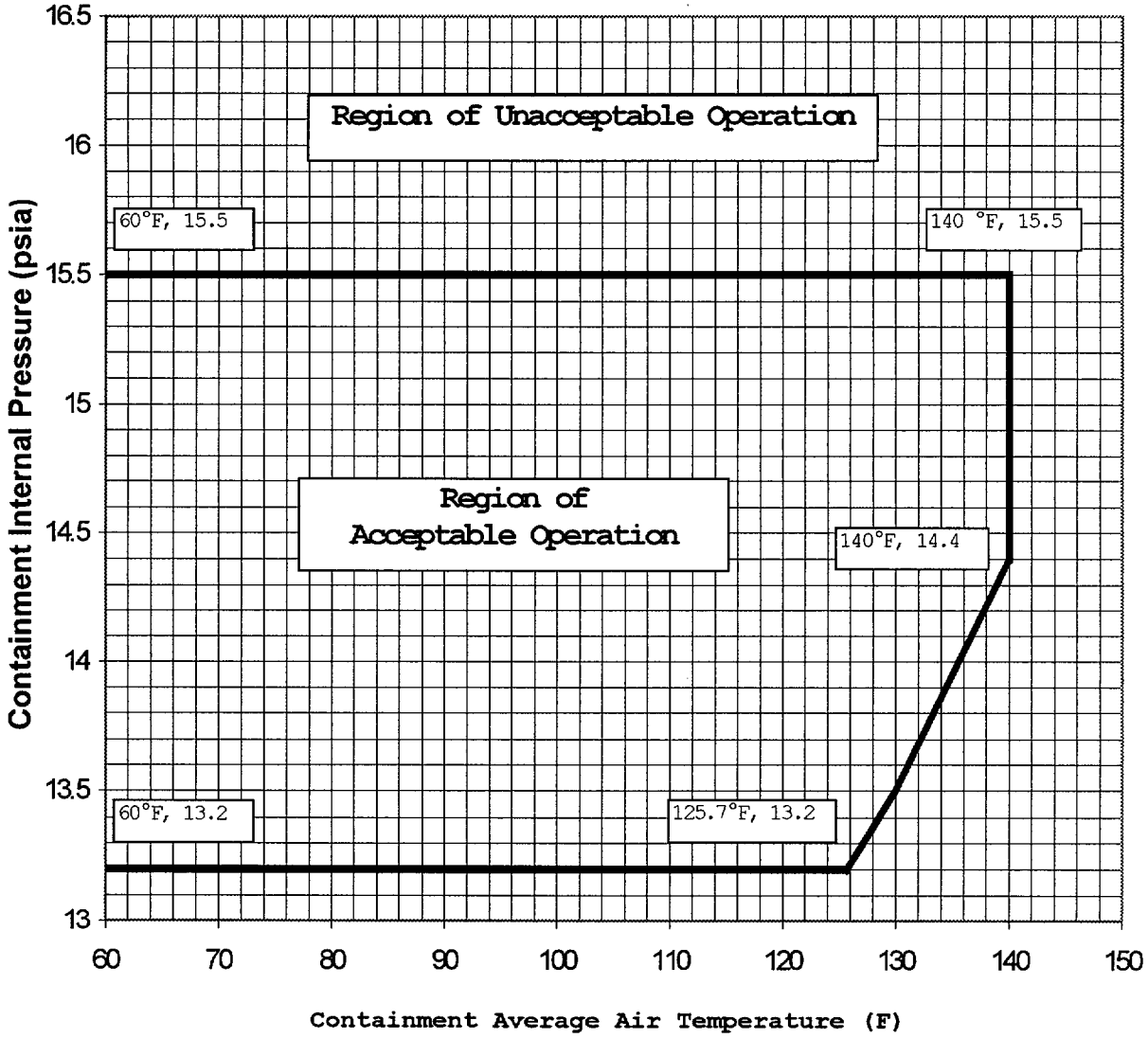
With the point defined by the combination of containment internal pressure and average air temperature outside the region of acceptable operation shown on Figure 3.6-1, restore the combination of containment internal pressure and average air temperature to within the above limits within 1 hour or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.1.4 The primary containment internal pressure and average air temperature shall be determined to be within the limits at least once per 12 hours. The containment average air temperature shall be the temperature of the air in the containment HVAC common return air duct upstream of the fan/cooler units.

FIGURE 3.6-1

CONTAINMENT INTERNAL PRESSURE VS. AVERAGE AIR TEMPERATURE



NOTE: Instrument Error is not Included on Curve

3/4.6.2 DEPRESSURIZATION, COOLING, AND pH CONTROL SYSTEMS

CONTAINMENT SPRAY SYSTEM

LIMITING CONDITION FOR OPERATION

3.6.2.1 Two independent containment spray systems shall be OPERABLE with each spray system capable of taking suction from the RWT on a Containment Spray Actuation Signal (CSAS) and automatically transferring suction to the containment sump on a Recirculation Actuation Signal (RAS). Each spray system flow path from the containment sump shall be via an OPERABLE shutdown cooling heat exchanger.

APPLICABILITY: MODES 1, 2, and 3.

ACTION:

With one containment spray system inoperable, restore the inoperable spray system to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.6.2.1 Each containment spray system shall be demonstrated OPERABLE:

a. At least once per 31 days by:

   1. Verifying that each valve (manual, power operated or automatic) in the flow path is positioned to take suction from the RWT on a Containment Pressure-High-High test signal.

   2. Verifying that the system piping is full of water from the RWT to at least elevation 505'(equivalent to > 12.5% indicated narrow range level) in the risers within the containment.

b. By verifying that each pump demonstrates degradation of ≤ 10% from its original acceptance test pump performance curve when tested pursuant to Specification 4.0.5.

6.15 CONTAINMENT LEAKAGE RATE TESTING PROGRAM

A program shall be established to implement the leakage rate testing of the containment as required by 10 CFR 50.54(o) and 10 CFR 50, Appendix J, Option B, as modified by approved exemptions. This program shall be in accordance with the guidelines contained in Regulatory Guide 1.163, "Performance-Based Containment Leak-Test Program," dated September 1995.

The peak calculated containment internal pressure for the design basis loss of coolant accident, P_a, is 58 psig.

The maximum allowable containment leakage rate, L_a, shall be 0.1% of containment air weight per day at P_a which is equivalent to 0.1% of containment volume per day.

Leakage rate acceptance criteria are:

a. Containment leakage rate acceptance criteria is $\leq 1.0\ L_a$. During the first unit startup following each test performed in accordance with this program, the leakage rate acceptance criteria are $\leq 0.60\ L_a$ for the Type B and Type C tests and $\leq 0.75\ L_a$ for Type A tests.

b. Air lock acceptance criteria are:

   1. Overall air lock leakage rate is $\leq 0.05\ L_a$ when tested at $\geq P_a$.

   2. Leakage rate for each door is $\leq 0.01\ L_a$ when pressurized to ≥ 10 psig.

The provisions of Specification 4.0.2 do not apply to the test frequencies specified in the Containment Leakage Rate Testing Program.

The provisions of Specification 4.0.3 are applicable to the Containment Leakage Rate Testing Program.

