N-4080-027 Suppl A&B Rev 0: MSLB Containment P/T

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| **Southern California Edison Company** | CALC. NO.<br>N-4080-027 | ICCN NO./ [✓ PRELIM. CCN] NO. N-2 | PAGE<br>1 | TOTAL NO. OF PAGES 52 |
| **INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN) COVER PAGE** | BASE CALC. REV.<br>0 | UNIT<br>2 & 3 | CCN CONVERSION :<br>CCN NO. **CCN-** 2 | CALC. REV.<br>0 |
| | CALCULATION SUBJECT : **CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB - SUPPLEMENT B** | | | |
| CALCULATION CROSS-INDEX<br>☒ New/Updated index included<br>☐ Existing index is complete | ENGINEERING SYSTEM NUMBER / PRIMARY STATION SYSTEM DESIGNATOR<br>1301 / ABB | | | Q-CLASS<br>II |
| **1**.BRIEF DESCRIPTION OF ICCN / CCN: | CONTROLLED PROGRAM OR DATABASE ACCORDING TO SO123-XXIV-5.1<br>☒ PROGRAM ☐ DATA BASE | PROGRAM / DATABASE NAME (S)<br>☒ ALSO, LISTED BELOW<br>NE100 (COPATTA) | | VERSION/RELEASE NO.(S)<br>G1-15 |

**Add Supplement B to the base calculation.**

**Revise sheets 6, 7 and 9 through 14 of the base calculation to refer to the Supplement B Results and Conclusions.**

**Supplement B provides a new Analysis of Record (AOR) for the Containment Building pressure and temperature response to the Design Basis Main Steam Line Break (MSLB) event. Consistent with the licensing basis for SONGS 2 & 3, the new AOR is performed with the containment initial pressure at 14.7 psia. A second analysis is also included which assumes the containnment initial pressure is at the Technical Specification maximum value of 1.5 psig (16.2 psia) to demonstrate that the peak post MSLB pressure remains below the 60 psig containment design value. The results of this new analysis are applicable to containment functional design as described in Section 6.2 of the UFSAR. The post-MSLB containment P/T response for in-containment equipment qualification (UFSAR Section 3.11) continues to be provided by Supplement A to the base calculation, which includes 8% condensate revaporization.**

**This new analysis employs a slightly lower containment spray flow rate than was used in the base calculation to bound the lowest spray flow rate expected with 7.5% degraded containment spray pump performance. In addition, the emergency air cooling unit start time has been delayed to coincide with the start of full containment spray flow at 50 seconds to provide margin to accomodate futlure changes in ECU startup timing.**

**The results of the base calculation are obsoleted by this new AOR. However, the base calculation, itself, remains applicable as a detailed source document for the input parameters used in the containment P/T analysis for the design basis MSLB event.**

INITIATING DOCUMENT (DCP, FCN, OTHER) N/A REV. –

**2.** OTHER AFFECTED DOCUMENTS (CHECK AS APPLICABLE FOR CCN ONLY):

SEE CALCULATION CROSS INDEX

● YES ○ NO OTHER AFFECTED DOCUMENTS EXIST AND ARE IDENTIFIED ON ATTACHED FORM 26-503.

**3.** APPROVAL : DISCIPLINE / ESC : **Nuclear Safety Anal.**

**ALLEN EVINAY** / AE / 3/14/95 — ORIGINATOR (Print name/initial/date)

3/14/95 — GS (Signature/date)

OTHER (Signature/date)

**PAUL BARBOUR** / PB / 3/14/95 — IRE (Print name/initial/date)

3/14/95 — DM (Signature/date)

OTHER (Signature/date)

**4.** ASSIGNED SUPPLEMENT ALPHA DESIGNATOR : B

CONVERSION TO CCN DATE 3/22/95

Tanya Castello

SCE CDM - SONGS

# CALCULATION TITLE PAGE

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Calc No. N-4080-027 DCP/FIDCN/ FCN No. & Rev. N/A

CCN CONVERSION: CCN NO CCN- 2

Subject : CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB - SUPPLEMENT B

Sheet B1 of

System Number/Primary Station System Designators 1301 / ABB

SONGS Unit 2&3

Q-Class II

Tech. Spec. Affecting? ○ NO ● YES Section No. LCO/SR 3/4.6.1.1,2,3 & B 3/4.6.1.4 and .6

Equipment Tag No. N/A

| CONTROLLED COMPUTER PROGRAM/ DATABASE | ☒ PROGRAM<br>☐ DATABASE<br>According to SO123-XXIV-5.1 | PROGRAM/ DATABASE NAME(S)<br>☐ ALSO, LISTED BELOW<br>NE100 (COPATTA) | VERSION/ RELEASE NO. (S)<br>G1-15 |
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## RECORD OF ISSUES

| REV. DISC | DESCRIPTION | TOTAL SHTS. LAST SHT | PREPARED (Print name/initial/date) | APPROVED (Signature/date) | |
|---|---|---|---|---|---|
| 0 | ORIGINAL ISSUE | 43 | ORIG. ALLEN E.VINAY AE 3/14/95 | GS 3/14/95 | OTHER |
| | | B43 | IRE PAUL BARBOUR PJB 3/14/95 | DM 3/14/95 | OTHER |
| | | | ORIG. | GS | OTHER |
| | | | IRE | DM | OTHER |
| | | | ORIG. | GS | OTHER |
| | | | IRE | DM | OTHER |
| | | | ORIG. | GS | OTHER |
| | | | IRE | DM | OTHER |

**Space for RPE Stamp, identify use of an alternate calc., and notes as applicable.**

This calculation was prepared using Word Perfect 5.1 software as an electronic word processor. The WP5.1 software was not used for any computational portions of the calculation.

This calc. was prepared for the identified DCP/FCN. DCP/FCN completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date. ____________ by ______________________ .

SCE 26-121-1 REV. 0 8/94 [REFERENCE: SO123-XXIV-7.15]

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Calculation No. N-4080-027 - SUPPLEMENT B

Sheet No. B-2

| Calc. rev. number and responsible supervisor initials and date | INPUTS These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation. | | OUTPUTS Results and conclusion of the subject calculation are used in these interfacing calculations and/or documents. | | Does the output interface calc/document require revision? | identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number. |
|---|---|---|---|---|---|---|
| | Calc/Document No. | Rev. No. | Calc/Document No. | Rev. No. | YES / NO | |
| △0<br>3/14/95 | Calculations:<br>N-4080-027<br>N-4080-027, Supplement A<br>M-0014-009, Supplement A<br>M-0072-036<br>N-4080-007<br>N-4080-003 | <br>0<br>0<br>0<br>0<br>2<br>5 | UFSAR, Section 6.2.1<br>DBD-SO23-TR-AA<br><br>SONGS Unit 2 Technical Specifications<br>SR 4.6.1.1<br>LCO 3.6.1.2<br>SR 4.6.1.2<br>LCO 3.6.1.3<br>SR 4.6.1.3<br>B 3/4.6.1.4<br>B 3/4.6.1.6 | 10<br>1<br><br>Amdt 114 | Yes<br>Yes<br><br>Yes | SAR23-357<br>NEDOTRAK Log AJB-94-004<br><br>NEDOTRAK Log AJB-94-002 |
| | Unit 2 Operating Liscense & Technical Specifications<br><br>Unit 3 Operating License & Technical Specifications | Amdt 114<br><br>Amdt 103 | SONGS Unit 3 Technical Specifications<br>SR 4.6.1.1<br>LCO 3.6.1.2<br>SR 4.6.1.2<br>LCO 3.6.1.3<br>SR 4.6.1.3<br>B 3/4.6.1.4<br>B 3/4.6.1.6 | Amdt 103 | Yes | NEDOTRAK Log AJB-94-002 |
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## 1.0 PURPOSE

### 1.1 TASK DESCRIPTION

The purpose of this Supplement B is to provide a new calculation of the Containment P/T response to the design basis Main Steam Line Break (DB MSLB) event consistent with the Licensing Basis of SONGS Units 2 and 3 (reference 6.2), where the pre-MSLB initial containment pressure is the nominal atmospheric value (14.7 psia) used in prior UFSAR containment functional design. The results of this Supplement B will become the Analysis of Record (AOR) for the design basis MSLB as it applies to containment functional design. Supplement B will also serve as the AOR for calculation of peak post-MSLB containment pressure with the initial containment pressure at 1.5 psig, documenting the existence of peak pressure margin under maximum containment initial pressure conditions [Technical Specification maximum value of 16.2 psia (1.5 psig) per LCO 3.6.1.4].

The prior analysis of reference 6.1 will remain valid for the purposes of defining the input modelling for the design basis MSLB containment P/T analysis for all parameters except those minor changes identified below.

Supplement B incorporates the following changes in the containment heat removal spray system performance parameters:

1.1.1 The containment injection mode spray flow rate is reduced to 1600 gpm, bounding the lowest calculated minimum injection spray flow with 7.5% degraded containment spray pumps (reference 6.3).

1.1.2 The emergency air cooling unit (ECU) start time is delayed to coincide with the start time of full containment spy flow at 50 seconds. This change will add 35 seconds to the currently calculated post-MSLB start start time for the ECUs without loss of power (reference 6.14) with negligible penalty in containment P/T response and provide margin for the future changes in ECU start time.

The MSLB evaluated in this calculation continues to be the design basis 7.48 $ft^2$ steam line break accident at 102% power with off-site power available and with a loss of one train each of containment emergency air coolers and containment sprays.

Bechtel Standard Computer Code NE100, Release G1-15 (COPATTA) (reference 6.5), on the Nuclear Fuels Engineering IBM-RISC workstation system will be used in this calculation to evaluate the containment pressure and temperature transients for the DB MSLB.

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### 1.2 CRITERIA, CODES and STANDARDS

The criteria, codes and standards applicable to the Containment P/T Analysis for Design Basis MSLB (reference 6.1), are also generally applicable in this analysis. The applicable regulatory design criteria include:

- General Design Criterion (GDC) 16, "Containment Design"
- General Design Criterion (GDC) 38, "Containment Heat Removal"
- General Design Criterion (GDC) 50, "Containment Design Basis".

The applicability of these criteria to peak containment pressure and temperature are described in detail in Reference 6.1.

The containment design pressure and temperature are 60 psig and 300 °F per the Technical Specifications (references 6.5, 6.6, 6.7 Section 5.2.2) respectively.

## 2.0 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

### 2.1 RESULTS/CONCLUSIONS

### 2.1.1 Initial Containment Pressure @ 0 PSIG

Figures 2-1 through 2-7 show the analysis results out to 10,000 seconds, which is well beyond the time of the affected steam generator dry-out and termination of significant mass and energy release into the containment (71.08 seconds). At 10,000 seconds, the containment temperature and pressure are well below the peak values and decreasing. Section 10 contains tabulated conditions to the end of the transient calculation at 1E+4 seconds, at which time the refueling water storage tank would have been depleted and operator action to place RCS on shutdown cooling for decay heat removal would have been underway.

Figure 2-1 presents the containment gauge pressure versus time for the CONTAINMENT P/T DESIGN BASIS MSLB. The plot in Figure 2.1 is generated using the data presented in Section 10.1.

Figure 2-2 presents the sump and vapor temperatures versus time for the CONTAINMENT P/T DESIGN BASIS MSLB. The plots in Figure 2.2 are generated using the data presented in Section 10.1.

Figure 2-3 presents the condensing heat transfer coefficient v.s. time used by the COPATTA Code during the DBMSLB. The plot in Figure 2.3 is generated using the data presented in Section 10.1.

Figure 2-4 presents the inside surface temperature of heat sink 1 (reactor building dome, painted steel liner plate) to represent the maximum post-MSLB temperature of the containment structure. The plot in Figure 2.4 is generated using the data presented in Section 10.1.

Figure 2-5 presents the integrated energy transferred from the containment vapor region by one train of air coolers, two Emergency Cooling Units (2ECUs) and one train of containment spray as a function of time. The plots in Figure 2.4 are generated using the data presented in Section 10.2. The ECUs transfer vapor energy to the component cooling water system (CCWS) which transports the energy outside the containment. The containment sprays are operating in the injection mode and transfer vapor energy to the containment sump region as hot water.

Figure 2-6 presents the integrated heat transfer of the air coolers and containment sprays. The plots prsented in Figure 2.6 are generated using the data tabulated in Section 10.2

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Figure 2-7 presents the rate of energy transfer from the vapor region by a single train of emergency cooling units (2ECUs) and by a single train of containment sprays as a function of time. The plots in Figure 2.5 are generated using the data presented in Section 10.2.

Table 2-1 presents the containment P/T Design Basis MSLB accident chronology with Initial Containment Pressure CPi = 14.7 psia (0 psig).

The calculated peak pressure of 56.6 psig is less than the 60 psig design pressure and also less than the previously identified peak pressure (58.5 psig) in the prior AOR (N-4080-027, reference 6.1). The decrease in the peak pressure is attributed to the change in the initial containment pressure from 1.5 psig to 0 psig.

The calculated peak vapor temperature of 427.7°F is greater than the 300°F design temperature, however the duration of the event is sufficiently brief to prevent heating of the containment structural materials beyond the design limits. The thermal response of the 0.25" thick containment steel liner plate to the MSLB environment shown in figure 2-4 presents a conservative example of the transient heating of the containment structure during the accident. As shown in the figure, the liner plate remains below 250 °F during the MSLB event.

The peak vapor temperature is about 7°F greater than the previously identified peak temperature in the prior AOR (N-4080-027, reference 6.1). The increase in the peak temperature is primarily attributed to the lower containment initial pressure (0 psig) compared to that in the prior analysis at 1.5 psig. The lower air inventory reduces the total containment heat capacity resulting in a small increase in short-term peak vapor temperature [see BN-TOP-3, Revision 4, Section 4.1.2 and Table 15 (reference 6.8)]. The delay in ECU start time from 15 to 50 seconds also adds slightly to the increase in peak vapor temperature as compared to the prior analysis.

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### 2.1.2 Initial Containment Pressure @ 1.5 PSIG

Table 2-2 presents the CONTAINMENT P/T DESIGN BASIS MSLB accident chronology with Initial Containment Pressure CPi = 16.2 psia.

The calculated peak pressure of 58.7 psig is less than the 60 psig design pressure but slightly greater than the previously identified peak pressure (58.5 psig) in the prior AOR (N-4080-027, reference 6.1). The increase in the peak pressure is attributed to the changes in the CSS flow rate and ECU start delay time.

The calculated peak vapor temperature of 421.6°F is greater than the 300°F design temperature, however the duration of the event is sufficiently short enough to prevent heating of the containment structural materials beyond the design limits. The peak vapor temperature with the initial containment pressure at 1.5 psig is about 6.1°F lower than for the case with the initial pressure at 0 psig due to the greater containment heat capacity which exists at the higher initial containment pressure.

The peak vapor temperature is about 0.6°F greater than the previously identified peak temperature in the prior AOR (N-4080-027, reference 6.1). The slight increase in peak temperature is attributed to the delay in ECU start time from 15 to 50 seconds.

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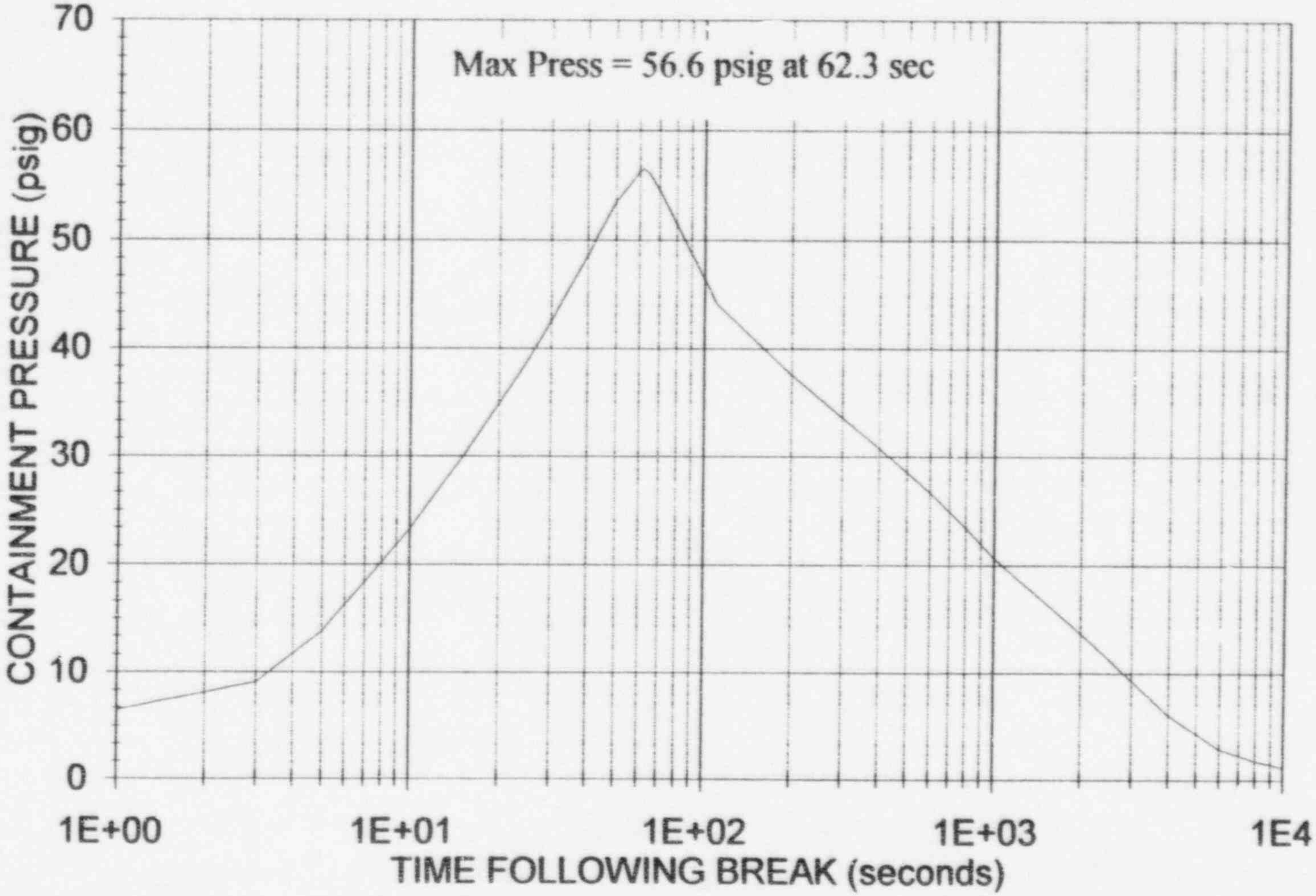
## FIGURE 2-1: PRESSURE
MSLB 102% POWER 7.48 Ft**2 BREAK AREA