3/4.6.1 PRIMARY CONTAINMENT

3/4.6.1.1 CONTAINMENT INTEGRITY

Primary CONTAINMENT INTEGRITY ensures that the release of radioactive materials from the containment atmosphere will be restricted to those leakage paths and associated leak rates assumed in the accident analyses. This restriction, in conjunction with the leakage rate limitation, will limit the site boundary radiation doses to within the limits of 10 CFR 100 during accident conditions.

3/4.6.1.2 CONTAINMENT LEAKAGE

The limitations on containment leakage rates ensure that the total containment leakage volume will not exceed the value assumed in the accident analyses at the peak design basis loss of coolant accident pressure, P_a, of 58 psig. As an added conservatism, the measured overall integrated leakage rate is further limited to $\leq 0.75\ L_a$ during the performance of the periodic tests to account for possible degradation of the containment leakage barriers between leakage tests.

The surveillance testing for measuring leakage rates are consistent with the requirements of Option B of Appendix "J" of 10 CFR 50.

The containment will be periodically leakage tested in accordance with the Containment Leakage Rate Testing Program. These periodic testing requirements verify the containment leakage rate does not exceed the assumptions used in the safety analysis. At $\leq 1.0\ L_a$ the offsite dose consequences are bounded by the assumptions of the safety analysis. During the first unit startup following testing in accordance with this program, the leakage rate acceptance criteria are $\leq 0.60\ L_a$ for the combined Type B and Type C leakage, and $\leq 0.75\ L_a$ for overall Type A leakage. At all other times between required leakage tests, the acceptance criteria is based on an overall Type A leakage limit of $\leq 1.0\ L_a$.

3/4.6.1.3 CONTAINMENT AIR LOCKS

Each containment air lock forms part of the containment pressure boundary. As part of the containment, the air lock safety function is related to control of the containment leakage rate resulting from a DBA. Thus, each air lock's structural integrity and leak tightness are essential to the successful mitigation of such an event. For the purposes of this specification, the vertical end plates of the air lock barrel, on which the doors themselves are mounted, shall be considered part of the door.

Each air lock is required to be OPERABLE. For the air lock to be considered OPERABLE, the air lock must be in compliance with the Type B air lock leakage test, and both air lock doors must be OPERABLE. The interlock allows only one air lock door of an air lock to be opened at one time. This provision ensures that a gross breach of containment does not exist when containment is required to be OPERABLE. Closure of a single door in each air lock is sufficient to provide a leak tight barrier following postulated events. Nevertheless, both doors are kept closed when the air lock is not being used for normal entry into and exit from containment.

3/4.6.1.4 INTERNAL PRESSURE AND AIR TEMPERATURE

The limitations on containment internal pressure and average air temperature, assuming a worst case relative humidity value of 0 %, ensure that 1) the containment structure is prevented from exceeding its design negative pressure differential with respect to the outside atmosphere of 5.0 psi, 2) the containment peak pressure does not exceed the design pressure of 59 psig during design basis conditions, and 3) the ECCS analysis assumptions are maintained, and 4) the containment cooling fan motor qualifications are maintained.

The limitation on containment average air temperature ensures that the containment liner plate temperature does not exceed the design temperature of 300°F during LOCA conditions. The containment temperature limit is consistent with the accident analyses. Figure 3.6-1 represents analysis limits and does not account for instrument error.

3/4.6.1.5 CONTAINMENT STRUCTURAL INTEGRITY

This limitation ensures that the structural integrity of the containment will be maintained comparable to the original design standards for the life of the facility. Structural integrity is required to ensure that the containment will withstand the maximum design pressure of 59 psig. The visual examination of tendons, anchorages and containment surfaces and the Type A leakage tests of the Unit 2 containment in conjunction with the required surveillance activities of the Unit 1 containment are sufficient to demonstrate this capability.

The surveillance requirements for demonstrating the containment's structural integrity are in compliance with the recommendations of Regulatory Guide 1.35 "Inservice Surveillance of Ungrouted Tendons in Prestressed Concrete Containment Structures", January 1976.

3/4.6.1.6 CONTAINMENT VENTILATION SYSTEM

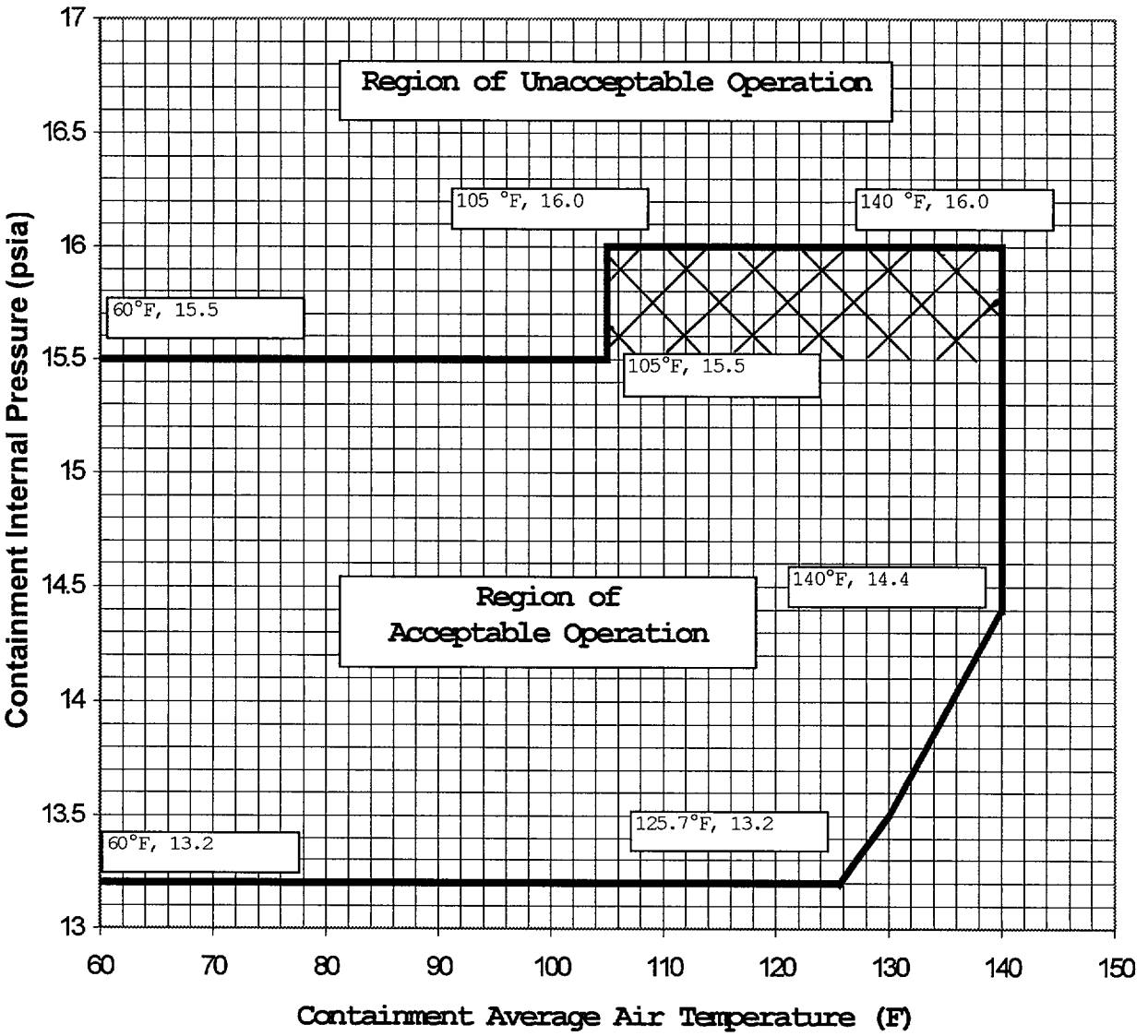
The containment purge supply and exhaust isolation valves are required to be closed during plant operation since these valves have not been demonstrated capable of closing during a LOCA. Maintaining these valves closed during plant operations ensures that excessive quantities of radioactive materials will not be released via the containment purge system.

MARK-UP OF REVISED ANO-2 TECHNICAL SPECIFICATION PAGES

(For Information Only)

FIGURE 3.6-1

CONTAINMENT INTERNAL PRESSURE VS. AVERAGE AIR TEMPERATURE



NOTE: Instrument Error is not Included on Curve

6.15 CONTAINMENT LEAKAGE RATE TESTING PROGRAM

A program shall be established to implement the leakage rate testing of the containment as required by 10 CFR 50.54(o) and 10 CFR 50, Appendix J, Option B, as modified by approved exemptions. This program shall be in accordance with the guidelines contained in Regulatory Guide 1.163, "Performance-Based Containment Leak-Test Program," dated September 1995.

The peak calculated containment internal pressure for the design basis loss of coolant accident, P_a, is ~~54~~58 psig.

The maximum allowable containment leakage rate, L_a, shall be 0.1% of containment air weight per day at P_a~~.~~ which is equivalent to 0.1% of containment volume per day.

Leakage rate acceptance criteria are:

a. Containment leakage rate acceptance criteria is $\leq 1.0\ L_a$. During the first unit startup following each test performed in accordance with this program, the leakage rate acceptance criteria are $\leq 0.60\ L_a$ for the Type B and Type C tests and $\leq 0.75\ L_a$ for Type A tests.

b. Air lock acceptance criteria are:

   1. Overall air lock leakage rate is $\leq 0.05\ L_a$ when tested at $\geq P_a$.

   2. Leakage rate for each door is $\leq 0.01\ L_a$ when pressurized to ≥ 10 psig.

The provisions of Specification 4.0.2 do not apply to the test frequencies specified in the Containment Leakage Rate Testing Program.

The provisions of Specification 4.0.3 are applicable to the Containment Leakage Rate Testing Program.

ENCLOSURE 2

MARKUP OF PROPOSED ANO-2 SAFETY ANALYSIS REPORT CHANGES

SAR Section 6.2

CONTAINMENT SYSTEMS

6.2.1.1.3.1.2 Containment Response Analysis

6.2.1.1.3.1.2.1 Methodology

The mass and energy release data was used by the COPATTA computer code, Reference 88, to calculate the containment pressure and temperature response.

The containment parameters such as the design pressure and temperature, the net free internal volume and the containment surface areas are given in Tables 6.2-7. 6.2-8D, and 6.2-8E. As an additional conservatism, the volume occupied by the reactor coolant prior to the LOCA was included as occupied volume rather than free volume.

The ESF performance parameters and initial conditions within the containment are provided in Table 6.2-8F. These parameters were used in the COPATTA analysis. An overview of the COPATTA methodology is provided below.

COPATTA modeled the containment as three regions – one region modeled the containment atmosphere, another region modeled the containment sump, and the third region modeled the reactor vessel. Conditions in the atmosphere and the sump were determined by solving the conservation of energy and mass equations for each region.

The mass added to the containment from the break separates into a steam phase, which was added to the atmosphere region, and a liquid phase, which was added to the sump region. The water phase was assumed to be at the saturation temperature corresponding to the total containment pressure, while the steam phase was assumed to be at the partial pressure of the steam in the containment atmosphere. Thermal equilibrium between the air and steam in the containment atmosphere was assumed.

Condensation of steam on the structural heat sinks occurred at the saturation temperature corresponding to the partial pressure of the steam phase. All condensate created in a particular time step was transferred immediately from the atmosphere to the sump, unless the steam in the atmosphere was superheated. During atmospheric superheat conditions, a maximum of 8% of the condensate was assumed to remain in the vapor region (i.e., be revaporized) rather than be transferred directly to the sump.

The various structures in the containment were modeled to interact with the containment atmosphere and the sump. The rate of heat transfer between the containment heat structures and the containment regions was determined by the surface area, the surface temperature, the heat transfer coefficient, the physical arrangement of the conducting masses, and the thermal properties of these masses. The heat transfer coefficient used during the turbulent blowdown phase of the event was determined using a modified Tagami correlation, References 74 and 75. After the blowdown phase, the heat transfer coefficient transitioned from the modified Tagami correlation to the Uchida correlation, Reference 76. With the exception of mass and energy transfer due to a boiling sump, heat transfer between the water in the sump and the containment atmosphere was not modeled.

The containment heat sink data specified for the heat transfer calculations during the LOCA are given in Tables 6.2-8D and 6.2-8E. Table 6.2-8D lists the geometric configuration of the heat

sinks, including materials, thicknesses, and surface areas for concrete, steel, and steel-lined structures, and lengths for piping. The carbon steel surfaces are assumed to be covered with a mild thickness of appropriate protective coating. Conservatively determined thermodynamic properties and heat transfer coefficients used in the analyses are given in Table 6.2-8E. These data plus the geometric

removal system performance described in Table 6.2-8F. Table 6.2-8G provides the results of those analyses. The limiting peak pressure was ~~57.7~~57.6 psig, which occurred for a double-ended slot break at the discharge of the reactor coolant pump with the single failure of an emergency diesel generator. For the case above, the peak temperature was ~~291~~285 °F. The maximum pressure is less than the maximum design pressure and the maximum temperature does not challenge the maximum design temperature of the containment structure. In addition to the limiting cases evaluated, runs were made to evaluate Limiting Conditions for Operation (LCO) action statements in the Technical Specifications. Table 6.2-8J documents the breaks evaluated.

Due to the limiting nature of a LOCA it is a more severe accident for design of containment than the MSLB. This is due to the larger release of mass and energy to the containment. Although the short term peak temperature is higher for MSLB the long term impact of the increased mass and energy release is a greater challenge to the containment. As such the DBA is defined as the most limiting LOCA, the Double Ended Discharge Leg Slot break (DEDLS).

Table 6.2-8H provides the sequence of events for the DBA and Figure 6.2-8E shows the transient pressure response. Figure 6.2-8F shows the transient atmosphere and sump temperatures for the DBA. Figures 6.2-8E and 6.2-8F also demonstrate that containment heat removal systems are sized adequately to reduce containment pressure and temperature to a low level following the accident and maintain this low level thereafter. The containment wall liner plate temperature peaks at 271 °F at 313 seconds. The containment wall temperature distribution is illustrated in Figure 6.2-8G.