REV. INDICATOR

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## CALCULATION SHEET

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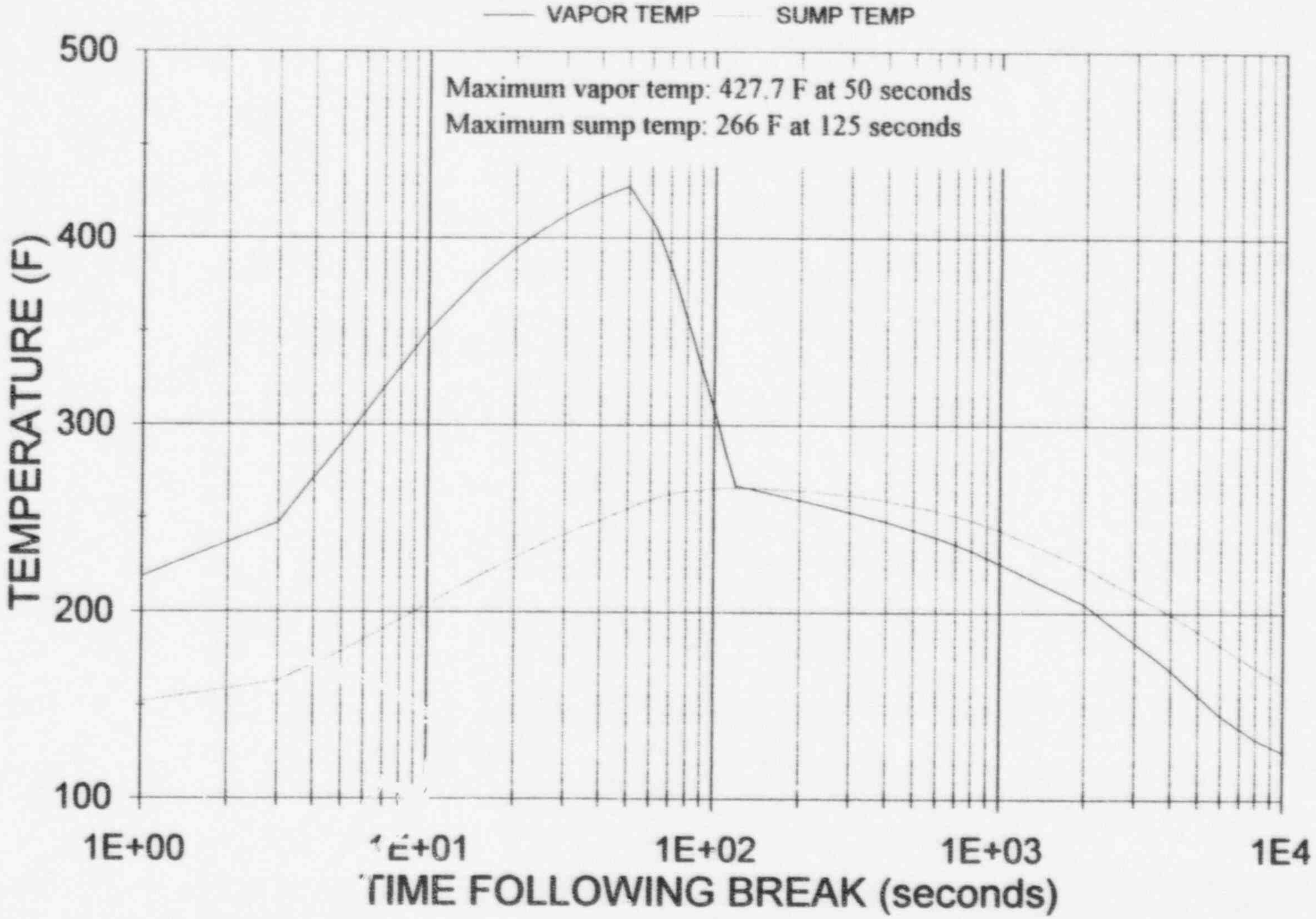
## FIGURE 2-2: TEMPERATURE

MSLB 102% POWER 7.48 FT**2 BREAK AREA



Maximum vapor temp: 427.7 F at 50 seconds

Maximum sump temp: 266 F at 125 seconds

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| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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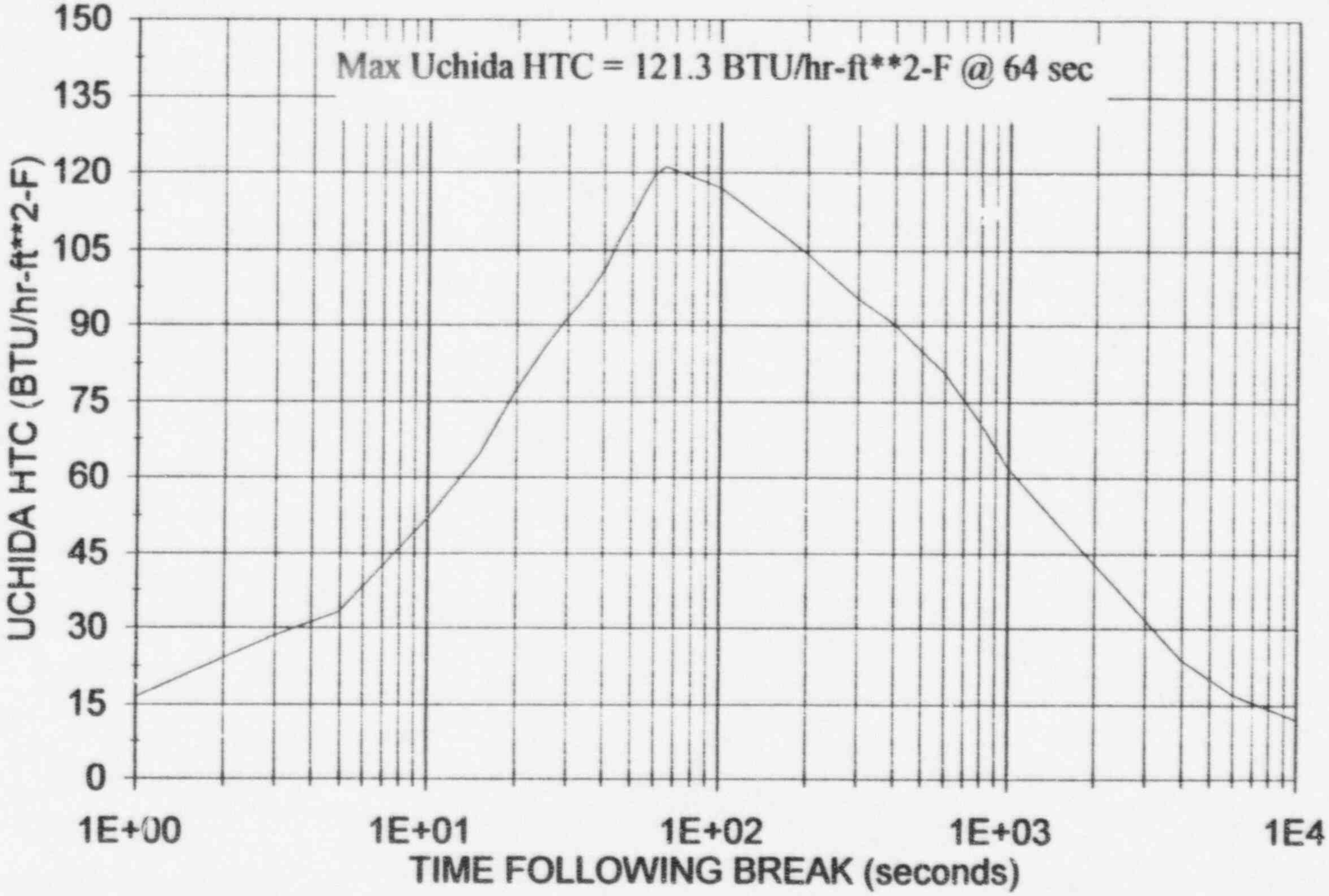
## FIGURE 2-3: CONDENSING HTC

MSLB 102% POWER 7.48 Ft**2 BREAK AREA



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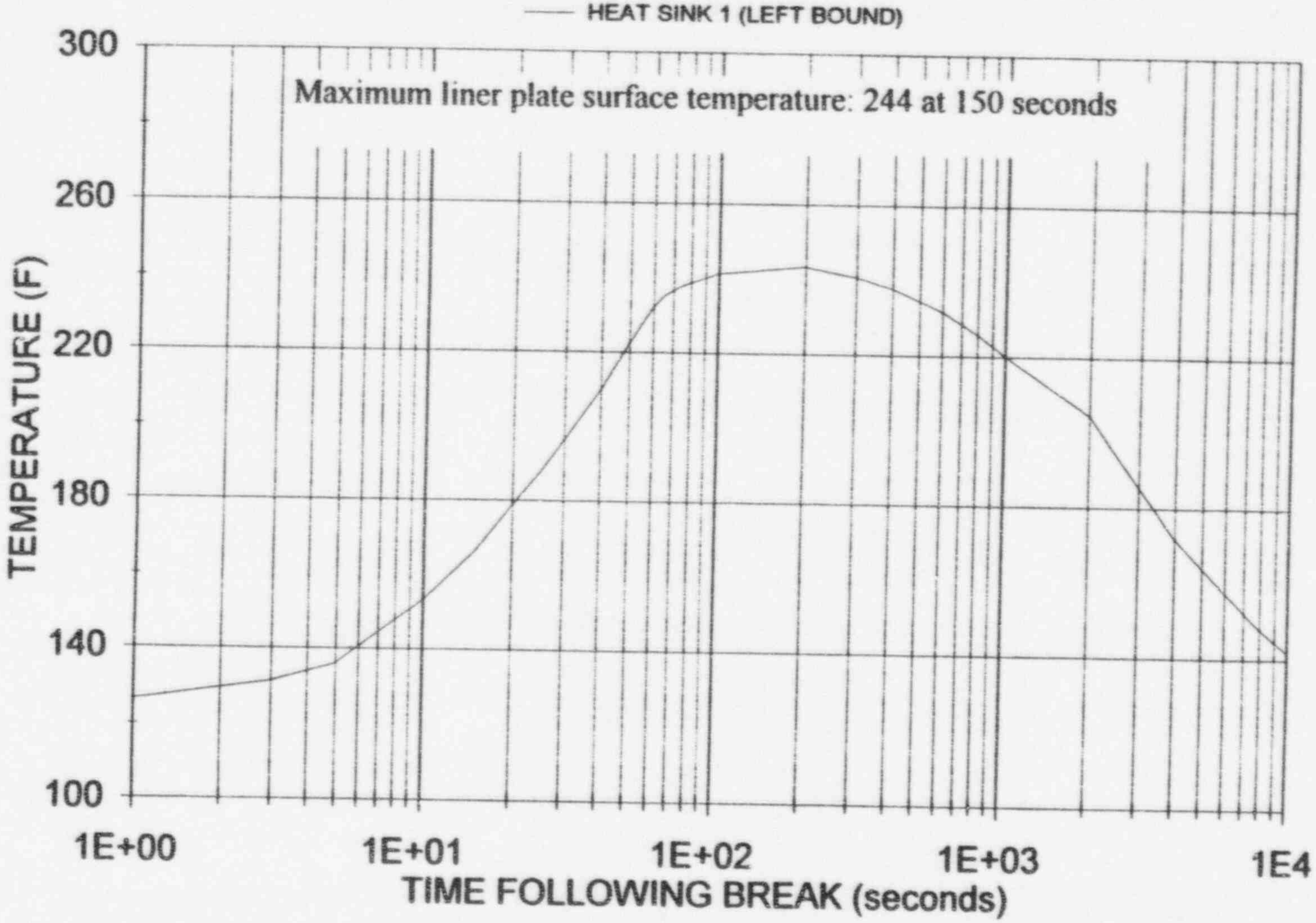
## FIGURE 2-4: LINER PLATE SURFACE TEMP.

MSLB 102% POWER 7.48 Ft**2 BREAK AREA



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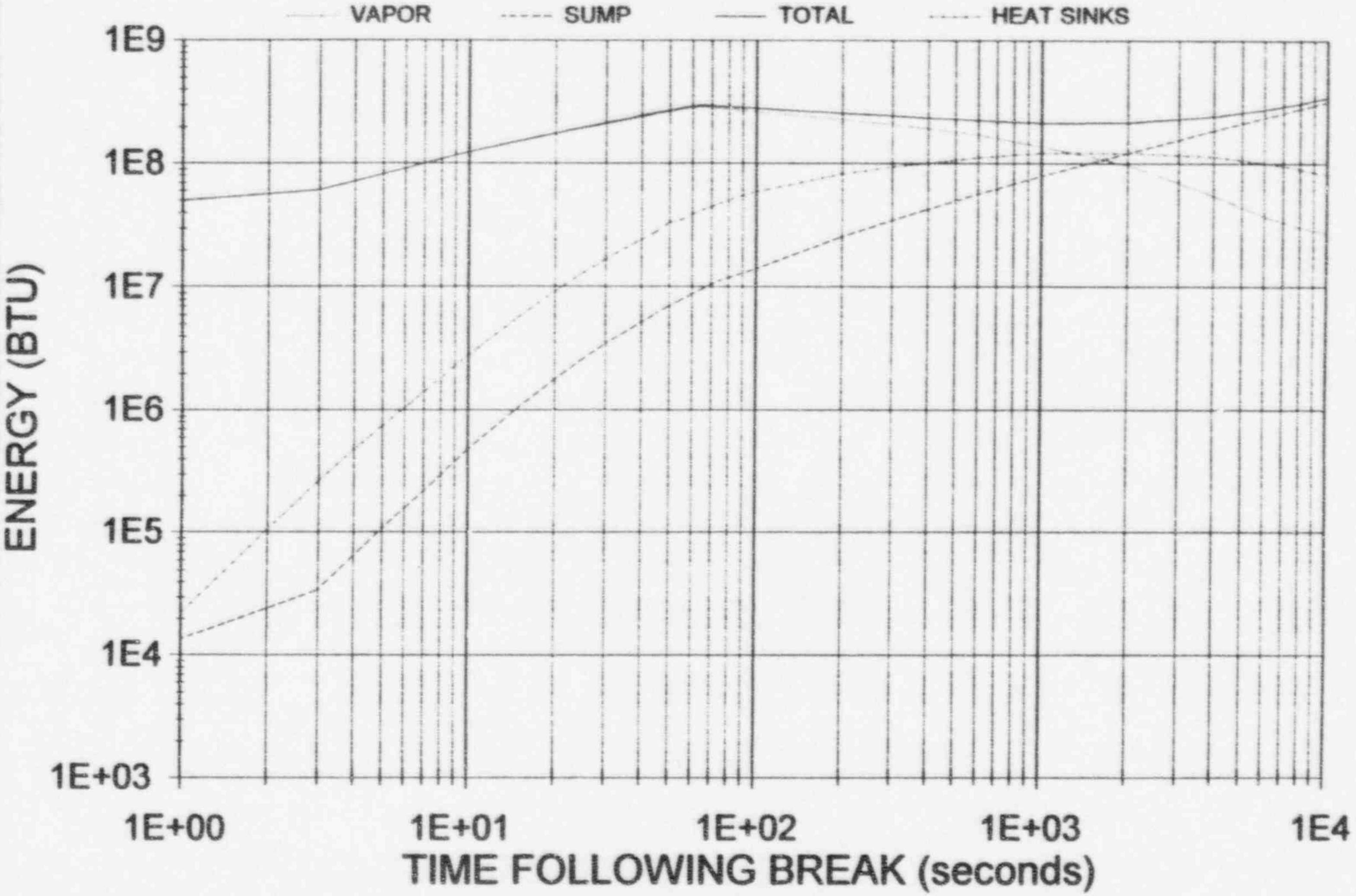
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |

FIGURE 2-5: ENERGY
MSLB 102% POWER, 7.48 FT**2 BREAK AREA



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|---|---|---|---|---|---|---|---|---|---|
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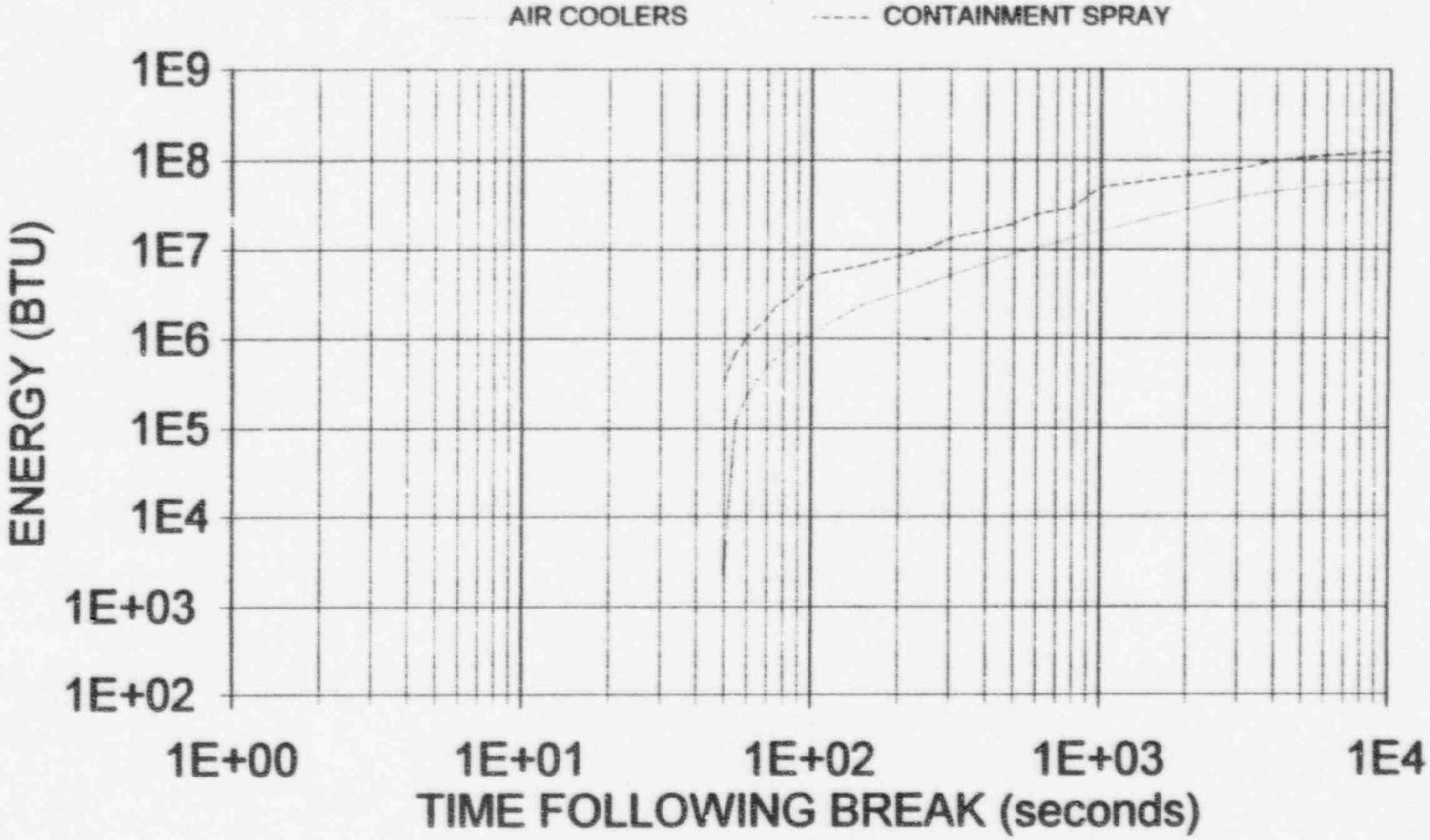
FIGURE 2-6 ENERGY
MSLB 102% POWER, 7.48 FT**2 BREAK AREA