6.2.1.1.3.2 Main Steam Line Break Maximum Pressure Containment Analysis

Similar to the LOCA, a MSLB inside containment is characterized by the rapid blowdown of steam into the containment due to the rupture in a main steam line. The location of this break is postulated to be at one of the SG outlet nozzles. The steam generator contains an integral flow restricting nozzle which effectively limits the break size to the venturi area or 1.9 ft^2. A full guillotine break was considered for all power levels except 0%, due to the venturi preventing entrainment from occurring for the higher power levels. For the limiting case at 0% power the effective break size was reduced so that no entrainment occurred. The general response of the containment, the reactor protection system, and the engineered safety features to main steam line breaks is discussed in Section 6.2.1.1.3. The following discussion augments that discussion as it applies to MSLB events:

- Until the Main Steam Isolation Valves (MSIVs) close, the initial portion of the transient is characterized by the blowdown of both SGs. In this early phase of the event, steam continues to flow to the turbine. Following the reactor trip, which occurs on a CPH signal, the turbine stop valves close. During this portion of the transient, the main feedwater continues to feed the SGs with the main feedwater pumps and main feedwater water regulating valves at their initial speed and position.

- When the containment pressure exceeds the CPHH setpoint, CSAS occurs and initiates closure of the MSIVs, the Main Feedwater Isolation Valves (MFIVs), and the Backup MFIVs along with spray initiation. It also trips the main feedwater, condensate, and heater drain pumps.

- the reactor vessel region model is not employed in the MSLB analysis,
- the Uchida correlation is used for the heat transfer coefficient to the structural heat sinks in the MSLB, rather than the modified Tagami correlation, and
- ESF performance parameters (provided in Table 6.2-9A).

The containment parameters such as design pressure and temperature, the net free volume, and the containment surface areas are the same as those used for the LOCA maximum containment pressure analysis, which are described in Tables 6.2-7, 6.2-8D, and 6.2-8E. The containment initial conditions and containment heat removal system performance used are provided in Table 6.2-9A.

6.2.1.1.3.2.2.2 Analysis Results for Limiting Cases

Mass and energy data for various power levels and single failures were analyzed to determine the limiting case. Table 6.2-9C provides the summary of those cases and the maximum containment pressure and temperature. The limiting peak pressure was ~~57.7~~57.4 psig for a slot break initiated from 0% power with the failure of one containment spray train with the corresponding peak containment temperature of ~~398~~392 °F. The limiting peak pressure is less than the maximum design pressure of 59 psig. In addition to the limiting cases evaluated, an additional run was made to evaluate an allowable Limiting Condition for Operation in the Technical Specifications.

Table 6.2-9D provides a sequence of events and Figure 6.2-8H shows the transient pressure and temperature response for the limiting peak pressure case. Note that the containment atmosphere temperature is reduced very rapidly by the injection of containment spray. Since the containment structure is initially subcooled, steam will condense on its surface at a temperature that is governed by the partial pressure of the steam.

The condensing heat transfer correlation used in main steam line break analysis is the Uchida correlation described in References 88 and 76. ~~In each instance~~For the time periods where condensing heat transfer is used, water is condensed on the heat sink and transferred directly to the sump at the temperature corresponding to the partial pressure of the steam phase, unless the steam in the atmosphere was superheated. During atmospheric superheat conditions, a maximum of 8% of the condensate was assumed to remain in the vapor region (i.e., be revaporized) rather than be transferred directly to the sump.

The design temperature for the containment liner is 300 °F. The qualification temperatures for safety-related equipment are provided in Section 3.11.

The COPATTA code predicts vapor temperatures in excess of 300 °F for the initial minutes following pipe breaks that result in accidents with high blowdown enthalpy and hence high containment vapor superheat. This is primarily due to the conservative COPATTA code assumption that most (92%) steam condensed from the atmosphere during any calculational time interval is added to the sump liquid immediately at the end of the interval, and is not available to absorb additional heat from the superheated steam in the containment atmosphere. ~~The original CONTEMPT code did not remove condensed mass from the vapor region, but assumed it remained suspended in the vapor region. Comparison with the CVTR (Reference 68) test results~~

~~have shown that the CONTEMPT code will underpredict and COPATTA will overpredict the vapor region superheat temperature. In general, the CONTEMPT assumption provides the closest prediction but is not conservative and has been rejected for use in the COPATTA code.~~

SAR Chapter 6

TABLES

Table 6.2-8D
CONTAINMENT HEAT SINK GEOMETRIC DATA FOR MAXIMUM CONTAINMENT PRESSURE ANALYSIS[1]

	Description	Material	Thickness (ft)	$A_{Surface}$ (ft^2) or L_{Pipe} (ft)
1.	Containment Walls and Dome[2]	Type B Coating	0.0005	56,059
		Steel	0.0208333	
		Air	0.01	
		Concrete	3.75	
2.	Containment Walls[2]	Type C Coating	0.00075	20,035
		Steel	0.0208333	
		Air	0.01	
		Concrete	3.75	
3.	Refueling Canal[3]	Stainless Steel	0.0208333	~~18,000~~8,000
		Air	0.01	
		Concrete	4.00	
4.	Steel Floor Structures	Type C Coating	0.0005	34,824
		Steel	0.0208333	
5.	Steel Floor Structures	Type C Coating	0.0005	44,700
		Steel	0.0078125	
6.	Concrete Floor Structures	Type C Coating	0.010667	11,500
		Concrete	1.096	
7.	Base Slab and Sump	Type C Coating	0.010667	9,300
		Concrete	1.5	
8.	Unlined Concrete Walls & Structures	Concrete	2.0	42,584
9.	Uninsulated Concrete Walls	Type C Coating	0.005458	13,116
		Concrete	2.0	
10.	Polar Crane Rail Support	Type D Coating	0.0005	8,542
		Steel	0.0625	
11.	Trolley Steel	Type D Coating	0.00092	40,371
		Steel	0.01568	
12.	Box Girders	Type D Coating	0.00092	6,020
		Steel	0.03125	

[1] Areas and pipe lengths shown are those in contact with the containment atmosphere
[2] Thickness is effective as a result of combining similar thickness walls
[3] One side of wall is exposed to containment atmosphere, one side is insulated

Table 6.2-8D (continued)

CONTAINMENT HEAT SINK GEOMETRIC DATA FOR MAXIMUM CONTAINMENT PRESSURE ANALYSIS[1]

	Description	Material	Thickness (ft)	$A_{Surface}$ (ft^2) or L_{Pipe} (ft)
13.	Elevator	Steel	0.002667	7,110
14.	Main Steam Pipe and Restraints	Type C Coating	0.0005	4,600
		Steel	0.05208	
15.	Spray Header and H_2 Recombiner	Stainless Steel	0.01	2,101
16.	Cable Trays	Steel	0.003458	11,620
17.	Conduit	Conduit	0.0104417	4,541
18.	Refueling Apparatus	Stainless Steel	0.03125	2,075
19.	Heating and Vent Ducts	Steel	0.0067167	22,690
20.	Safety Injection Tanks	Type C Coating	0.0005	3,796
		Steel	0.1529	
21.	Containment Walls and Dome with Stiffeners	Type B Coating	0.0005	575
		Steel	1.1975	
		Air	0.01	
		Concrete	2.57333	
22.	Concrete Walls with Stiffeners	Type C Coating	0.00075	265
		Steel	1.27	
		Air	0.01	
		Concrete	2.50083	
23.	Quench Tank Cylinder[3]	Stainless steel	0.0283	189
24.	Quench Tank Ends[3]	Stainless steel	0.0342	39
25.	Reactor Coolant Drain Tank Cylinder[3]	Stainless steel	0.0258	158
26.	Reactor Coolant Drain Tank Ends[3]	Stainless steel	0.142	39
27.	Missile Shield Platform	Type B coating	0.00038	716
		Steel	0.02083	
		Air	0.00833	
		Concrete	2.0	
		Type C coating	0.01067	