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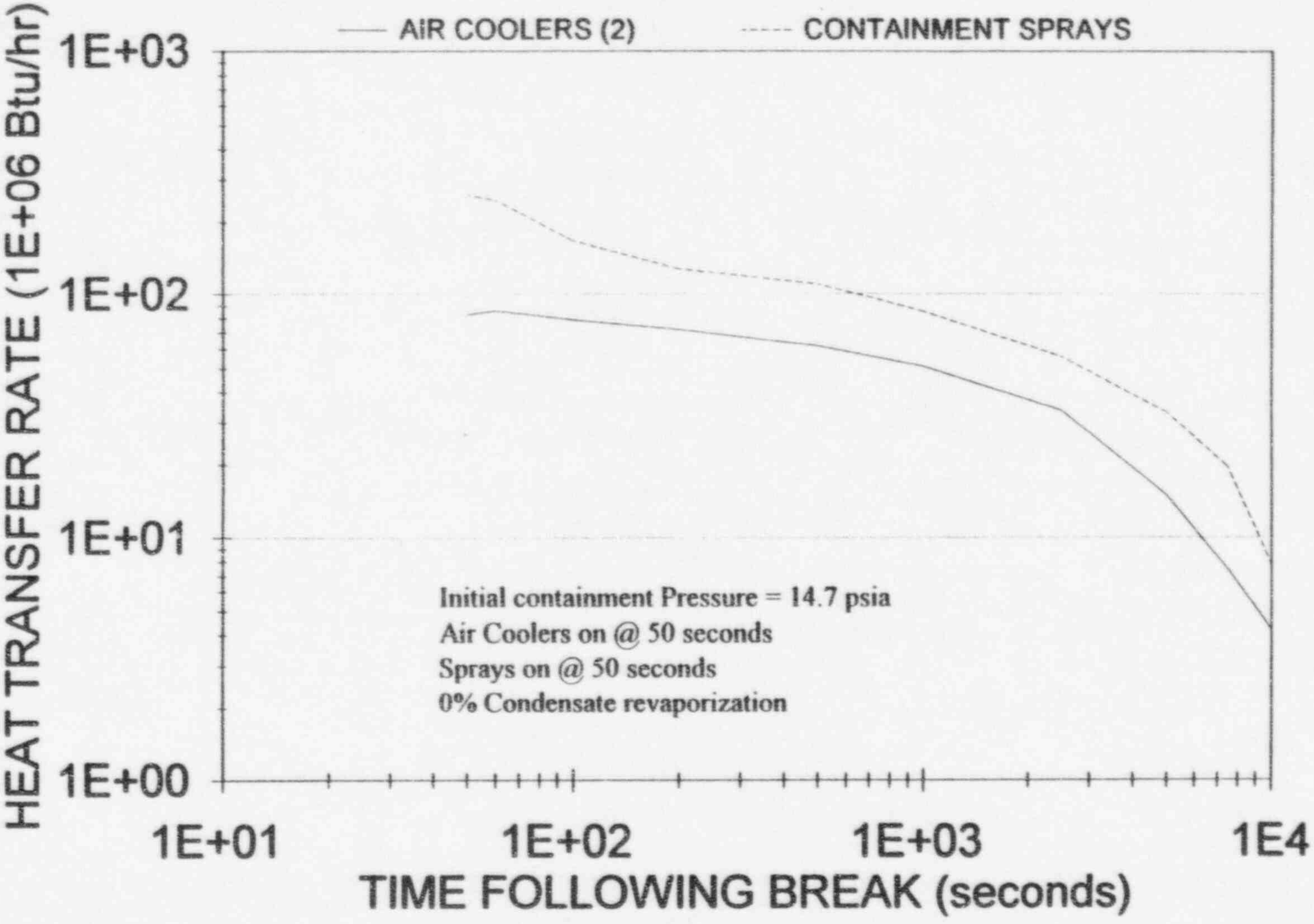
# FIGURE 2-7: VAPOR HEAT REMOVAL RATES

## DB MSLB 102% POWER-7.48 FT2 BREAK AREA



Initial containment Pressure = 14.7 psia
Air Coolers on @ 50 seconds
Sprays on @ 50 seconds
0% Condensate revaporization

SCE 26-426 NEW 4/90

## Table 2-1

CONTAINMENT P/T DESIGN BASIS MSLB EVENT CHRONOLOGY

**Initial Containment Pressure CPi = 14.7 psia**

| TIME ( seconds ) | EVENT |
|---|---|
| 0.0 | MSLB Occurs |
| 50 | Containment Sprays Start ( Nozzles at Full Discharge Flow ) AND Emergency Fan Coolers Start ( Full capacity) |
| **50** | **Peak Containment Temperature of 427.7 °F reached** |
| **62.2** | **Peak Containment Pressure of 56.6 psig reached** |
| 71.08 | End of Blowdown ( Affected Steam Generator ) |
| 175.0 | Containment Liner Plate Maximum Temperature of 243.8 °F reached |
| 9000.0 | Maximum Tech. Spec. Containment Pressure of 1.499 psig ≤ **1.5 psig** reached |
| 10,000.0 | End of Analysis |

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## Table 2-2

CONTAINMENT P/T DESIGN BASIS MSLB EVENT CHRONOLOGY

**Initial Containment Pressure CPi = 16.2 psia**

| TIME ( seconds ) | EVENT |
|---|---|
| 0.0 | MSLB Occurs |
| 50.0 | Containment Sprays Start ( Nozzles at Full Discharge Flow ) AND Emergency Fan Coolers Start ( Full capacity) |
| **50.0** | **Peak Containment Temperature of 421.6 °F reached** |
| **62.3** | **Peak Containment Pressure of 58.7 psig reached** |
| 71.08 | End of Blowdown ( Affected Steam Generator ) |
| 200.0 | Containment Liner Plate Maximum Temperature of 242.8 °F reached |
| 10,000.0 | End of Analysis |

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| △0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | | |
| | | | | | | | | | | |

## 2.2 RECOMMENDATIONS

This Supplement B provides a new analysis of record for the containment pressure and temperature response to the Design Basis MSLB event for containment functional design as reported in Section 6.2 of the UFSAR. The new analysis does not apply to in-containment equipment qualification which is separately addressed by Supplement A of the base calculation. Supplement B also provides analysis for the determination of peak post-MSLB pressure margin starting with the maximum initial containment pressure conditions (Technical Specification maximum value of 16.2 psia (1.5 psig per LCO 3.6.1.4)).

Section 6.2 of the UFSAR will be revised to replace the detailed results of the old AOR (initial containment pressure at zero psig) with the results of the new AOR for the same initial containment pressure of zero psig. Text will be added to clarify that analyses were also done with the initial containment pressure at 1.5 psig to confirm that the peak post-MSLB pressure remains below the containment design value of 60 psig when the initial pressure is at the Technical Specification maximum LCO value of 1.5 psig.

Technical Specification LCO/SRs 3/4.6.1.1, 3/4.6.1.2, and 3/4.6.1.3 will be revised to incorporate the $P_a$ of 56.6 psig from the new AOR; the value of $P_t$ (one-half $P_a$) will be revised to 28.3 psig. Technical Specification Basis 3/4.6.1.4 will be revised to identify the peak pressure of 58.7 psig calculated with the initial containment pressure at 1.5 psig, demonstrating compliance with the containment design value of 60 psig. Technical Specification Basis 3/4.6.1.6 will be revised to identify the maximum steam line break containment pressure of 56.6 psig as calculated by the current AOR.

The prior containment P/T response analysis contained in N-4080-027 Revision 0, remains applicable only for the purposes of defining the input modelling for the DB MSLB containment P/T analysis for all parameters except those changes identified in this Supplement B to the calculation.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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## 3.0 ASSUMPTIONS

The assumptions used in this calculation are identical to those used in the prior Containment P/T Analysis for Design Basis MSLB (reference 6.1), except where noted. Reference 6.1 remains valid for the purposes of defining the input modelling for the DB MSLB containment P/T analysis for all parameters except those changes identified in this Supplement B to the calculation. The assumptions in reference 6.1 are arranged in groups which parallel the COPATTA Code card series data input. The modifications to reference 6.1 assumptions are listed below.

### 3.1 CARD SERIES 1

### 3.1.a ITEM 5: CONTAINMENT INITIAL TEMPERATURE

In both the AOR (reference 6.1) and this analysis, the containment initial temperature was assumed to be 120°F. This is the maximum average containment temperature per SONGS Units 2 and 3 Technical Specification LCO 3.6.1.5 (references 6.6 and 6.7).

### 3.1.b ITEM 11: CONTAINMENT HEAT SINK REVAPORIZATION FRACTION

This analysis is performed for Containment P/T Design Basis MSLB Temperature and Pressure profile generation and supports containment functional design and not in-containment equipment qualification. Therefore credit for revaporization of heat sink condensate will not be taken. Supplement Aa to the base calculation contains the MSLB analysis supporting equipment qualification.

### 3.2 CARD SERIES 5

### 3.2.a ITEM 3: CONTAINMENT EMERGENCY AIR COOLER START TIME

In the AOR (reference 6.1), the containment air cooler start delay time was identified as 15 seconds in the Design Input 4.3.a. In the present analysis the air cooler start time has been increased to 50 seconds to coincide with the containment spray actuation time. The emergency air cooling units have relatively little impact on short-term containment pressure and temperature, and by adding 35 seconds delay to ECU initiation, margin is added to accommodate potential changes in the timing of ECU startup. For example, based on the methodology contained in calculation N-4080-003 (reference 6.15), the 50 second start time for the ECUs is equivalent to assuming a 47-second stroke time for the CCW block valves that supply cooling water to the air coolers, if all other parameters affecting ECU start time were to remain unchanged.

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Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 20**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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### 4.0 DESIGN INPUT

The design inputs used in this calculation are identical to those used in the prior Containment P/T Analysis for Design Basis MSLB (reference 6.1), except where noted. Reference 6.1 remains valid for the purposes of defining the input modelling for the DB-MSLB containment P/T analysis for all parameters except those changes identified in this Supplement B to the calculation. The assumptions in reference 6.1 are arranged in groups which parallel the COPATTA Code card series data input. The modifications to reference 6.1 assumptions are listed below.

### 4.1 CARD SERIES 0

The last four zero entries on this card are deleted. The G1-15 (RISC) version of COPATTA does not utilize these data entry locations.

### 4.2 CARD SERIES 1

a. ITEM 2: PROBLEM RUN TIME

The appropriate problem run time is 10,000 seconds ( ~2.8 hours ). The pipe break mass and energy release into the containment provided by the Combustion Engineering ( ABB-CE) included on CARD SERIES 301 terminate at 71.08 seconds, when dryout of the affected steam generator is calculated to occur for this Design Basis MSLB event. This run time of 10,000 seconds is well past the end of significant mass and energy release into the containment. Generally a run time of 1000 seconds is adequate to show that the containment pressure and temperature are decreasing rapidly and well below the peak values calculated prior to steam generator dryout. For this calculation, however, the run time has been extended to 10,000 seconds to be consistent with the prior AOR. The 10,000 second run time also roughly coincides with the time at which the refueling water storage tank would become depleted by the operation of a single spray train. Containment spray would be discontinued when the RWST is empty, since the shutdown heat exchanger, normally used for cooling recirculated spray water from the sump, would be required for shutdown cooling of the RCS.

b. ITEM 3: INITIAL CONTAINMENT PRESSURE

Consistent with the original design basis containment P/T response analysis for MSLB reported in the UFSAR supporting containment functional design (UFSAR Section 6.2), and SONGS Units 2 and 3 licensing basis (reference 6.2), the initial containment pressure will be set to 14.7 psia (0 psig). Sensitivity studies in Bechtel Topical report BN-TOP-3 (reference 6.8) show that the short-term peak vapor temperature increases with decreasing initial containment pressure because lower initial pressure corresponds to a smaller initial air mass in containment and a corresponding smaller containment total heat capacity.

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Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 21**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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The Supplement B also provides an analysis for the detrmination of peak post-MSLB containment pressure where the initial containment pressure is set at the Technical Specification maximum value of 16.2 psia (1.5 psig per LCO 3.6.1.4).

## 4.3 CARD SERIES 5

The last two entries on this card (0 and 105) are deleted. The G1-15 (RISC) version of COPATTA does not utilize these entry locations

### 4.3.a ITEM 3: CONTAINMENT EMERGENCY AIR COOLER START TIME

In the present analysis, the air cooler start delay time has been increased from 15 seconds to 50 seconds to coincide with the containment spray actuation time. The increase in air cooler start delay time will provide margin to accommodate potential changes in the timing of ECU startup such as an increase in the stroke time of the CCW block valves that isolate the cooling water from the air coolers.

## 4.4 CARD SERIES 301

No changes are made to card series 301 input which provides the mass flow rate and fluid enthalpy entering the containment from the main steam line break. The data is for the Design basis MSLB at 102% power with a break area of 7.48 ft$^2$.

As documented by CCN 1 to N-4080-004 (reference 6.3) and CCN 1 to N-4080-007 (reference 6.13), single failure of one of the isolation valves (HV8200 and/or HV8201) on the steam line feeding the auxiliary feed water pump turbine could allow cross-flow of steam from the intact steam generator into the containment through the affected steam generator. This cross-flow would come from the 1" diameter bypass lines installed around steam line check valves 1301MU003 and 1301MU005 by MMP 2 & 3 6869.00SM. This potential additional mass and energy input is not included in this new AOR. The referenced CCNs demonstrate that the effect of the cross-flow on short-term peak containment conditions is not significant. The increase in peak pressure and peak temperature due to this potential cross-flow are less than 0.1 psi and 0.3$^{0}$F, respectively.

Similarly, a single failure of the containment isolation valve on instrument air or high/low nitrogen supply lines to close, coupled with a MSLB-induced failure of one of the supply or distribution lines inside the containment would also lead to additional mass and energy release beyond what is provided by ABB-CE. CCN 2 to N-4080-007 (reference 6.13) evaluated this single failure and concluded that there would be no significant impact to the short-term peak containment pressure or temperature. Therefore, the mass and energy releases from a failed air or nitrogen line is not included in this Design Basis MSLB AOR.

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Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 22**

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|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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4.5 CARD SERIES 801

No changes are made to card series 801 input except:

a.2(a) Containment Spray Injection Mode Spray Flow Rate

The minimum Containment Pump Spray Flow Rate has been changed to 1606 gpm (reference 6.3). In this Supplement B the value has been rounded down to 1600 gpm providing a small margin over the minimum predicted spray flow. Using the same criteria as in the AOR, this value translates to a flow rate of 7.956E+5 lb/hr for 100°F water coming from the RWST.

The containment spray flow would be discontinued at about 1E4 seconds, consistent with a calculated time to deplete the refueling water storage tank inventory, using a single spray train, of about 1.1E4 seconds (reference 6.1, section 4.5.b.1). Following spray termination, containment heat removal is provided by the continued operation of the single train emergency air cooler units (2ECUs). Long-term RCS decay heat removal for the DB MSLB would be provided by placing the RCS on shutdown cooling.

4.6 CARD SERIES 1101

The G1-15 (RISC) version of COPATTA does not have the option of multiple tables of ECU performance versus containment temperature for various values of cooling water supply temperature. Therefore, following the card series identifier ($LIST POOL=1101), the input consists data pairs of containment saturation temperature and ECU heat removal rate.

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| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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## 5.0 METHODOLOGY

The MSLB for Equipment Qualification evaluated in this calculation is the design basis 7.48 ft$^2$ steam line break accident at 102% power with off-site power available and with a loss of one train each of containment emergency air coolers and containment sprays.

The evaluation used the Bechtel COPATTA computer code (reference 6.5) to simulate the containment response to the MSLB.

The methodology employed in this calculation is identical to the present AOR (reference 6.1) for the Containment P/T Design Basis MSLB, with the exception that two different pre-MSLB containment pressure conditions are analyzed:

1) Initial Containment Pressure of 14.7 psia (reference 6.2) for containment P/T functional design.

2) Initial Containment Pressure of 16.2 psia, maximum Technical Specification value, for peak post-MSLB containment pressure margin determination.

Small reductions in containment spray flow have been made to provide some margin with respect to currently calculated minimum values. In addition, the start time of the emergency air cooling units (ECUs) has been arbitrarily delayed to coincide with the start of containment spray to provide future margin on the timing of ECU startup.

## 6.0 REFERENCES

6.1 SONGS Units 2&3 Calculation N-4080-027, Revision 0, "Containment P/T Analysis for Design Basis MSLB", January 13, 1994.

6.2 Memo from J.L. Rainsberry to A.J. Brough, "Peak Containment Pressure Calculations, San Onofre Nuclear Generating Station, Units 2 and 3", May 12, 1994.

6.3 SONGS Units 2&3 Calculation M-0014-009, Revision 0, Supplement A, "Containment Spray (CSS) In Service Minimum Requirements, July 28, 1994.

6.5 Bechtel Standard Computer Program, NE100, COPATTA, Version G1-15, "Containment Temperature and Pressure Transient Analysis", User and Theory Manuals.

6.6 SONGS Unit 2 Operating License and Technical specifications, up to and including Amendment 114.

6.7 SONGS Unit 3 Operating License and Technical specifications, up to and including Amendment 103.

6.8 Bechtel Topical report BN-TOP-3, Revision 4, "Performance and Sizing of Dry; Pressure Containments", March 1983.

6.12 SONGS Units 2 and 3 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification", December 9, 1993.

6.13 SONGS Units 2 and 3 Calculation N-4080-007, Revision 2, "Containment Pressure and Temperature from MSLB at various Power Levels", April 21, 1983 ( includes CCNs 1 and 2 ).

6.14 SONGS Units 2&3 Calculation N-4080-027, Revision 0, Supplement A "Containment P/T Design Basis MSLB For Equipment Qualification", November 4, 1994.

6.15 SONGS Units 2 and 3 Calculation N-4080-003, Revision 5, "Containment Spray (CSS) and Emergency Cooling Unit (ECU) Actuation Times", December 23, 1993

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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## 7.0 NOMENCLATURE

Abbreviations are defined when first used within the body of the text.

## 8.0 CALCULATIONS

### 8.1 COPATTA CODE INPUT DATA - **Initial Containment Pressure CPi = 14.7 psia**

COPATTA input data for the Containment P/T Design Basis MSLB Analysis for uses the current AOR (reference 6.1) input data with modifications to reflect changes in containment spray flow rate (reference 6.3), initial containment pressure and Air Cooler start time to generate containment temperature and pressure profiles for the containment P/T design basis MSLB. Only the changes to the reference 6.1 input data will be presented in the following subsections.

#### 8.1.1 TITLE CARD

*DBMSLB 102%P, Pi=14.7, EV=0%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-B

#### 8.1.2 CARD SERIES 0

No changes made to Card Series 0 of reference 6.1 other than the deletion of the last four zero entries on the Bechtel input file as non-applicable to COPATTA version G1-15.

#### 8.1.3 CARD SERIES 1: General Problem Information

&LIST POOL=1,1E5,14.7,2.305E6,120,0.6,20,582.945,1,1,0.00,14.7,0,0.50 $END

ITEM 2: TNFL = 2E4 seconds (per 4.2.a)

ITEM 3: PAIR = 14.7 psia

The initial containment pressure before the MSLB mass and energy release is set to 14.7 psia for DB-MSLB for containment P/T finctional design (UFSAR Section 6.2), as discussed in the Design Input Item 4.2.b.

Card Series input ITEMS 4 through 10 remain unchanged from that of reference 6.1.

ITEM 11: EVAP = 0.0

The fraction of heat sink condensate which will be allowed to revaporize is set to 0.0. NO credit for revaporization will be taken for the purposes of DB MSLB analysis per assumption 3.1.a.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
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| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

8.1.4 CARD SERIES 5: Air Cooler Information

```
$LIST POOL=5,2,50,1E7,0,0 $END
```

ITEM 3: This item reflect the change of Containment Air Cooler start time from 15 seconds to 50 seconds as discussed in Design Input Item 4.3.a. No other changes have been made to this card data.

8.1.5 CARD SERIES 801: ( Table 9 )

This Card Series reflect the change of Containment Spray System (CSS) Flow Rate from 1612 gpm to 1600 gpm and the termination of containment spray flow at 10,000 seconds.

```
$LIST POOL=801,
         0,        0,   0,   0,   100,   100,
        50,        0,   0,   0,   100,   100,
        50, 7.956E5,   0,   0,   100,   100,
       1E4, 7.956E5,   0,   0,   100,   100,
       1E4,      0.0,   0,   0,   100,   100,
       2E7,      0.0,   0,   0,   100,   100 $END
```

8.1.6 CARD SERIES 1101

Items 2,3 and 4 of reference 6.1 input are deleted as not applicable to the G1-15 (RISC) version of COPATTA.

All other input used in this calculation remain unchanged from that of Reference 6.1, as described in Sections 8.1.1 through 8.1.33, except as changed in the preceding paragraphs.

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Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 28**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
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8.2 COPATTA CODE INPUT DATA - **Initial Containment Pressure CPi = 16.2 psia**

Supplement B also provides additional analysis to determine the margin for peak post-MSLB containment pressure under maximum containment initial pressure conditions [Technical Specification maximum value of 16.2 psia (1.5 psig) per LCO 3.6.1.4]. COPATTA input data for the this case is presented as changes made to the COPATTA input for Containment P/T Design Basis MSLB Analysis and Equipment Qualification, presented in Section 8.1 of this document.

8.2.1 TITLE CARD

*TSMSLB 102%P, Pi=16.2, EV=0%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-B

8.2.2 CARD SERIES 0

No changes made to Card Series 0 of reference 6.1 other than the deletion of the last four zero entries on the Bechtel input file as non-applicable to COPATTA version G1-15.

8.2.3 CARD SERIES 1: General Problem Information

&LIST POOL=1,1E5,16.2,2.305E6,120,0.6,20,582.945,1,1,0.00,14.7,0,0.50 $END

ITEM 3: PAIR = 16.2 psia

The initial containment pressure before the MSLB mass and energy release is set to 16.2 psia for the peak post-MSLB containment pressure analysis, as discussed in the Design Input Item 4.2.b.

## 9.0 COPATTA INPUT FILES

### 9.1 DBMSLB CPi = 14.7 psia

```
*DBMSLB 102%P, Pi=14.7, EV=0%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-B
 $LIST POOL=0,0,1,0,1 $END
 $LIST POOL=1,1E5,14.7,2.305E6,120,0.6,20,582.945,1,1,0.00,14.7,0.5 $END
 $LIST POOL=2,0,0,0,0,0,120,2E7 $END
 $LIST POOL=3,0,0,0,0,0,2E7,0,0,0,0 $END
 $LIST POOL=4,0,0,0,0,0,0,0,0,0,0,0,0 $END
 $LIST POOL=5,2,50,1E7,0,0 $END
 $LIST POOL=6,0,0,0 $END
 $LEAK NOPEN=0 $END
 $LIST POOL=101,
          0,      0,
        2E7,      0 $END
 $LIST POOL=201,
          0,      0,
        2E7,      0 $END
 $LIST POOL=301,
                    0,    5.145520E7,    1.195589E3,
                 0.22,    4.869032E7,    1.197482E3,
                 0.42,    4.622234E7,    1.198466E3,
                 0.62,    4.405936E7,    1.199410E3,
                 1.08,    4.003276E7,    1.201595E3,
                 1.58,    3.688855E7,    1.201757E3,
                 2.08,    3.445970E7,    1.202018E3,
                 2.58,    3.326288E7,    1.200986E3,
                 3.58,    3.152606E7,    1.201058E3,
                 4.58,    3.028468E7,    1.201655E3,
                 5.58,    2.940080E7,    1.201123E3,
                 6.58,    2.874870E7,    1.201126E3,
                 7.58,    2.706574E7,    1.204404E3,
                 8.58,    2.468326E7,    1.204367E3,
                 9.58,    2.294968E7,    1.204238E3,
                10.58,    2.160122E7,    1.203908E3,
                12.58,    1.943143E7,    1.203195E3,
                14.58,    1.765940E7,    1.202277E3,
                16.58,    1.637240E7,    1.201556E3,
                18.58,    1.544720E7,    1.200963E3,
                20.58,    1.473293E7,    1.200422E3,
                25.58,    1.327525E7,    1.198820E3,
                30.58,    1.221858E7,    1.197825E3,
                35.58,    1.146406E7,    1.196753E3,
                40.58,    1.059131E7,    1.195307E3,
                45.58,    9.801216E6,    1.194165E3,
```

```
              50.58,    9.132588E6,     1.193086E3,
              60.58,    8.280324E6,     1.190935E3,
              61.08,    7.245576E6,     1.190949E3,
              62.08,    5.803344E6,     1.189165E3,
              62.58,    3.238704E6,     1.184658E3,
              64.58,    3.948840E5,     1.179953E3,
              68.58,    1.074240E5,     1.251072E3,
              71.08,             0,              0,
                2E7,             0,              0 $END
$LIST POOL=401,
         0,     0,     0,
       2E7,     0,     0 $END
$LIST POOL=501,
         0,     0,     0,
       2E7,     0,     0 $END
$LIST POOL=601,
         0,     7.2E4,     7.2E6,
      0.05,     7.2E4,     7.2E6,
      0.05,       0.0,       0.0,
       2E7,     0,     0 $END
$LIST POOL=701,
         0,     0,     0,     0,
       2E7,     0,     0,     0 $END
$LIST POOL=801,
       0,       0,   0,   0,   100,   100,
      50,       0,   0,   0,   100,   100,
      50, 7.956E5,   0,   0,   100,   100,
     1E4, 7.956E5,   0,   0,   100,   100,
     1E4,     0.0,   0,   0,   100,   100,
     2E7,     0.0,   0,   0,   100,   100 $END
$LIST POOL=901,
         0,     0,     0,
       2E7,     0,     0 $END
$LIST POOL=1001,
         0,   100,   2.0,
        24,   100,   2.0 $END
$LIST POOL=1101,
           105,        0,
           120,  1.670E6,
           130,  3.020E6,
           140,  4.570E6,
           150,  6.320E6,
           160,  8.270E6,
           170,  1.040E7,
           180,  1.273E7,
           190,  1.523E7,
```

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|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

```
           200,  1.788E7,
           210,  2.068E7,
           220,  2.361E7,
           230,  2.664E7,
           240,  2.974E7,
           250,  3.291E7,
           260,  3.611E7,
           270,  3.931E7,
           280,  4.252E7,
           287,  4.474E7,
           290,  4.569E7,
           300,  4.882E7 $END
 $LIST POOL=1201,
             0,  0.729,
           0.1,  0.737,
           0.2,  0.747,
           0.3,  0.757,
           0.4,  0.771,
           0.5,  0.788,
           0.6,  0.809,
           0.7,  0.832,
           0.8,  0.863,
           0.9,  0.912,
           1.0,  0.961,
           1.1,  0.983,
           1.2,  0.995,
           1.3,  1.000 $END
 $LIST POOL=9001,
               5,  0.05,    1.0,   5,
              10,  0.05,    1.0,   5,
              15,  0.05,    1.0,   5,
              20,  0.05,    1.0,   5,
             100,   0.1,    1.0,   5,
             200,   1.0,    5.0,   5,
             600,   1.0,   10.0,   5,
             800,   2.0,   20.0,   5,
             1E3,   5.0,   50.0,   1,
             1E4,  50.0,   1000,   2,
             1E4,  50.0,    500,   2,
             5E4,  50.0,   5000,   2,
             2E5,  50.0,  10000,   2 $END
 $LIST POOL=9999 $END
* HS #1 - REACTOR BUILDING DOME
 $LIST POOL=101001, 100, 7, 0, 0, 0, 34693.22 $END
 $LIST POOL=101101, 5, 0.00075,   3,   0.02158,
                    3, 0.02193,  10,   0.06360,
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

```
                   20, 0.23028,  37,   1.00110,
                   21, 4.06363 $END
 $LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=101300, 0, 0 $END
 $LIST POOL=101400, 9, 2, 1, 1 $END
* HS #2 - CYLINDER WALL BETWEEN El. 29'6" AND 112'0"
 $LIST POOL=102001, 100, 7, 0, 0, 0, 0, 38120 $END
 $LIST POOL=102101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526 $END
 $LIST POOL=102201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=102300, 0, 0 $END
 $LIST POOL=102400, 9, 2, 1, 1 $END
* HS #3 - CYLINDER WALL BETWEEN El. 15'0" AND El. 29'6"
 $LIST POOL=103001, 100, 7, 0, 0, 0, 0, 6667.38 $END
 $LIST POOL=103101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526 $END
 $LIST POOL=103201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=103300, 0, 0 $END
 $LIST POOL=103400, 9, 2, 0, 2 $END
* HS #4 - BASEMAT (OTHER THAN REACTOR BASEMAT)
 $LIST POOL=104001, 53, 5, 0, 0, 0, 0, 12800 $END
 $LIST POOL=104101, 3,  0.00067,   7,      0.1,
                   20,  1.52698,   2, 1.54781,
                   20, 11.02150 $END
 $LIST POOL=104201, 4, 2, 2, 1, 2 $END
 $LIST POOL=104300, 0, 0 $END
 $LIST POOL=104400, 3, 3, 0, 3 $END
* HS #5 - REACTOR BASEMAT & S.G. PEDESTALS
 $LIST POOL=105001, 70, 4, 0, 0, 0, 0, 1644 $END
 $LIST POOL=105101, 4, 0.00158,   10,      0.1,
                   30,    2.00,   25, 8.43092 $END
 $LIST POOL=105201, 4, 2, 2, 2 $END
 $LIST POOL=105300, 0, 0 $END
 $LIST POOL=105400, 3, 3, 0, 3 $END
* HS #6 - REACTOR CAVITY WALLS BELOW El. 15'0"
 $LIST POOL=106001, 93, 5, 1, 11.75, 0, 0, 21.5 $END
 $LIST POOL=106101, 5, 11.75192,    7, 11.77292,
                   30, 13.29923,   30, 19.29923,
                   20, 25.25192 $END
 $LIST POOL=106201, 4, 2, 2, 2, 2 $END
 $LIST POOL=106300, 0, 0 $END
 $LIST POOL=106400, 3, 3, 0, 3 $END
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

```
* HS #7 - REACTOR CAVITY WALLS ABOVE El. 15'0"
 $LIST POOL=107001, 68, 5, 0, 0, 0, 0, 2810 $END
 $LIST POOL=107101, 5, 0.00192,   7, 0.02292,
                   15, 0.40192,  20,    2.00,
                   20, 4.00192 $END
 $LIST POOL=107201, 4, 2, 2, 2, 2 $END
 $LIST POOL=107300, 0, 0 $END
 $LIST POOL=107400, 9, 2, 0, 2 $END
* HS #8 - LINED REFUELING CANAL WALLS
 $LIST POOL=108001, 86, 6, 0, 0, 0, 0, 9200 $END
 $LIST POOL=108101, 5, 0.01563,    20,     0.1,
                   15, 0.41563,    20,    2.00,
                   20, 4.01563,     5, 4.01755 $END
 $LIST POOL=108201, 3, 2, 2, 2, 2, 4 $END
 $LIST POOL=108300, 0, 0 $END
 $LIST POOL=108400, 9, 2, 9, 2 $END
* HS #9 - S.G. CMPRTMNT WALLS, UNLINED REFL CNL WALLS/OTH INT WALLS
 $LIST POOL=109001, 78, 4, 0, 0, 0, 0, 41976 $END
 $LIST POOL=109101, 5, 0.00192,    10, 0.04233,
                   12,     0.1,    50, 1.71876 $END
 $LIST POOL=109201, 4, 2, 2, 2 $END
 $LIST POOL=109300, 0, 0 $END
 $LIST POOL=109400, 9, 2, 0, 2 $END
* HS #10 - FLOOR SLABS (OTHER THAN BASEMATS)
 $LIST POOL=110001, 67, 6, 0, 0, 0, 0, 17474 $END
 $LIST POOL=110101, 3, 0.00014, 5, 0.005348,
                   20, 0.105348, 15, 0.505348,
                   20, 1.505348, 3, 1.506015 $END
 $LIST POOL=110201, 4, 1, 2, 2, 2, 4 $END
 $LIST POOL=110300, 0, 0 $END
 $LIST POOL=110400, 9, 2, 9, 2 $END
* HS #11 - LIFTING DEVICES (EXCEPT STAINLESS STEEL PARTS)
 $LIST POOL=111001, 17, 2, 0, 0, 0, 0, 57286 $END
 $LIST POOL=111101, 6, 0.00125, 10, 0.042917 $END
 $LIST POOL=111201, 4, 1 $END
 $LIST POOL=111300, 0, 0 $END
 $LIST POOL=111400, 9, 2, 0, 2 $END
* HS #12 - MISCELLANEOUS CARBON STEEL - THICKNESS > 2.50 INCHES
 $LIST POOL=112001, 64, 4, 0, 0, 0, 0, 516 $END
 $LIST POOL=112101, 6, 0.0005, 17, 0.084,
                   15, 0.20, 25, 0.310849 $END
 $LIST POOL=112201, 4, 1, 1, 1 $END
 $LIST POOL=112300, 0, 0 $END
 $LIST POOL=112400, 9, 2, 0, 2 $END
* HS #13 - MISCELLANEOUS CARBON STEEL: 1.00"<THICKNESS<2.50"
 $LIST POOL=113001, 32, 2, 0, 0, 0, 0, 12042 $END
```

```
 $LIST POOL=113101, 6, 0.00063, 25, 0.16967 $END
 $LIST POOL=113201, 4, 1 $END
 $LIST POOL=113300, 0, 0 $END
 $LIST POOL=113400, 9, 2, 0, 2 $END
* HS #14 - MISCELLANEOUS CARBON STEEL: 0.50"<THICKNESS<1.00"
 $LIST POOL=114001, 19, 2, 0, 0, 0, 0, 64693 $END
 $LIST POOL=114101, 5, 0.000674, 13, 0.038607 $END
 $LIST POOL=114201, 4, 1 $END
 $LIST POOL=114300, 0, 0 $END
 $LIST POOL=114400, 9, 2, 0, 2 $END
* HS #15 - MISCELLANEOUS CARBON STEEL: THICKNESS<0.5"
 $LIST POOL=115001, 17, 2, 0, 0, 0, 0, 98913.6 $END
 $LIST POOL=115101, 6, 0.000606, 10, 0.012833 $END
 $LIST POOL=115201, 4, 1 $END
 $LIST POOL=115300, 0, 0 $END
 $LIST POOL=115400, 9, 2, 0, 2 $END
* HS #16 - ELECTRICAL EQUIPMENT
 $LIST POOL=116001, 8, 1, 0, 0, 0, 0, 37644.5 $END
 $LIST POOL=116101, 7, 0.0054 $END
 $LIST POOL=116201, 1 $END
 $LIST POOL=116300, 0, 0 $END
 $LIST POOL=116400, 9, 2, 0, 2 $END
* HS #17 - MISCELLANEOUS STAINLESS STEEL
 $LIST POOL=117001, 16, 1, 0, 0, 0, 0, 24048 $END
 $LIST POOL=117101, 15, 0.01747 $END
 $LIST POOL=117201, 3 $END
 $LIST POOL=117300, 0, 0 $END
 $LIST POOL=117400, 9, 2, 0, 2 $END
* HS #18 - UNLINED REFUELING CANAL WALLS BELOW El. 63'6"
 $LIST POOL=118001, 48, 4, 0, 0, 0, 0, 3700 $END
 $LIST POOL=118101, 5, 0.00192, 7, 0.02292,
                   15, 0.40192, 20, 2.00192 $END
 $LIST POOL=118201, 4, 2, 2, 2 $END
 $LIST POOL=118300, 0, 0 $END
 $LIST POOL=118400, 9, 2, 0, 2 $END
* HS #19 - REACTOR BLDG CYLINDER #3: SECTIONS WITH STIFFENERS
 $LIST POOL=119001, 100, 7, 0, 0, 0, 0, 1590.68 $END
 $LIST POOL=119101, 5, 0.00075,   20,  0.66742,   3,   0.66777,
                   15, 0.70944,   20,  0.79278,  16,  1.44278,
                   20, 4.87885 $END
 $LIST POOL=119201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=119300, 0, 0 $END
 $LIST POOL=119400, 9, 2, 1, 1 $END
* HS #20 - VENT TUNNELS
 $LIST POOL=120001, 23, 2, 0, 0, 0, 0, 2827 $END
 $LIST POOL=120101, 10, 0.0005,  12, 0.03175 $END
```

NES&L DEPARTMENT

# CALCULATION SHEET

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CCN CONVERSION
CCN NO. CCN - 2

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027 Supplement B**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 35**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

```
$LIST POOL=120201, 4, 1 $END
$LIST POOL=120300, 0, 0 $END
$LIST POOL=120400, 9, 2, 0, 2 $END
$LIST POOL=410001,
          25,     54,
         0.8,     30,
          10,     54,
         0.1,     20,
     0.0174, 0.0103 $END
$LIST POOL=500000 $END
```

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# CALCULATION SHEET

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CCN CONVERSION
CCN NO. CCN - 2

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027 Supplement B**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 36**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

**9.2 TSMSLB** CPi = **16.2** psia

```
*DBMSLB 102%P, Pi=16.2, EV=0%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-B
 $LIST POOL=0,0,1,0,1 $END
 $LIST POOL=1,1E5,16.2,2.305E6,120,0.6,20,582.945,1,1,0.00,14.7,0.5 $END
```

All other input data is identical to the DBMSLB input data.