[1] Areas shown are those in contact with the containment atmosphere
[3] One side of wall is exposed to containment atmosphere, one side is insulated

Table 6.2-8D (continued)

CONTAINMENT HEAT SINK GEOMETRIC DATA FOR MAXIMUM CONTAINMENT PRESSURE ANALYSIS[1]

	Description	Material	Thickness (ft)	$A_{Surface}$ (ft^2) or L_{Pipe} (ft)
28.	Missile Shield Structural Steel, Thin[2,3]	Type B coating	0.00038	151
		Steel	0.02083	
29.	Maintenance Structure and Missile Shield Structural Steel[2,3]	Type B coating	0.00038	3142
		Steel	0.04167	
30.	Safety Injection 2CCA 12 Inch Pipe[4]	Water	0.4375	147 ft
		Stainless steel	0.0938	
31.	Safety Injection 2CCA 8 Inch Pipe[4]	Water	0.2992	332 ft
		Stainless steel	0.0599	
32.	White Elephant Mast[2,3]	Type C coating	0.00058	333
		Steel	0.0833	
33.	White Elephant Other than Mast[2,3]	Type C coating	0.00058	220
		Steel	0.0417	
34.	Safety Injection 2CCA 6 Inch Pipe[4]	Water	0.2292	18 ft
		Stainless steel	0.0468	
35.	Safety Injection 2CCA 3 Inch Pipe[4]	Water	0.1092	38 ft
		Stainless steel	0.0365	
36.	Fire Water 4 Inch Pipe[4]	Water	0.1675	119 ft
		Steel	0.0198	
		Type B coating	0.00038	
37.	Fire Water 3 Inch Pipe[4]	Water	0.1275	566 ft
		Steel	0.018	
		Type B coating	0.00038	

[1] Areas shown are those in contact with the containment atmosphere
[2] Thickness is effective as a result of combining similar thickness walls
[3] One side of wall is exposed to containment atmosphere, one side is insulated
[4] Water filled pipe exposed to containment atmosphere, dimensions are radial from center of pipe

Table 6.2-8D (continued)

CONTAINMENT HEAT SINK GEOMETRIC DATA FOR MAXIMUM CONTAINMENT PRESSURE ANALYSIS[1]

	Description	Material	Thickness (ft)	$A_{Surface}$ (ft^2) or L_{Pipe} (ft)
38.	Safety Injection 2FCB 12 Inch Pipe[4]	Water	0.5	12 ft
		Stainless steel	0.03125	
39.	Safety Injection 2DCD 2 Inch Pipe[4]	Water	0.0703	403 ft
		Stainless steel	0.0287	
40.	Safety Injection 2DCD 1 Inch Pipe[4]	Water	0.0339	71 ft
		Stainless steel	0.0208	
41.	Polar Crane Walkway Plate[2,3]	Type D coating	0.00092	791
		Steel	0.03125	
42.	TSP Basket Tops[3]	Stainless steel	0.005	140
43.	TSP Basket Bottoms[3]	Stainless steel	0.2083	108

[1] Areas shown are those in contact with the containment atmosphere
[2] Thickness is effective as a result of combining similar thickness walls
[3] One side of wall is exposed to containment atmosphere, one side is insulated
[4] Water filled pipe exposed to containment atmosphere, dimensions are radial from center of pipe

Table 6.2-8E

HEAT SINK THERMODYNAMIC DATA
and
MATERIAL PROPERTIES

Thermal Properties for Heat Sinks

Material	Heat Capacity (Btu/ft^3-°F)	Thermal Conductivity (Btu/hr-ft-°F)
Type A Coating	N/A	N/A
Type B Coating	30	0.9
Type C Coating	33	0.1
Type D Coating	30	7.4
Concrete	30	0.8
Carbon Steel	54	25
Stainless Steel	54	10
Air	0.017	1.0
Conduit	42	62
Water	0.376	61

Heat Transfer Coefficients

Region	Heat Transfer Coefficient (Btu/hr-ft^2-°F)
Sump Liquid to Containment Atmosphere	0.0
Containment Sump and Floor to Sump Liquid	0.4
Heat Sink Surfaces Exposed to Outside Air.	2.0
Sink Surfaces Exposed to Containment Atmosphere	Modified Tagami

Table 6.2-8F

ESF PERFORMANCE PARAMETERS AND CONTAINMENT INITIAL CONDITIONS FOR CONTAINMENT PRESSURE RESPONSE ANALYSIS (LOCA)

ESF SYSTEM	PERFORMANCE DATA
Containment Air Coolers	
Actuation (CPH), psia	20.7
Actuation Delay Time, sec.[1]	52.0
Heat Removal per Train	See Table 6.2-8I
Service Water Temperature, °F	See Figure 6.2-3B
Containment Spray	
Actuation Signal (CPHH)	25.7
Actuation Delay Time, sec.[1]	~~53.6~~60.0[2]
Flow Rate (pre-RAS) per pump, gpm	1875
Flow Rate (post-RAS) per pump, gpm	2000
Temperature (pre-RAS), °F	120
Shutdown Cooling Heat Exchangers	
Heat Transfer Area, ft^2	5220 per unit
Overall Heat Transfer Coef., Btu/hr-ft^2-°F	155.5
Service Water Flow Rate (post-RAS), gpm	3350
Service Water Temperature, °F	See Figure 6.2-3B

INITIAL CONTAINMENT CONDITIONS	DATA
Pressure, psia	~~16~~15.5
Temperature, °F	140
Relative Humidity, %	0
Leakage	None
Outside Temperature, °F	90

[1] Assumes a loss of offsite power

[2] This includes ~~11~~17.4 seconds fill time for spray header

Table 6.2-8G

MAXIMUM CONTAINMENT PRESSURE AND TEMPERATURE RESULTS (LOCA)

Break Location	Break Size (ft^2)	Single Failure	Pressure (psig)	Time of Peak Pressure (sec)	Temperature (°F)
RCP Discharge	9.82	1 Containment Spray Train	~~57.1~~56.9	143.8~~143.6~~	~~290~~284
RCP Discharge	9.82	1 EDG	~~57.7~~57.6	148.6~~149.0~~	~~291~~285
RCP Suction	9.82	1 Containment Spray Train	~~53.9~~53.1	61.4~~54.9~~	~~294~~284
RCP Suction	9.82	1 EDG	~~54.0~~53.2	61.4~~54.9~~	~~294~~285
Hot Leg	19.24	1 Containment Spray Train	~~56.1~~55.7	11.0~~10.9~~	283
Hot Leg	19.24	1 EDG	~~56.1~~55.7	10.8~~10.9~~	283

Note: all breaks were double-ended slot

Table 6.2-8H

SEQUENCE OF EVENTS
DESIGN BASIS ACCIDENT

Time (sec)	Event Description
0.0	Pipe rupture (9.82 ft^2 DEDLS), reactor coolant system (RCS) depressurization begins.
~~0.5~~0.6	Containment Air Cooling Actuation Setpoint (CPH)
~~1.0~~1.1	Containment Spray Actuation Setpoint (CPHH)
8.0	Safety injection tanks begin injection into the RCS.
14.9	End of Blowdown.
14.9	Safety injection (HPSI) and (LPSI) pumps begin injection into the RCS.
~~52.5~~52.6	Containment air coolers begin operation.
~~54.6~~61.1	Containment sprays begin operation.
73.6	Safety injection tanks empty.
~~149.0~~148.6	Containment reaches peak pressure (~~57.7~~57.6 psig).
~~54.6~~148.8	Containment reaches peak temperature (~~291~~285°F).
2707.62	Switchover to sump recirculation as RWT reaches low level.
2600000	End of Analysis

Table 6.2-8J
LOCA Maximum Containment Pressure and Temperature Results Supporting Technical Specification Limiting Conditions for Operation

Case[1,2,3,4]	Break Location	CS	CAC	Pressure (psia)	Temperature (°F)
1	RCP Suction	1	1	~~54.0~~53.2	~~294.2~~284
2	RCP Discharge	1	1	~~57.5~~57.4	~~290.5~~285
3	RCP Suction	2	1	~~54.0~~53.2	~~294.2~~284
4	RCP Discharge	2	1	~~56.5~~56.4	~~290.5~~283
5	RCP Suction	2	0	~~54.0~~53.2	~~294.3~~285
6	RCP Discharge	2	0	~~57.0~~56.9	~~290.5~~284

Notes:
1 Loss of offsite power is considered.
2 No additional single failure is considered.
3 Both Emergency Diesel Generators are considered to operate.
4 Full Flow of both Safety Injection Trains Considered.

Table 6.2-9A

ESF PERFORMANCE PARAMETERS AND NSSS ASSUMPTIONS ~~FOR MASS AND ENERGY ANALYSIS (MSLB)~~ CONTAINMENT ANALYSES

ESF SYSTEM	PERFORMANCE DATA
Containment Air Coolers	
Actuation (CPH), psia	20.7
Actuation Delay Time, sec.[1]	30
Heat Removal per Train	See Table 6.2-8I
Service Water Temperature, °F	See Figure 6.2-3B
Containment Spray	
Actuation Signal (CPHH)	25.7
Actuation Delay Time, sec. [1]	~~38.6~~45.0[2]
Flow Rate (pre-RAS) per pump, gpm	1875
Flow Rate (post-RAS) per pump, gpm	2000
Temperature (pre-RAS), °F	120
RPS/ESF Performance Parameters	
Reactor Trip Actuation Signal, Containment Cooling Actuation Signal	Containment Pressure High
Containment Pressure High setpoint, psia	20.7
Containment Spray Actuation Signal	Containment Pressure High-High
Containment Pressure High-High setpoint, psia	25.7
CSAS Actuation Delay, sec.	1.6
MSIV Closure Time, sec.	3.5
MFIV Closure Time, sec.	25
Backup MFIV Closure Time, sec.	18.5

INITIAL CONTAINMENT CONDITIONS	DATA
Pressure, psia	~~16~~15.5
Temperature, °F	140
Relative Humidity, %	0
Leakage	None

[1] Assumes offsite power available

[2] This includes ~~11~~17.4 seconds fill time for spray header

Table 6.2-9C

MAXIMUM CONTAINMENT PRESSURE AND TEMPERATURE RESULTS (MSLB)

Power[1]	Failure	Peak Pressure		Peak Temperature	
		psig	sec.	°F	sec
102%	Main feedwater pump to trip	~~55.3~~55.1	141.8	~~410~~402	~~43.1~~49.8
94.9%	Main feedwater pump to trip	~~54.9~~54.7	~~149.0~~150.0	~~409~~401	~~43.0~~49.7
75%	Condensate pump to trip	~~54.0~~53.7	~~157.8~~158.0	~~407~~399	~~42.8~~49.5
50%	Main feedwater pump to trip	~~55.4~~55.2	182.4	~~405~~397	~~42.5~~49.1
25%	Condensate pump to trip	~~55.3~~55.2	~~228.0~~228.2	~~403~~395	~~42.2~~48.9
0%	Containment Spray Train	~~57.7~~57.4	~~196.6~~196.0	~~398~~392	~~45.5~~52.4
0%[2]	1 Train of Containment Sprays and 1 Train of Containment Air Coolers (Tech. Spec. LCO case)	~~58.3~~58.1	196.4	~~398~~392	~~45.6~~52.4

Note:

1 All cases were double-ended guillotine breaks except the 0% Power case which was a slot break of 1.94 ft^2.

2 This case does not represent the DBA. This case, however, does represent the limiting case for the Technical Specification (TS) Limiting Condition for Operation (LCO). In addition to the typical single failure peak containment pressure cases presented in the original FSAR, other cases have been assessed to determine the results of peak pressure conditions under the bounding TS LCO action statements (One CSS and one CCS available bounds two CSS available and two CCS out of service) for containment heat removal systems. The results of these additional analyses demonstrate that peak pressures are bounded by the containment design pressure of 59 psig.

Table 6.2-9D

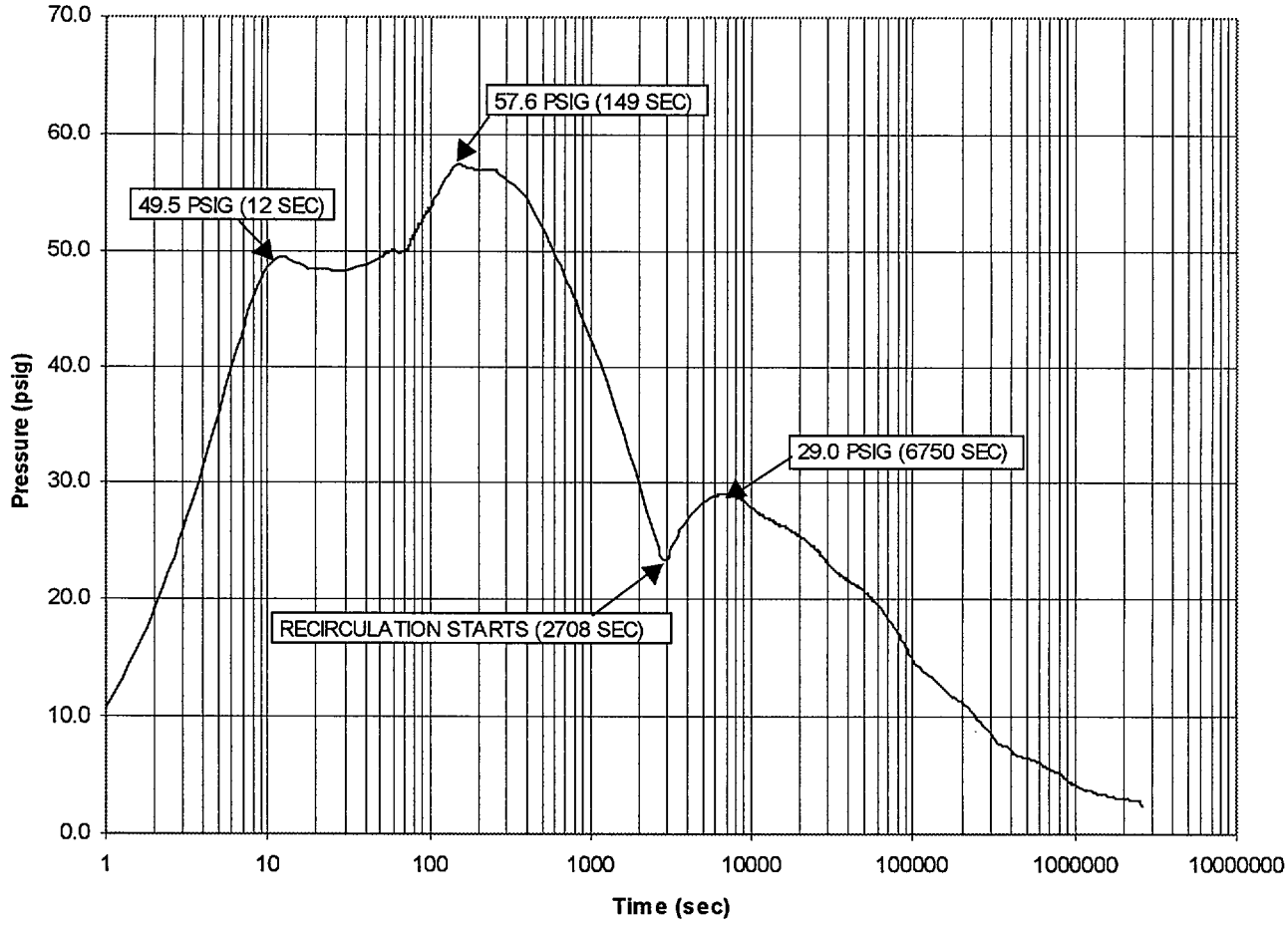
SEQUENCE OF EVENTS
LIMITING CONTAINMENT PEAK PRESSURE ANALYSIS (MSLB)