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**CALCULATION SHEET**

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|---|---|
| | CCN CONVERSION<br>CCN NO. CCN - 2 |

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027 Supplement B**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 37**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

REV. INDICATOR

## 10.0 SELECTED OUTPUT DATA

The tabulated data presented in Sections 10.1 and 10.2 consists of partial output of the COPATTA calculation made for this analysis.

10.1

### Table for Figures 2-1, 2-2 and 2-4

| | | CONTAINMENT | | |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMPERATURE | SUMP TEMPERATURE | HEAT SINK 1 LEFT BOUNDARY |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| | | | | |
| 0 | 0.0 | 120.0 | 120.0 | 118.4 |
| 5 | 13.7 | 289.3 | 178.8 | 136.0 |
| 10 | 23.3 | 349.8 | 204.3 | 153.4 |
| 15 | 29.8 | 378.0 | 218.9 | 166.6 |
| 20 | 34.8 | 394.0 | 228.4 | 178.5 |
| 25 | 38.8 | 404.5 | 235.4 | 188.0 |
| 30 | 42.4 | 412.1 | 240.8 | 196.2 |
| 35 | 45.7 | 417.7 | 245.1 | 203.4 |
| 40 | 48.6 | 422.1 | 248.8 | 210.1 |
| 45 | 51.2 | 425.3 | 251.9 | 216.7 |
| 50 | 53.5 | 427.7 | 254.7 | 222.6 |
| 55 | 54.9 | 418.4 | 257.2 | 227.7 |
| 60 | 56.3 | 409.6 | 259.3 | 232.4 |
| 62 | 56.6 | 406.0 | 260.1 | n/a |
| 65 | 56.1 | 398.6 | 261.2 | 235.4 |
| 70 | 54.6 | 385.3 | 262.6 | 236.9 |

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# CALCULATION SHEET

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CCN CONVERSION
CCN NO. CCN - 2

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027 Supplement B

Subject CONTAINMENT P/T DESIGN BASIS MSLB Sheet No. B- 38

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

| | | CONTAINMENT | | |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMPERATURE | SUMP TEMPERATURE | HEAT SINK 1 LEFT BOUNDARY |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| | | | | |
| 75 | 53.1 | 372.0 | 263.6 | 238.1 |
| 80 | 51.6 | 359.0 | 264.3 | 239.0 |
| 85 | 50.2 | 346.3 | 264.8 | 239.9 |
| 90 | 49.0 | 333.9 | 265.2 | 240.6 |
| 95 | 47.7 | 321.5 | 265.5 | 241.1 |
| 100 | 46.5 | 309.2 | 265.7 | 241.5 |
| 105 | 45.4 | 297.8 | 265.9 | n/a |
| 110 | 44.2 | 285.8 | 265.9 | n/a |
| 120 | 43.3 | 267.0 | 266.0 | n/a |
| 200 | 37.6 | 259.7 | 264.7 | 243.6 |
| 300 | 33.7 | 253.3 | 262.1 | 241.0 |
| 400 | 30.9 | 248.1 | 259.4 | 238.0 |
| 600 | 26.7 | 239.8 | 254.2 | 232.0 |
| 800 | 23.5 | 232.7 | 248.9 | 225.9 |
| 1000 | 20.8 | 226.1 | 243.6 | 220.3 |
| 2000 | 13.7 | 204.7 | 224.1 | 204.6 |
| 4000 | 6.2 | 169.4 | 199.8 | 172.3 |
| 6000 | 3.0 | 145.1 | 182.9 | 157.8 |
| 8000 | 1.8 | 132.3 | 170.7 | 148.3 |
| 9000 | 1.50 | 128.6 | 165.9 | 144.8 |
| 10000 | 1.25 | 125.8 | 161.7 | 141.9 |

n/a = not available in computer output at the time cited.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

10.2 (continued)

Table for FIGURE 2-5

Integrated Energy Transferred from the Containment Vapor Region by one Train of Air Coolers, 2ECUs and one Train of Containment Spray v.s. Time

| | | INTEGRATED | ENERGY | | | |
|---|---|---|---|---|---|---|
| TIME | STEAM | AIR | VAPOR | SUMP | TOTAL | HEAT SINKS |
| SEC | BTU | BTU | BTU | BTU | BTU | BTU |
| | | | | | | |
| 1 | 3.23e+07 | 1.71e+07 | 4.93e+07 | 1.35e+04 | 4.93e+07 | 2.22e+04 |
| 3 | 4.26e+07 | 1.78e+07 | 6.03e+07 | 3.40e+04 | 6.04e+07 | 2.63e+05 |
| 5 | 6.17e+07 | 1.88e+07 | 8.05e+07 | 1.05e+05 | 8.06e+07 | 7.28e+05 |
| 10 | 1.02e+08 | 2.04e+07 | 1.23e+08 | 4.71e+05 | 1.23e+08 | 2.79e+06 |
| 15 | 1.31e+08 | 2.11e+07 | 1.52e+08 | 1.05e+06 | 1.53e+08 | 5.73e+06 |
| 20 | 1.53e+08 | 2.15e+07 | 1.75e+08 | 1.77e+06 | 1.76e+08 | 9.19e+06 |
| 25 | 1.72e+08 | 2.17e+07 | 1.94e+08 | 2.58e+06 | 1.96e+08 | 1.29e+07 |
| 30 | 1.88e+08 | 2.19e+07 | 2.10e+08 | 3.44e+06 | 2.14e+08 | 1.67e+07 |
| 35 | 2.04e+08 | 2.21e+07 | 2.26e+08 | 4.31e+06 | 2.30e+08 | 2.05e+07 |
| 40 | 2.17e+08 | 2.22e+07 | 2.39e+08 | 5.19e+06 | 2.45e+08 | 2.42e+07 |
| 45 | 2.30e+08 | 2.23e+07 | 2.52e+08 | 6.08e+06 | 2.58e+08 | 2.80e+07 |
| 50 | 2.41e+08 | 2.23e+07 | 2.63e+08 | 6.97e+06 | 2.70e+08 | 3.30e+07 |
| 55 | 2.51e+08 | 2.20e+07 | 2.73e+08 | 7.88e+06 | 2.81e+08 | 3.52e+07 |
| 60 | 2.61e+08 | 2.19e+07 | 2.83e+08 | 8.77e+06 | 2.92e+08 | 3.86e+07 |
| 65 | 2.65e+08 | 2.16e+07 | 2.86e+08 | 9.63e+06 | 2.96e+08 | 4.19e+07 |
| 70 | 2.61e+08 | 2.12e+07 | 2.83e+08 | 1.04e+07 | 2.93e+08 | 4.49e+07 |
| 75 | 2.58e+08 | 2.09e+07 | 2.79e+08 | 1.12e+07 | 2.90e+08 | 4.76e+07 |
| 100 | 2.46e+08 | 1.93e+07 | 2.65e+08 | 1.40e+07 | 2.79e+08 | 5.85e+07 |
| 200 | 2.12e+08 | 1.81e+07 | 2.31e+08 | 2.54e+07 | 2.56e+08 | 8.11e+07 |

NES&L DEPARTMENT

# CALCULATION SHEET

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CCN CONVERSION
CCN NO. CCN - 2

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027 Supplement B**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B- 40**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

| | | INTEGRATED | ENERGY | Fig 2-5 | | |
|---|---|---|---|---|---|---|
| TIME | STEAM | AIR | VAPOR | SUMP | TOTAL | HEAT SINKS |
| SEC | BTU | BTU | BTU | BTU | BTU | BTU |
| | | | | | | |
| 300 | 1.91e+08 | 1.79e+07 | 2.09e+08 | 3.47e+07 | 2.44e+08 | 9.30e+07 |
| 400 | 1.76e+08 | 1.78e+07 | 1.93e+08 | 4.25e+07 | 2.36e+08 | 1.00e+08 |
| 600 | 1.52e+08 | 1.76e+07 | 1.70e+08 | 5.61e+07 | 2.26e+08 | 1.10e+08 |
| 800 | 1.34e+08 | 1.74e+07 | 1.52e+08 | 6.79e+07 | 2.20e+08 | 1.16e+08 |
| 1000 | 1.20e+08 | 1.72e+07 | 1.37e+08 | 7.84e+07 | 2.15e+08 | 1.20e+08 |
| 2000 | 8.02e+07 | 1.67e+07 | 9.69e+07 | 1.21e+08 | 2.18e+08 | 1.21e+08 |
| 4000 | 3.87e+07 | 1.58e+07 | 5.45e+07 | 1.86e+08 | 2.40e+08 | 1.12e+08 |
| 6000 | 2.21e+07 | 1.52e+07 | 3.74e+07 | 2.36e+08 | 2.74e+08 | 1.01e+08 |
| 8000 | 1.60e+07 | 1.49e+07 | 3.08e+07 | 2.79e+08 | 3.10e+08 | 8.96e+07 |
| 9000 | 1.43e+07 | 1.48e+07 | 2.90e+07 | 2.99e+08 | 3.28e+08 | 8.47e+07 |
| 10000 | 1.29e+07 | 1.47e+07 | 2.76e+07 | 3.19e+08 | 3.46e+08 | 8.03e+07 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

FIGURE 2-6
Integrated Heat Transfer of the Air Coolers and Containment Sprays

| TIME | INTERGRATED ENERGY CONTAINMENT SPRAYS | INTERGRATED ENERGY AIR COOLERS |
|---|---|---|
| (SEC) | (BTU) | (BTU) |
| 50 | | 2.31e+03 |
| 55 | 3.56e+05 | 1.19e+05 |
| 60 | 7.03e+05 | 2.38e+05 |
| 65 | 1.04e+06 | 3.57e+05 |
| 70 | 1.36e+06 | 4.76e+05 |
| 75 | 1.67e+06 | 5.94e+05 |
| 85 | 2.24e+06 | 8.24e+05 |
| 100 | 2.99e+06 | 1.16e+06 |
| 150 | 5.28e+06 | 2.43e+06 |
| 200 | 6.70e+06 | 3.24e+06 |
| 250 | 8.44e+06 | 4.23e+06 |
| 300 | 1.01e+07 | 5.18e+06 |
| 400 | 1.34e+07 | 7.02e+06 |
| 500 | 1.66e+07 | 9.12e+06 |
| 600 | 1.95e+07 | 1.05e+07 |
| 800 | 2.50e+07 | 1.36e+07 |
| 1000 | 3.00e+07 | 1.66e+07 |
| 2000 | 5.07e+07 | 2.88e+07 |
| 3000 | 6.71e+07 | 3.81e+07 |
| 4000 | 8.01e+07 | 4.49e+07 |
| 6000 | 9.87e+07 | 5.34e+07 |
| 8000 | 1.11e+08 | 5.81e+07 |
| 10,000 | 1.20e+08 | 6.11e+07 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

FIGURE 2-7

Rate of Energy Transfer from the Vapor Region by a Single Train of Emergency Cooling Units (2ECUs) and by a Single Train of Containment Sprays vs Time

| TIME | ENERGY REMOVAL RATE BY CONTAINMENT SPRAYS | TIME | ENERGY REMOVAL RATE BY CONTAINMENT AIR COOLERS |
|---|---|---|---|
| secs | (btu/hr)xE6 | secs | (btu/hr)xE6 |
| | | | |
| 51.5 | 258.1 | 50 | 82.7 |
| 60.0 | 246.0 | 60 | 85.4 |
| 99.5 | 167.3 | 100 | 78.6 |
| 200 | 126.9 | 200 | 72.1 |
| 500 | 110.3 | 500 | 61.8 |
| 975 | 85.0 | 1000 | 50.9 |
| 2750 | 55.7 | 2500 | 33.7 |
| 5000 | 33.1 | 5000 | 15.0 |
| 7750 | 19.6 | 7500 | 7.5 |
| 10000 | 15.5 | 10000 | 4.4 |

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-2

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CCN CONVERSION
CCN NO. CCN - 2

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027 Supplement B**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB** Sheet No. **B-43**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 01/27/95 | PAUL BARBOUR | 02/14/95 | | | | | |
| | | | | | | | | | |

APPENDIX A (COPATTA Code I/O File)

The COPATTA Code input files are presented in Section 9 of this calculation.

The COPATTA Code output files are included on Microfiche. The output file name and date are as follows:

FICHE TITLE : DBMSLB J5284 18-Jan-95

JOB TITLE : *DBMSLB 102%P, CPi=14.7, EVAP=0%, CT=1, LOP=0, CS=1600, N-4080-027-SUP-B

RUN DATE : 20-Dec-94

LAST SHEET : Page 409

FICHE TITLE : TSMSLB J5303 18-Jan-95

JOB TITLE : *TSMSLB 102%P, CPi=16.2, EVAP=0%, CT=1, LOP=0, CS=1600, N-4080-027-SUP-B

RUN DATE : 28-Dec-94

LAST SHEET : Page 409

NES&L DEPARTMENT

## CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N - 2

PAGE 45 OF 52

CCN CONVERSION: CCN NO. CCN - 2

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 6

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | | |

THIS SECTION REPLACED BY SECTION 2 IN SUPPLEMENT B 1

# 2 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

## 2.1 RESULTS/CONCLUSIONS

Figure 2-1 presents the sump and vapor pressures versus time for the DBA MSLB. The plots in Figure 2-1 are generated using the data presented in Section 10.1.

Figure 2-2 presents the containment gauge pressure versus time for the DBA MSLB. The plot in Figure 2-2 is generated using the data presented in Section 10.1.

Figure 2-3 presents the condensing heat transfer coefficient used by the COPATTA Code versus time for the DBA MSLB. The plot in Figure 2-3 is generated using the data presented in Section 10.1.

Figure 2-4 presents the inside surface temperature of heat sink 1 (reactor building dome) to represent the temperature of the containment structure. The plot in Figure 2-4 is generated using the data presented in Section 10.1.

Figure 2-5 presents the instantaneous energy vs. time data used by COPATTA to determine heat transfer in the DBA MSLB. The plots in Figure 2-5 are generated using the data presented in Section 10.2. Included are:

| | |
|---|---|
| VAPOR ENERGY: | Instantaneous steam+air energy. |
| SUMP ENERGY: | Instantaneous energy of sump water. |
| TOTAL ENERGY: | Instantaneous energy inventory. |
| HEAT SINKS: | Instantaneous energy stored in structures. |

Figure 2-6 presents the integrated heat transfer of the air coolers and containment sprays. The plots presented in figure 2-6 are generated using the data in Section 10.2. Included are:

| | |
|---|---|
| AIR COOLERS: | Integrated energy removed by emergency fan coolers. |
| CONT. SPRAY: | Integrated energy transferred to sump by sprays. |

The following table presents the accident chronology for the analysis.

NES&L DEPARTMENT

# CALCULATION SHEET

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Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

CCN CONVERSION: CCN NO. CCN – 2

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 7

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/94 | | | | | |

REV ⇓

THIS TEXT AND TABLE REPLACED BY TEXT IN SEC. 2 & TABLES 2-1 & 2-2 IN SUPPLEMENT B

| ~~TIME (seconds)~~ | ~~EVENT~~ |
|---|---|
| ~~0.0~~ | ~~Break occurs~~ |
| ~~15~~ | ~~Emergency fan coolers start (at full capacity)~~ |
| ~~50~~ | ~~Containment spray nozzles at full discharge flow~~ |
| ~~50.0~~ | ~~Peak containment temperature of 421 °F~~ |
| ~~62.3~~ | ~~Peak containment pressure of 58.5 psig~~ |
| ~~71.08~~ | ~~End of Blowdown~~ |

~~Note that although the peak vapor temperature of 421 °F is greater than the 300 °F design temperature, the duration of the event is sufficiently small to prevent heating of the containment structural materials beyond the design limits. As indicated by Figure 2-4, the 241 °F peak surface temperature of the containment liner remains well below 300 °F. Because the liner inside surface (actually a layer of organic paint) remains below 300 °F, the containment structure will not exceed design temperatures.~~

~~As can be seen from Figures 2-2 and 2-4, the peak pressure (58.5 psig) is below the design pressure of 60 psig and the peak temperature of the containment structure (241 °F) is below the design temperature of 300 °F. Therefore, General Design Criteria 16 and 50 (See Section 1.2) are met. The gauge pressure with respect to the outside atmosphere at 10,000 seconds is less than 3.0 psig. The pressure remaining after 24 hours is therefore expected to be only a small fraction of the 60 psig design pressure; therefore, the requirements of General Design Criterion 38 (See Section 1.2) are met.~~

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# CALCULATION SHEET

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CCN CONVERSION: CCN NO. CCN -- 2

Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 9

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | |

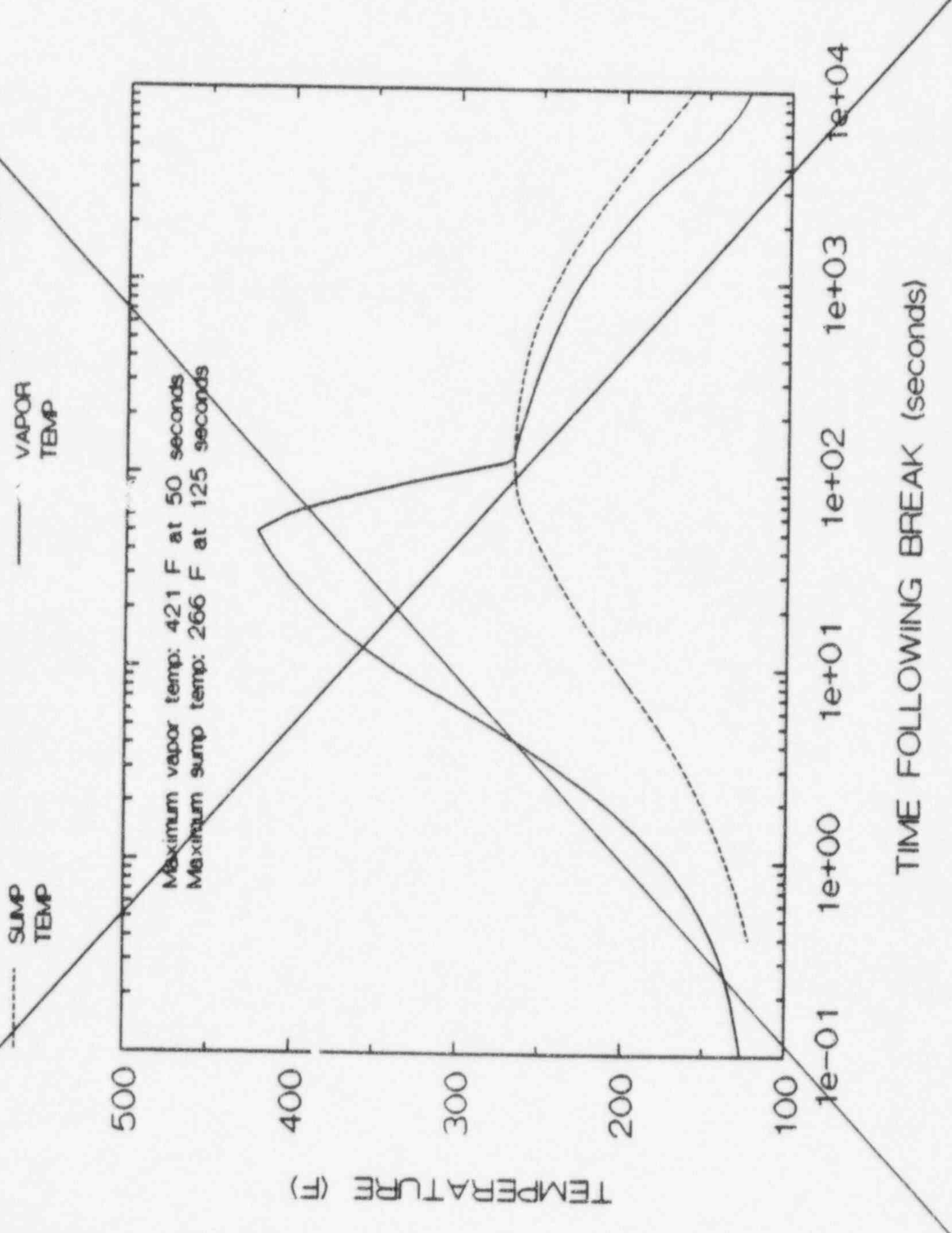
R E V ⇓

THIS FIGURE IS REPLACED BY FIGURE 2-2 IN SUPPLEMENT B

△

FIGURE 2-1: TEMPERATURE

MSLB 102% POWER, 7.48 FT² BREAK AREA



Maximum vapor temp: 421 F at 50 seconds
Maximum sump temp: 266 F at 125 seconds

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# CALCULATION SHEET

| ICCN NO./ PRELIM. CCN NO. N-2 | PAGE 48 OF 52 |
|---|---|
| | CCN CONVERSION: CCN NO. CCN - 2 |

Project or DCP/MMP SONGS Units 2 & 3  Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB  Sheet No. 10

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A.EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | |

R E V ⇓

THIS FIGURE IS REPLACED BY FIGURE 2-1 IN SUPPLEMENT B

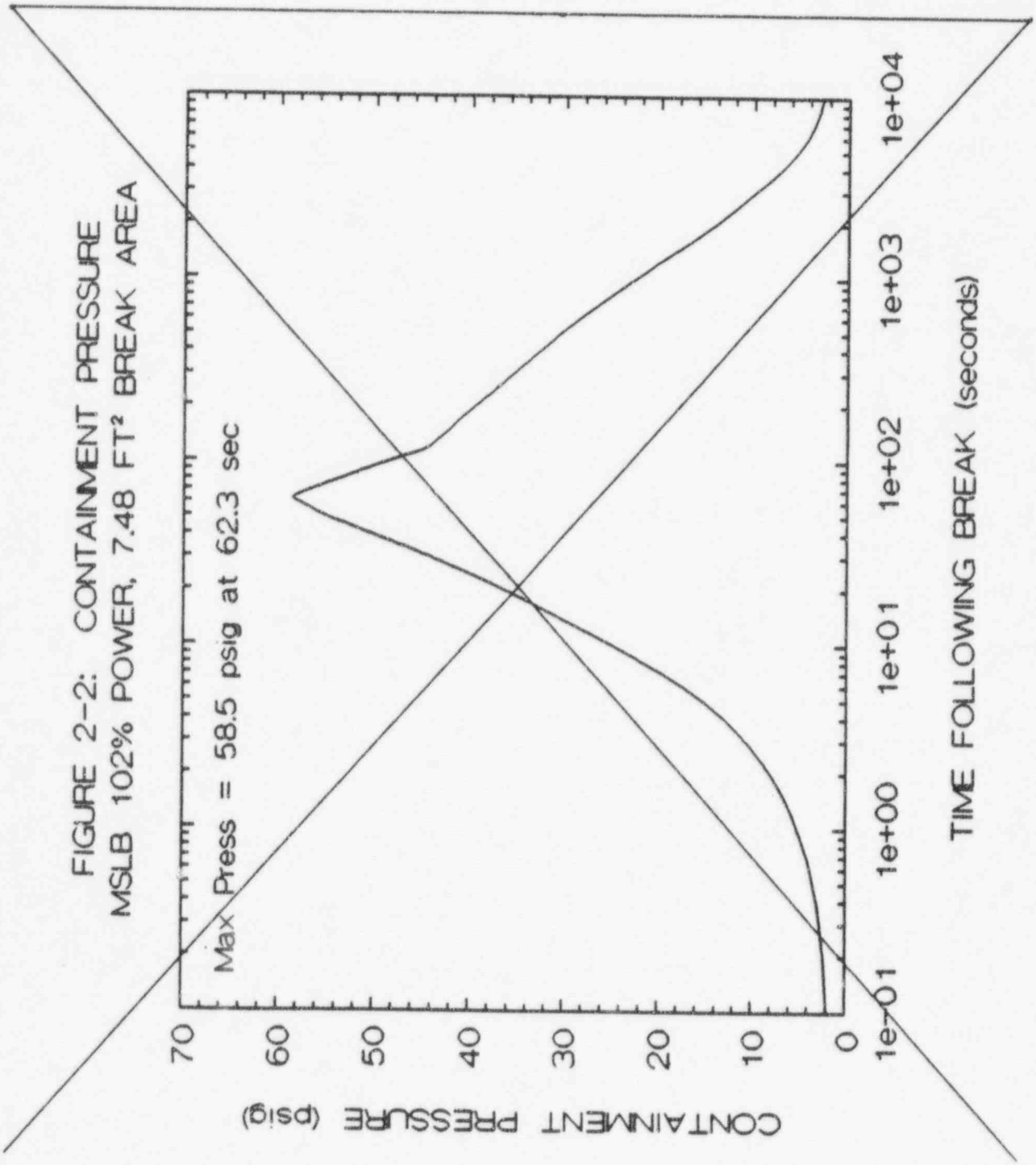
FIGURE 2-2: CONTAINMENT PRESSURE
MSLB 102% POWER, 7.48 FT² BREAK AREA

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## CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-2 | PAGE 49 OF 52

CCN CONVERSION:
CCN NO. CCN -

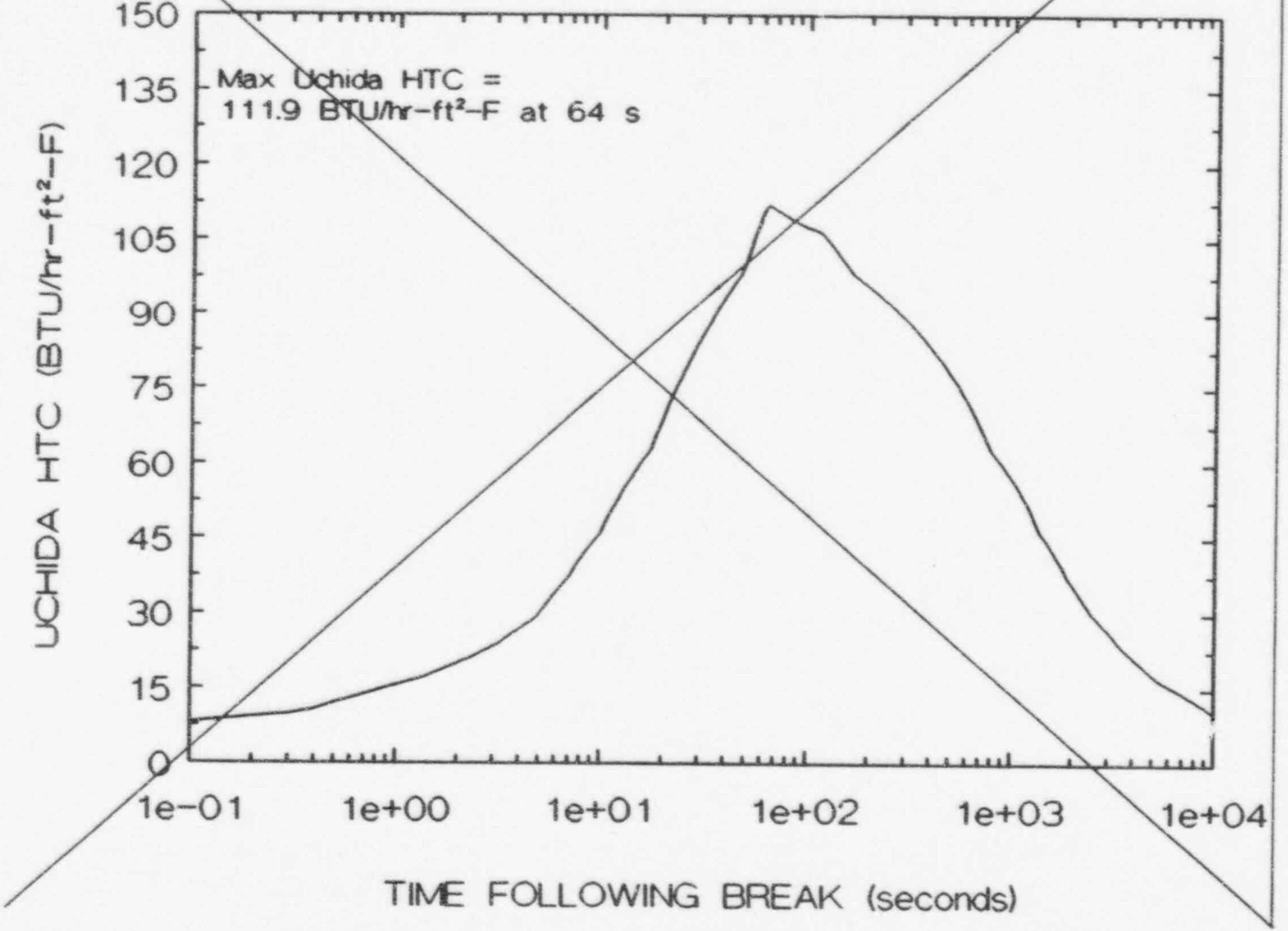
Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 11

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A.EVINJAY | 3/14/95 | P.BARBOUR | 3/14/95 | | | | | |

THIS FIGURE IS REPLACED BY FIGURE 2-3 IN SUPPLEMENT B

FIGURE 2-3: CONDENSING HTC
MSLB 102% POWER, 7.48 FT² BREAK AREA



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# CALCULATION SHEET

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

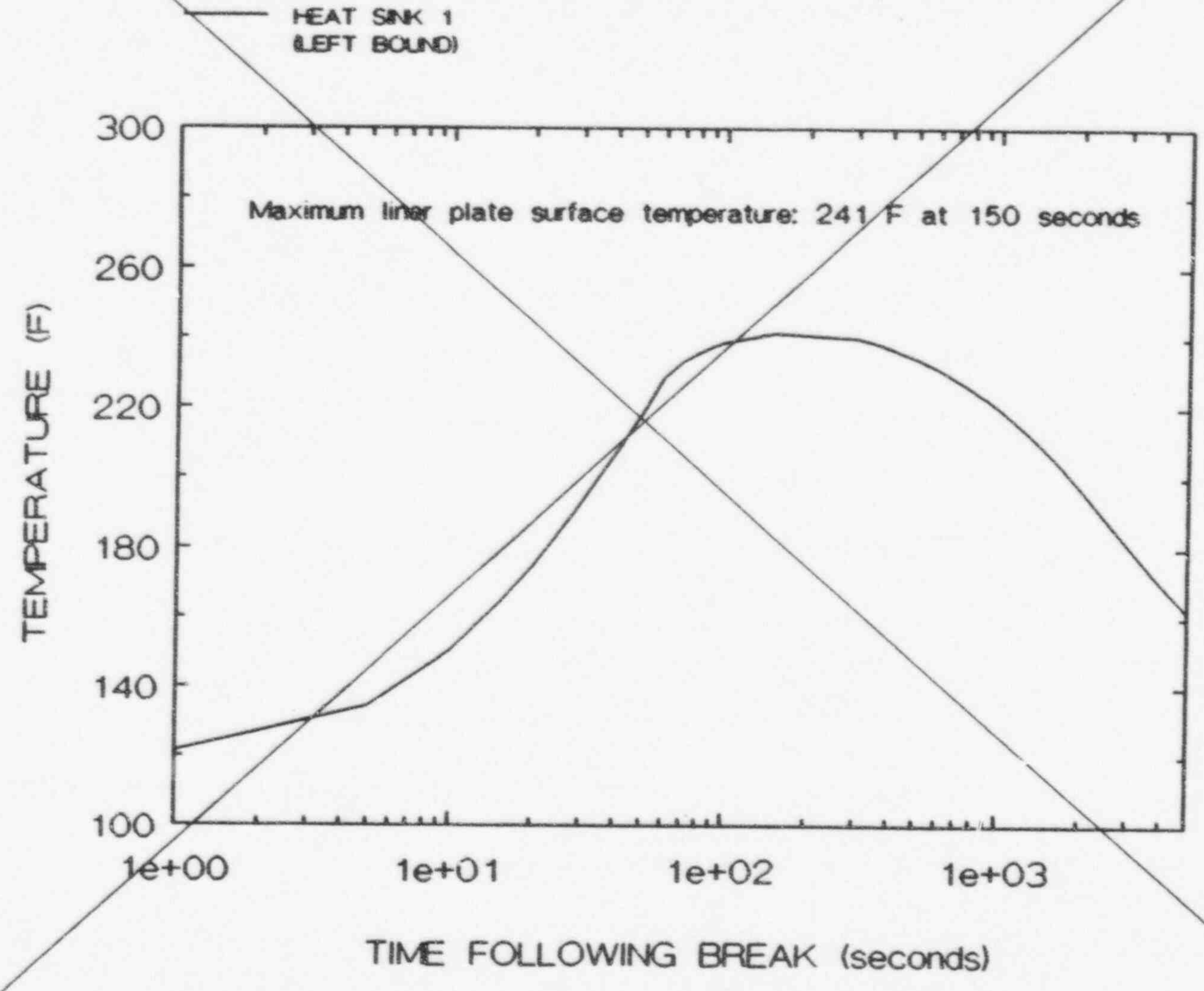
Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 12

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | |

THIS FIGURE IS REPLACED BY FIGURE 2-4 IN SUPPLEMENT B

FIGURE 2-4: LINER PLATE SURFACE TEMP.
MSLB 102% POWER, 7.48 $FT^2$ BREAK AREA



R E V ⇒

NES&L DEPARTMENT

# CALCULATION SHEET

| | |
|---|---|
| ICCN NO./<br>PRELIM. CCN NO. N-2 | PAGE 51 OF 52 |
| | CCN CONVERSION:<br>CCN NO. CCN – 2 |

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 13

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | |

REV ⇓

THIS FIGURE IS REPLACED BY FIGURE 2-5 IN SUPPLEMENT B | △

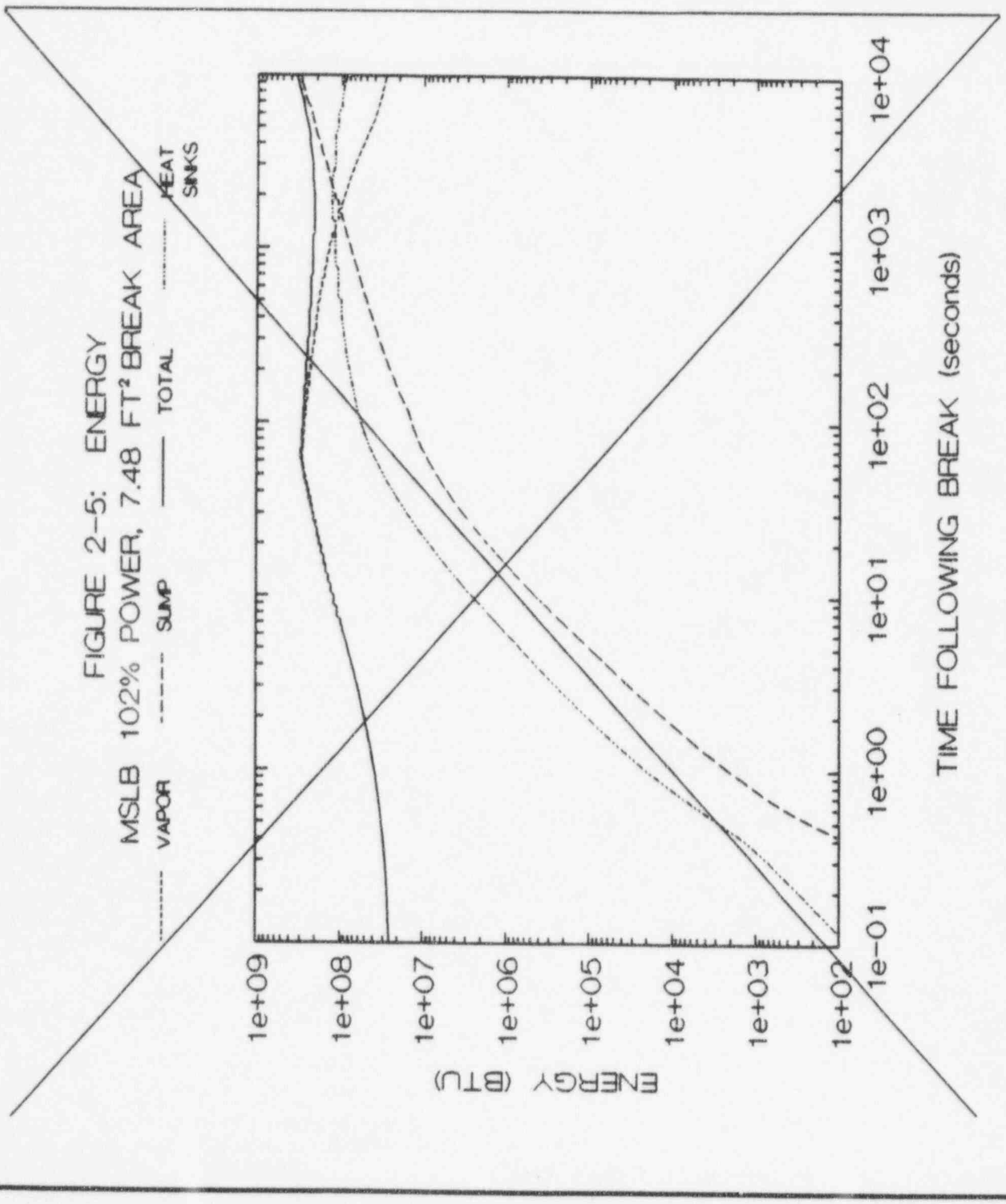


FIGURE 2–5: ENERGY
MSLB 102% POWER, 7.48 FT² BREAK AREA

NES&L DEPARTMENT

# CALCULATION SHEET

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PRELIM. CCN NO. N-2

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Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN - 2