(Slot break initiated from 0% power with failure of one containment spray train)

Time (sec)	Event Description
0.0	Start of Event
3.6	Containment Air Cooler Actuation Signal (CPH)
7.4	Containment Spray Actuation Signal (CPHH)
12.1	MSIV shuts
27.1	Backup MFIVs shut
33.~~2~~6	Containment Air Coolers Start
52.4	Containment Spray Starts (time of peak containment temperature)
196.0	Time of Peak Containment Pressure
400.0	End of Analysis

SAR Chapter 6

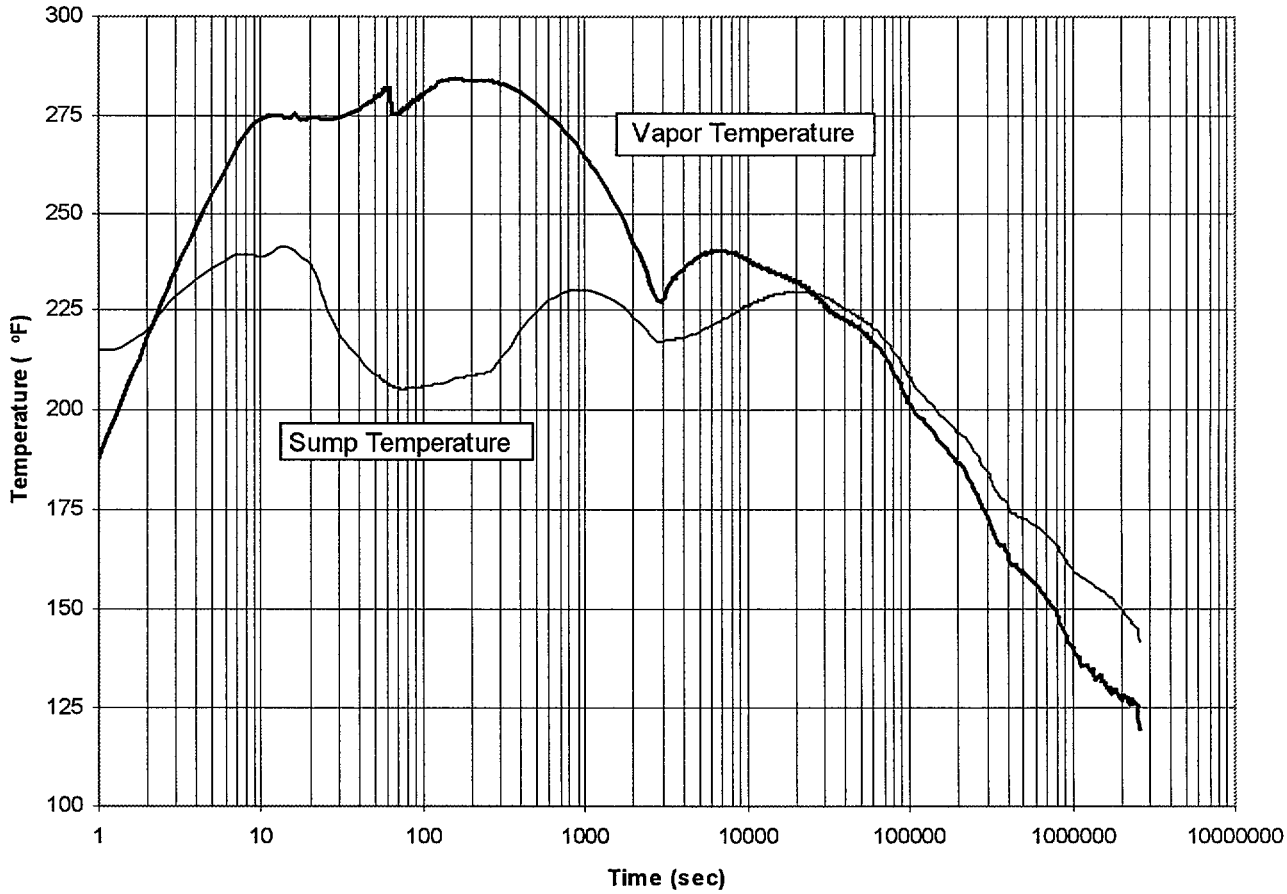
FIGURES



SAR FIGURE NO. 6.2-8E

AMENDMENT 16

ARKANSAS NUCLEAR ONE UNIT 2 RUSSELLVILLE, ARKANSAS	Entergy	SCALE:	NONE
		DRAWN:	D. COFFMAN
		DESIGN:	ENTERGY
		CAD NO:	NONE
CONTAINMENT PRESSURE VS. TIME LIMITING LOCA - DEDLS BREAK WITH LOSS OF ONE EDG	DRAWING NO	SHEET	REV.