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 14

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | A. EVINAY | 3/14/95 | P. BARBOUR | 3/14/95 | | | | | |

R
E
V

THIS FIGURE IS REPLACED BY FIGURE 2-6 IN SUPPLEMENT B

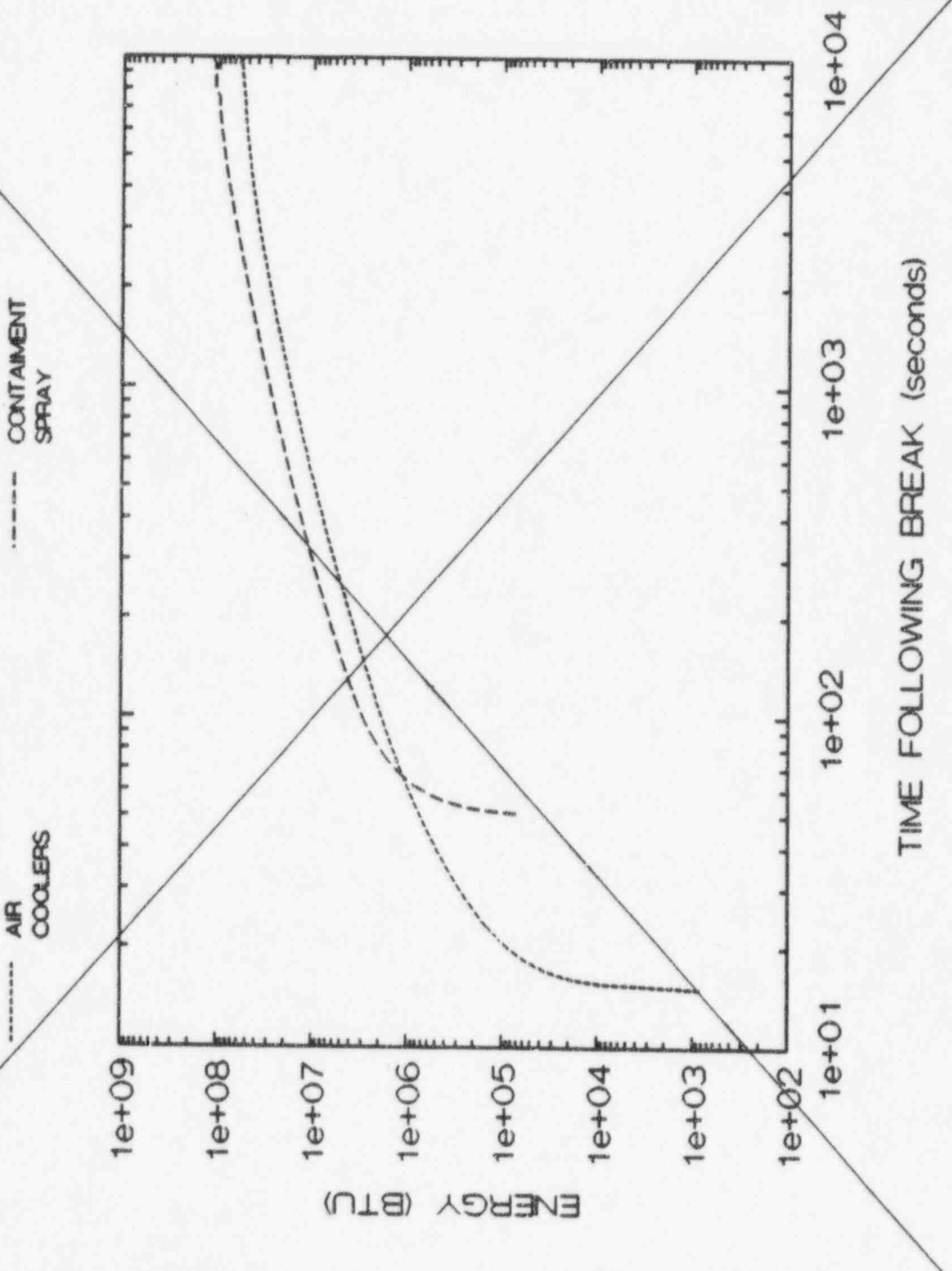

FIGURE 2-6 ENERGY

MSLB 102% POWER, 7.48 FT² BREAK AREA

**Southern California Edison Company**

**INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN)**

CALC NO. N-4080-027

ICCN NO./ [✓ PRELIM. CCN NO.] N-1

PAGE 1

TOTAL NO. OF PAGES 41

BASE CALC. REV. 0

UNIT 2 & 3

CCN CONVERSION: CCN NO. CCN- 1

CALC. REV. 0

CALCULATION SUBJECT: Containment P/T Design Basis MSLB for Equipment Qualification - SUPPLEMENT A

CALCULATION CROSS-INDEX
☒ New/Updated Index Included
☐ Existing Index is Complete

ENGINEERING SYSTEM NUMBER/PRIMARY STATION SYSTEM DESIGNATOR 1301 / ABB

Q-CLASS II

CONTROLLED PROGRAM OR DATABASE IN ACCORDANCE WITH NES&L 41-5-1
☒ PROGRAM ☐ DATABASE

PROGRAM/DATABASE NAME(S) ☐ ALSO, LISTED BELOW
NE100 (COPATTA)

VERSION/RELEASE NO.(S) G1-15

**1.** BRIEF DESCRIPTION OF ICCN/CCN:

Add Supplement A to the base calculation.

Supplement A provides a new Analysis of Record for the Containment Building pressure and temperature reaponse to the Design Basis MSLB event specifically applicable to the evaluation of the environmental qualification of in-containment equipment, important to safety, that must function during and/or following a design basis accident. The analysis results are applicable only to equipment qualification because of the inclusion of 8% condensate revaporization which slightly lowers the calculated peak containment pressure and vapor temperature below the values calculated to support containment structural design,and reported in Section 6.2 of the UFSAR.

INITIATING DOCUMENT (DCP/MMP, FCN, OTHER) NCRs 93030001-03, 93030002-02, 93030003-02, and 93030004-02 Rev. —

**2.** OTHER AFFECTED DOCUMENTS (CHECK AS APPLICABLE FOR CCN ONLY):
See Calc Cross Index
☒ YES ☐ NO OTHER AFFECTED DOCUMENTS EXIST AND ARE IDENTIFIED ON ATTACHED FORM 26-503.

**3.** APPROVAL:

DISCIPLINE/ESC: NUCLEAR SAFETY ANALYSIS

ALLEN EVINAY AE 51385
ORIGINATOR (Print name/initial) PAX

GS (Signature)

OTHER (Signature)

PAUL BARBOUR PB 51379
IRE (Print name/initial) PAX

NES&L DM (Signature)

11/4/94
Date

**4.** ASSIGNED SUPPLEMENT ALPHA DESIGNATOR: A

CONVERSION TO CCN DATE 11/14/94

Tanya Castello
SCE CDM-SONGS

SCE 26-122-1 REV. 9/91

# CALCULATION TITLE PAGE

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CCN CONVERSION:
CCN NO. CCN- 1

Calc. No. **N-4080-027** DCP/MMP/FIDCN/FCN No. & Rev. N/A

Subject **Containment P/T Design Basis MSLB for Equipment Qualification - SUPPLEMENT A** Sheet **A1**

System Number/Primary Station System Designator 1301 / ABB SONGS Unit 2&3 Q-Class II

Tech. Spec. Affecting? ☒ NO ☐ YES, Section No. N/A Equipment Tag No. N/A

| CONTROLLED COMPUTER PROGRAM/ DATABASE | ☒ PROGRAM<br>☐ DATABASE<br>IN ACCORDANCE WITH NES&L 41-5-1 | PROGRAM/DATABASE NAME(S)<br>☐ ALSO, LISTED BELOW<br>NE100 (COPATTA) | VERSION/RELEASE NO.(S)<br>G1-15 |
|---|---|---|---|

RECORDS OF ISSUES

| REV. DISC. | DESCRIPTION | TOTAL SHTS. LAST SHT. | PREPARED (Print name/initial) | APPROVED (Signature) | |
|---|---|---|---|---|---|
| △ 0 | ORIGINAL ISSUE | 40 | ORIG. ALLEN EVINAY AE | GS | Other |
| | | A40 | IRE PAUL BARBOUR PB | DM | DATE 11/4/94 |
| △ | | | ORIG. | GS | Other |
| | | | IRE | DM | DATE |
| △ | | | ORIG. | GS | Other |
| | | | IRE | DM | DATE |
| △ | | | ORIG. | GS | Other |
| | | | IRE | DM | DATE |

Space for RPE Stamp, identify use of an alternate calc., and notes as applicable.

This calculation was prepared using Word Perfect 5.1 software as an electric typewriter. The WP5.1 software was not used for any computational portions of the calculation.

This calc. was prepared for the identified DCP/MMP. DCP completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date ________ by ________.

# CALCULATION CROSS-INDEX

ICCN NO./
PRELIM. CCN NO.

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CCN CONVERSION:
CCN NO. CCN# 1

Calculation No. N-4080-027 - SUPPLEMENT A

Sheet No. A2

| Calc. rev. number and responsible supervisor initials and date | INPUTS<br>These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation. | | OUTPUTS<br>Results and conclusion of the subject calculation are used in these interfacing calculations and/or documents. | | Does the output interface calc/document require revision? | Identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number. |
|---|---|---|---|---|---|---|
| | **Calc/Document No.** | **Rev. No.** | **Calc/Document No.** | **Rev. No.** | **YES / NO** | |
| △ 0 | Calculations: | | UFSAR, Section 3.11.3.1.2 | 10 | Yes | SAR 23-341 |
| | N-4080-027 | 0 | | | | |
| 11/4/94 | M-0014-009, Supplement A | 0 | DBD-SO23-TR-EQ | 1 | Yes | NEDOTRAK Log BC-93-079 |
| | M-0072-036 | 0 | | | | |
| | N-4080-007, incl CCNs 1 & 2 | 2 | Calculation M-DSC-243 | 0 | Yes | NEDOTRAK Action 93030001/3 sub#5 |
| | | | EQDPs M37600 | | Yes | NEDOTRAK Log BC-93-079 |
| | | | M37601 | | | |
| | | | M37606 | | | |
| | | | M37607 | | | |
| | | | M37608 | | | |
| | Unit 2 Operating Liscense & Technical Specifications | Amdt 101 | M37609<br>M37610 | | | |
| | | | M37612 | | | |
| | Unit 3 Operating License & Technical Specifications | Amdt 90 | M37615<br>M37618 | | | |
| | | | M37619 | | | |
| | | | M37620 | | | |
| | | | M37621 | | | |
| | | | M37624 | | | |
| | | | M37629 | | | |
| | | | M37631 | | | |
| | Non-Conformance Reports (NCRs) | | M37635 | | | |
| | 93030001 | 3 | M37636 | | | |
| | 93030002 | 2 | M37640 | | | |
| | 93030003 | 2 | M37641 | | | |
| | 93030004 | 2 | M37644 | | | |
| | | | M37646 | | | |
| | | | M37703 | | | |
| | | | M37704 | | | |
| | | | M37705 | | | |
| | | | M37706 | | | |
| | | | M38279 | | | |

# CALCULATION CROSS-INDEX

| | |
|---|---|
| ICCN NO./<br>PRELIM. CCN NO. | PAGE 4 OF 41 |
| | CCN CONVERSION: 1<br>CCN NO. CCN-- |

Calculation No. N-4080-027 - SUPPLEMENT A

Sheet No. A3

| Calc. rev. number and responsible supervisor initials and date | **INPUTS** These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation. | | **OUTPUTS** Results and conclusion of the subject calculation are used in these interfacing calculations and/or documents. | | Does the output interface calc/document require revision? | Identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number. |
|---|---|---|---|---|---|---|
| | **Calc/Document No.** | **Rev. No.** | **Calc/Document No.** | **Rev. No.** | **YES / NO** | |
| △ 0<br>11/4/94 | | | EQDPs, cont'd<br>M38290<br>M38377<br>M38378<br>M38379<br>M38381<br>M38382<br>M38383<br>M38384<br>M38385<br>M38773 | | Yes | NEDOTRAK Log BC-93-079 |
| | | | M38785<br>M38790<br>M38798<br>M39079<br>M40819<br>M85083<br>M85091<br>M85102<br>M85108 | | | |
| | | | | | | |

SCE 26-424 REV. 0 7/92 [REFERENCE: NES&L 24-7-15]

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## TABLE OF CONTENTS

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PRELIM. CCN NO. N-1

CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-5

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## 1.0 PURPOSE

### 1.1 TASK DESCRIPTION

The purpose of the Containment P/T Steam Line Break analysis for Equipment Qualification Thermal Analysis performed here is several fold:

1.1.1 Determine the containment temperature and pressure response to the Design Basis Main Steam Line Break (MSLB) event for use by the Nuclear Engineering Design Organization (NEDO) Equipment Qualification (EQ) Group as the bounding containment harsh environment resulting from such a MSLB event. The analysis uses the input data from the present analysis of record (AOR) Design Basis MSLB (102% Power MSLB, reference 6.1), modified as necessary to include NUREG-0588 (reference 6.9) methodology applicable to equipment qualification at SONGS and also to conform with the Licensing Organization's interpretation of our licensing basis for P/T Analyses (reference 6.14).

1.1.2 Streamline the Containment P/T MSLB Analysis for Equipment Qualification by limiting this analysis to only generating the containment harsh environmental conditions. The Equipment Thermal Lag analysis contained in the present calculation N-4080-004 (reference 6.4) have been largely obsoleted by later analyses (reference 6.10 and 6.11) using more sophisticated equipment modelling.

1.1.3 Create a CCN for the existing Containment MSLB P/T Equipment Qualification calculation, N-4080-004 (reference 6.4) to identify Supplement A to N-4080-027 Rev 0, as containing the current Design Basis MSLB Containment P/T Response AOR for the in-containment equipment qualification environment .

1.1.4 This calculation supplement uses a minimum containment spray flow rate consistent with degraded spray pump performance documented in the calculation M-0014-009 (reference 6.2) and completes NFM action required in the disposition step 2 of NCRs 93030001, 93030002, 93030003 and 93030004,

Bechtel Standard Computer Code NE100, Release G1-15 (COPATTA) (reference 6.5), on the Nuclear Fuels Engineering IBM-RISC workstation system will be used in this calculation to evaluate the containment pressure and temperature transients for the Equipment Qualification Analysis.

NES&L DEPARTMENT

**CALCULATION SHEET**

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PRELIM. CCN NO. N-1
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CCN CONVERSION
CCN NO. CCN -

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027-Sup-A**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION** Sheet No. **A-6**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

1.2 CRITERIA, CODES and STANDARDS

The criteria, codes and standards applicable to the Containment P/T Analysis for Design Basis MSLB (reference 6.1), are also generally applicable in this analysis. The applicable regulatory design criteria include:

- General Design Criterion (GDC) 16, "Containment Design"
- General Design Criterion (GDC) 38, "Containment Heat Removal"
- General Design Criterion (GDC) 50, "Containment Design Basis".

The applicability of these criteria to peak containment pressure and temperature are described in detail in Reference 6.1.

Additional general criteria applicable to Equipment qualification analysis are contained in

- 10 CFR 50.49, "Environmental qualification of Electric Equipment Important to safety For Nuclear Power Plants"
- NUREG-0588, Revision 1, "Interim Staff Position On Environmental Qualification of Safety-Related Electrical Equipment".

Title 10, CFR 50.49 requires that the time-dependent environmental temperature and pressure at the location of equipment important to safety must be established for the most severe design basis accident during or following which the equipment is required to remain functional.

NUREG-0588 provides methodology applicable to the calculation of post accident environmental conditions and the evaluation of equipment thermal response to the post-accident environment.

The containment design pressure and temperature are 60 psig and 300 °F per the Technical Specifications (references 6.5 and 6.6, Section 5.2.2) respectively.

## 2.0 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

### 2.1 RESULTS/CONCLUSIONS

Figures 2.1 through 2.5 show the analysis results out to 1000 seconds, which is well beyond the time of the affected steam generator dry-out and termination of significant mass and energy release into the containment. At 1000 seconds, the containment temperature and pressure are well below the peak values and decreasing. Section 10 contains tabulated conditions to the end of the transient calculation at 1E+5 seconds.

Figure 2.1 presents the sump and vapor temperatures versus time for the CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION. The plots in Figure 2.1 are generated using the data presented in Section 10.1.

Figure 2.2 presents the containment gauge pressure versus time for the CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION. The plot in Figure 2.2 is generated using the data presented in Section 10.1.

Figure 2.3 presents the inside surface temperature of heat sink 1 (reactor building dome, painted steel liner plate) to represent the maximum post-MSLB temperature of the containment structure. The plot in Figure 2.3 is generated using the data presented in Section 10.1.

Figure 2.4 presents the integrated energy transferred from the containment vapor region by one train of air coolers, two Emergency Cooling Units (2ECUs) and one train of containment spray as a function of time. The plots in Figure 2.4 are generated using the data presented in Section 10.2.

Figure 2.5 presents the rate of energy transfer from the vapor region by a single train of emergency cooling units (2ECUs) and by a single train of containment sprays as a function of time. The plots in Figure 2.5 are generated using the data presented in Section 10.2.

Table 1 presents the CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION accident chronology.

The calculated peak vapor temperature of 407.1 °F is greater than the 300 °F design temperature, however the duration of the event is sufficiently small enough to prevent heating of the containment structural materials beyond the design limits.