SAR FIGURE NO. 6.2-8F

AMENDMENT 16

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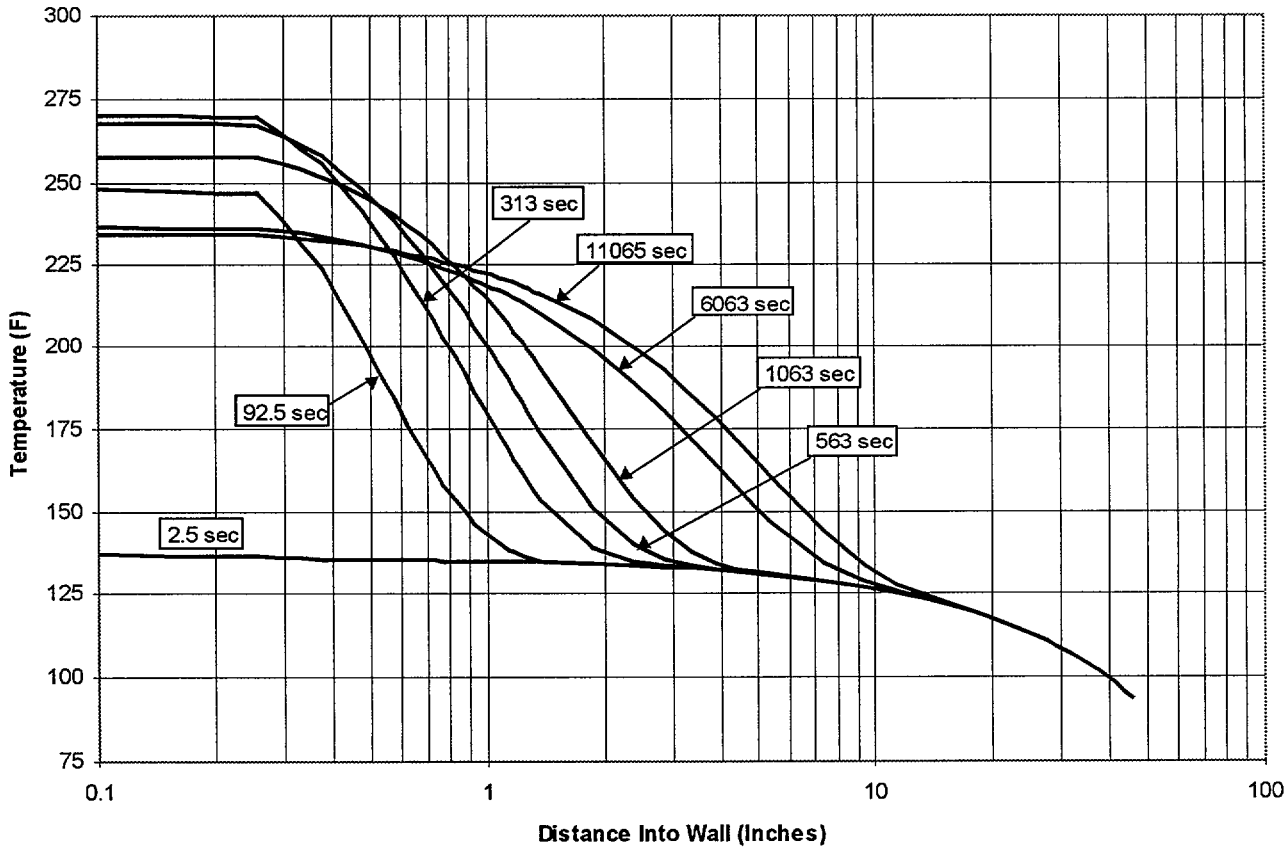
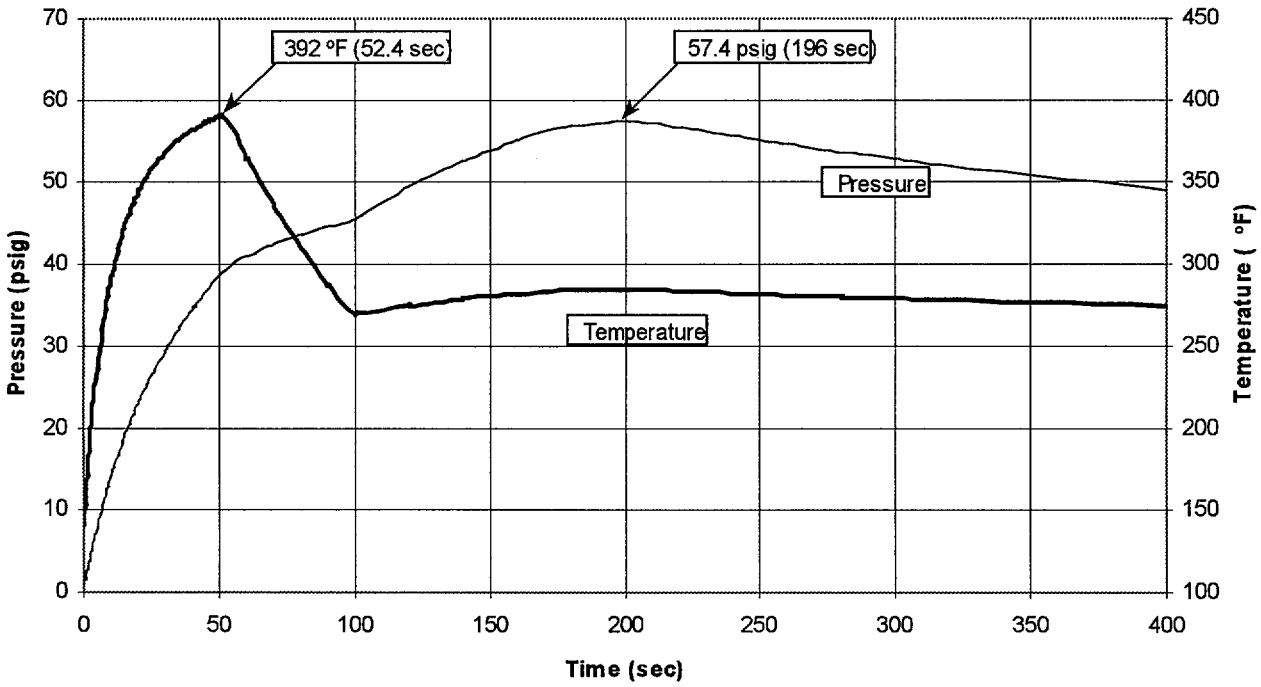
		DRAWN:	D. COFFMAN
		DESIGN:	ENTERGY
		CAD NO:	NONE
CONTAINMENT TEMPERATURE VS. TIME LIMITING LOCA - DEDLS BREAK WITH LOSS OF ONE EDG	DRAWING NO	SHEET	REV.



SAR FIGURE NO. 6.2-8G

AMENDMENT 16

ARKANSAS NUCLEAR ONE UNIT 2 RUSSELLVILLE, ARKANSAS	Entergy	SCALE:	NONE
		DRAWN:	D. COFFMAN
		DESIGN:	ENTERGY
		CAD NO:	NONE
CONTAINMENT LINER/CONCRETE TEMPERATURE PROFILES LIMITING LOCA - DEDLS BREAK WITH LOSS OF ONE EDG	DRAWING NO	SHEET	REV.



SAR FIGURE NO. 6.2-8H

AMENDMENT 16

ARKANSAS NUCLEAR ONE UNIT 2 RUSSELLVILLE, ARKANSAS	Entergy	SCALE:	NONE
		DRAWN:	D. COFFMAN
		DESIGN:	ENTERGY
		CAD NO:	NONE
CONTAINMENT PRESSURE AND TEMPERATURE VS. TIME LIMITING MSLB - 0% POWER, ONE SPRAY TRAIN FAIURE	DRAWING NO	SHEET	REV.