The peak vapor temperature is about 1.5 °F greater than the previously identified peak temperature in the prior AOR (N-4080-004, reference 6.4). The increase in the peak temperature is attributed to the reduced ECU heat transfer capacity (M-0072-036, Revision 0, reference 6.12) and the delayed spray start time of 50 seconds v.s. the prior analysis spray start time of 45 seconds. The containment vapor pressure remains at, or above, 300 °F for about 85 seconds (6 sec to 91 sec) compared to about 79 seconds (6 secs to 85 secs) in the prior analysis in Reference 6.4.

The primary purpose of this calculation is to provide a conservative analysis of the containment pressure-temperature response to the design basis MSLB. The objective is to define containment conditions for post-accident equipment qualification with emphasis on the relatively short time frame when the MSLB harsh environment is more severe than that created by the design basis loss of coolant accident ( LOCA ). In this regard, an analysis duration of 1000 seconds is more than adequate to simulate the desired post-MSLB harsh environment. However, to provide insight into the longer-term post-MSLB containment environment, the analysis has been extended to 100,000 seconds ( ~ 28 hours). The analysis includes containment spray termination at 10,000 seconds, following refueling water storage tank ( RWST ) inventory depletion. Following termination of containment spray, the vapor temperature rises from 126 °F to about 145 °F due to the reduction in vapor region energy removal rate. The vapor temperature then resumes a slow downward trend continuing to the end of the analysis run time. At the end of the run ( 1E+5 seconds ), the containment pressure and vapor temperature are about 0.6 psig and 132 °F, respectively. The long-term containment cooldown is conservative due to modelling which allows no evaporative or convective heat transfer between the sump water and the vapor region. Thus, in the absence of continued spray, or sump water recirculation, cooling of the containment sump occurs only through heat convection into the flooded lower concrete. In any event, the longer analysis does demonstrate that the longer-term MSLB environment does remain bounded by the design basis LOCA event as provided in N-4080-026 (reference 6.16)

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# CALCULATION SHEET

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CCN NO. CCN -

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-9

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## Table 1

## CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION

## EVENT CHRONOLOGY

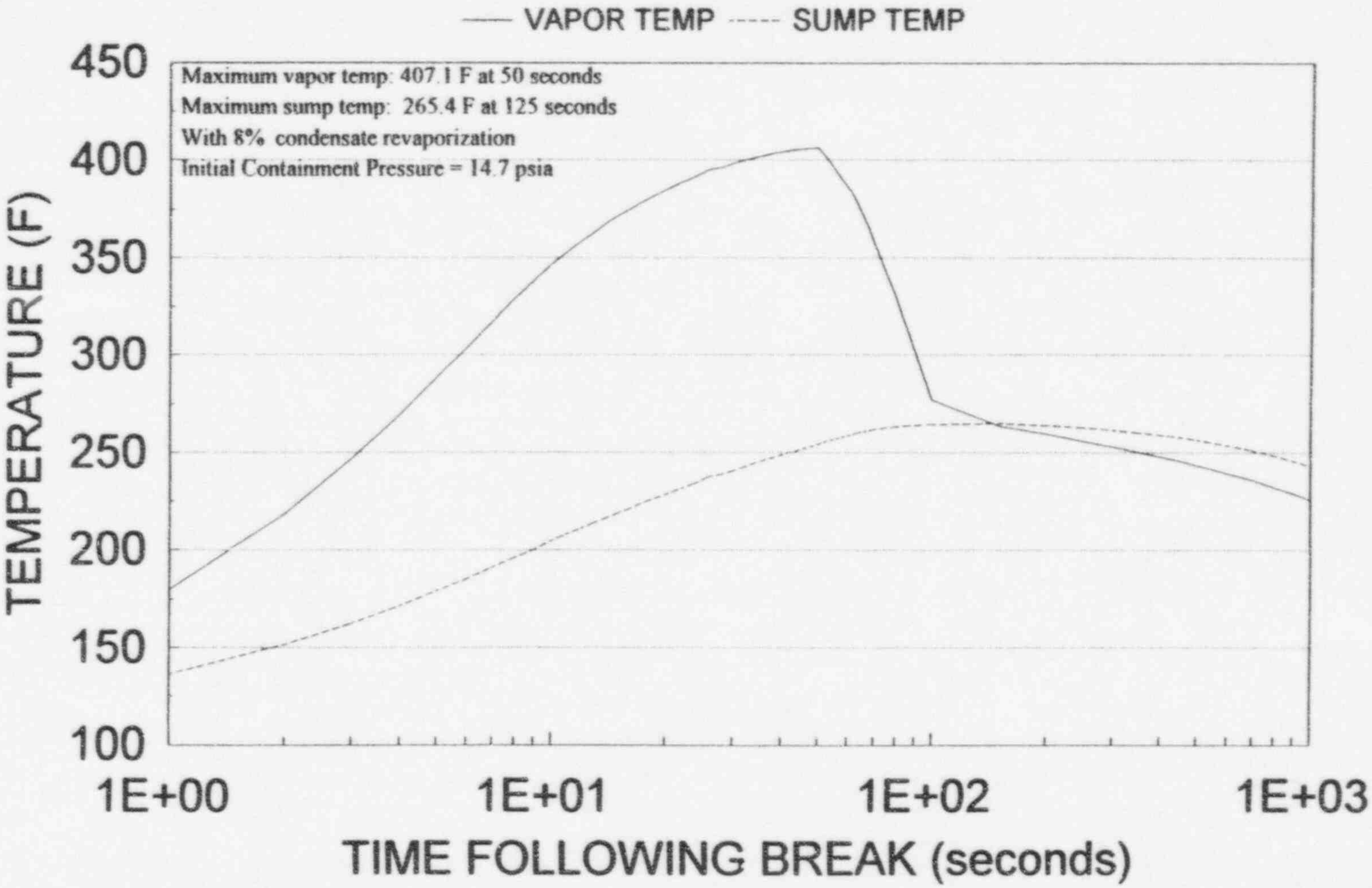
| TIME ( seconds ) | EVENT |
|---|---|
| 0.0 | MSLB Occurs |
| 50 | Containment Sprays Start<br>( Nozzles at Full Discharge Flow )<br>AND<br>Emergency Fan Coolers Start<br>( Full capacity) |
| 50 | Peak Containment Temperature of 407.1 °F reached |
| 62.2 | Peak Containment Pressure of 55.3 psig reached |
| 71.08 | End of Blowdown<br>( Affected Steam Generator ) |
| 175.0 | Containment Liner Plate Maximum Temperature of 243.8 °F reached |
| 9000.0 | Maximum Tech. Spec. Containment Pressure of 1.499 psig ≤ **1.5 psig** reached |
| 10000.0 | Containment Spray Flow Terminated<br>Containment Pressure = 1.3 psig<br>Containment Temperature = 125.8 °F |
| 100000.0 | Containment Pressure = 0.6 psig<br>Containment Vapor Temp = 131.9 °F<br>Containment Sump Temp = 159.8 °F |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |

REV. INDICATOR

# FIGURE 2-1: TEMPERATURE

## EQ MSLB 102% POWER-7.48 FT2 BREAK AREA



NES&L DEPARTMENT

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| | |
|---|---|
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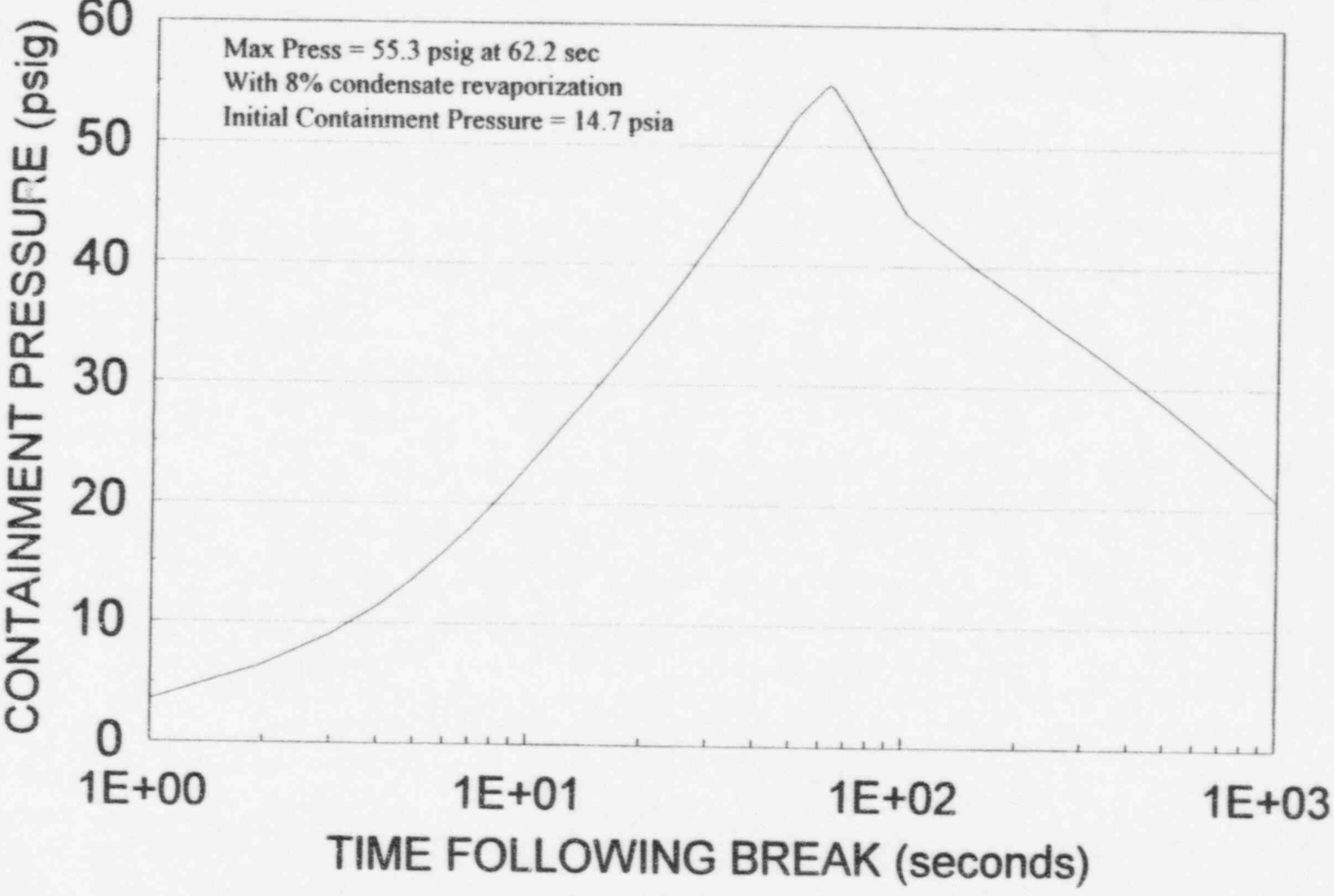
Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-11

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| △ | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |

## FIGURE 2-2: CONTAINMENT PRESSURE

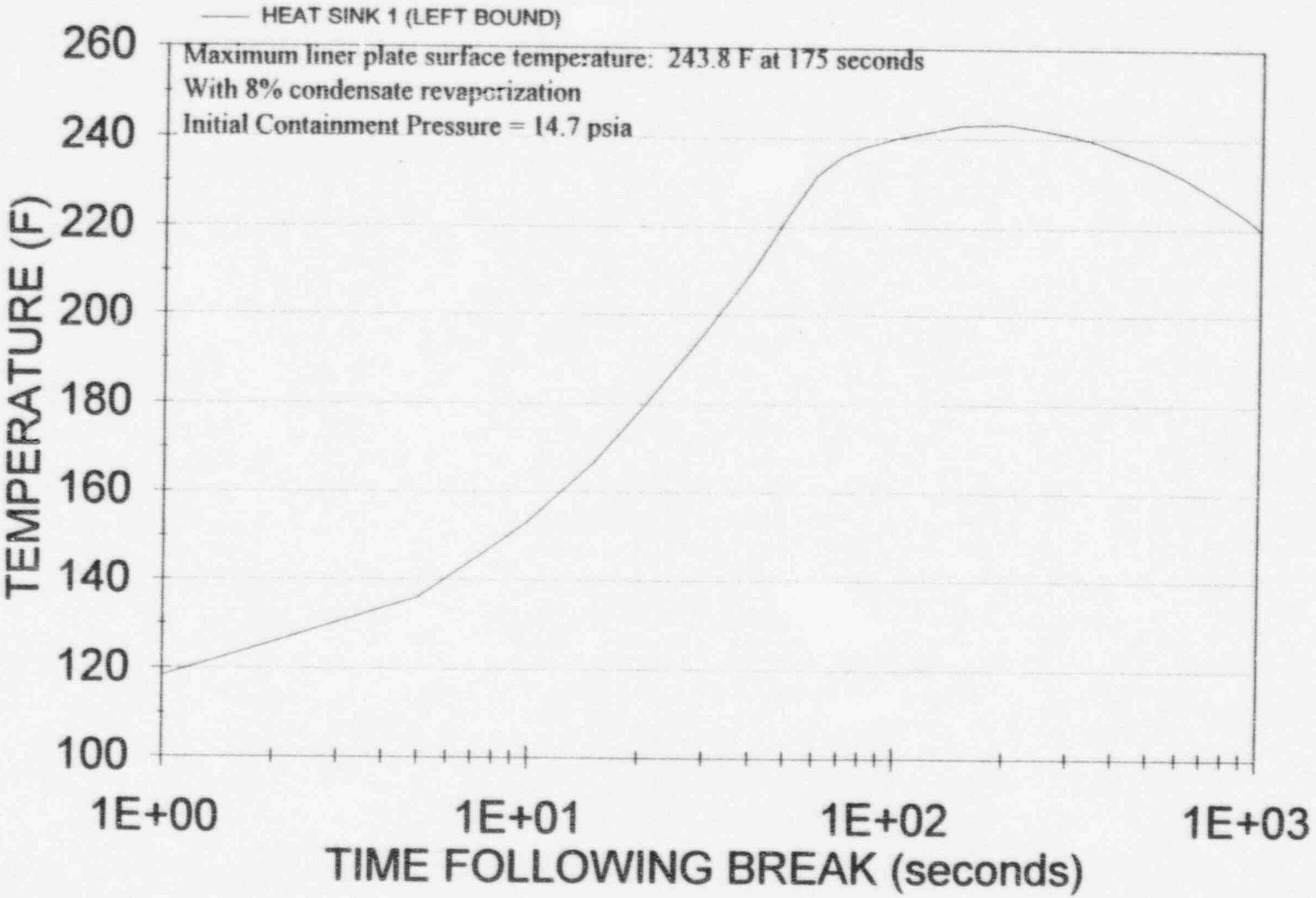
EQ MSLB 102% POWER-7.48 FT2 BREAK AREA



| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |

## FIGURE 2-3: LINER PLATE SURFACE TEMP

EQ MSLB 102% POWER-7.48 FT2 BREAK AREA



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CCN CONVERSION
CCN NO. CCN - 1

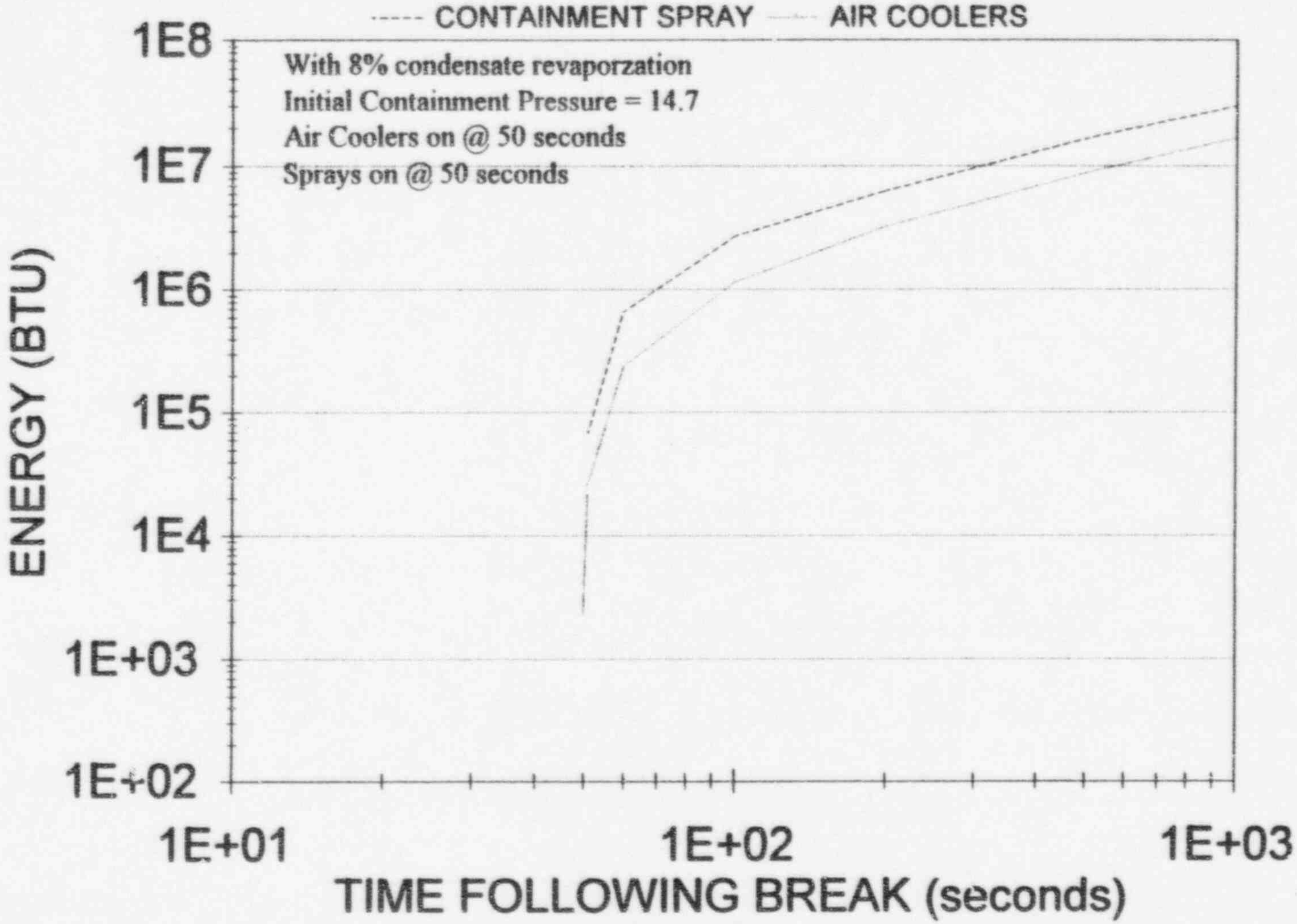
Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-13

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

# FIGURE 2-4 INTEGRATED ENERGY

## EQ MSLB 102% POWER-7.48 FT2 BREAK AREA



NES&L DEPARTMENT
## CALCULATION SHEET

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-14

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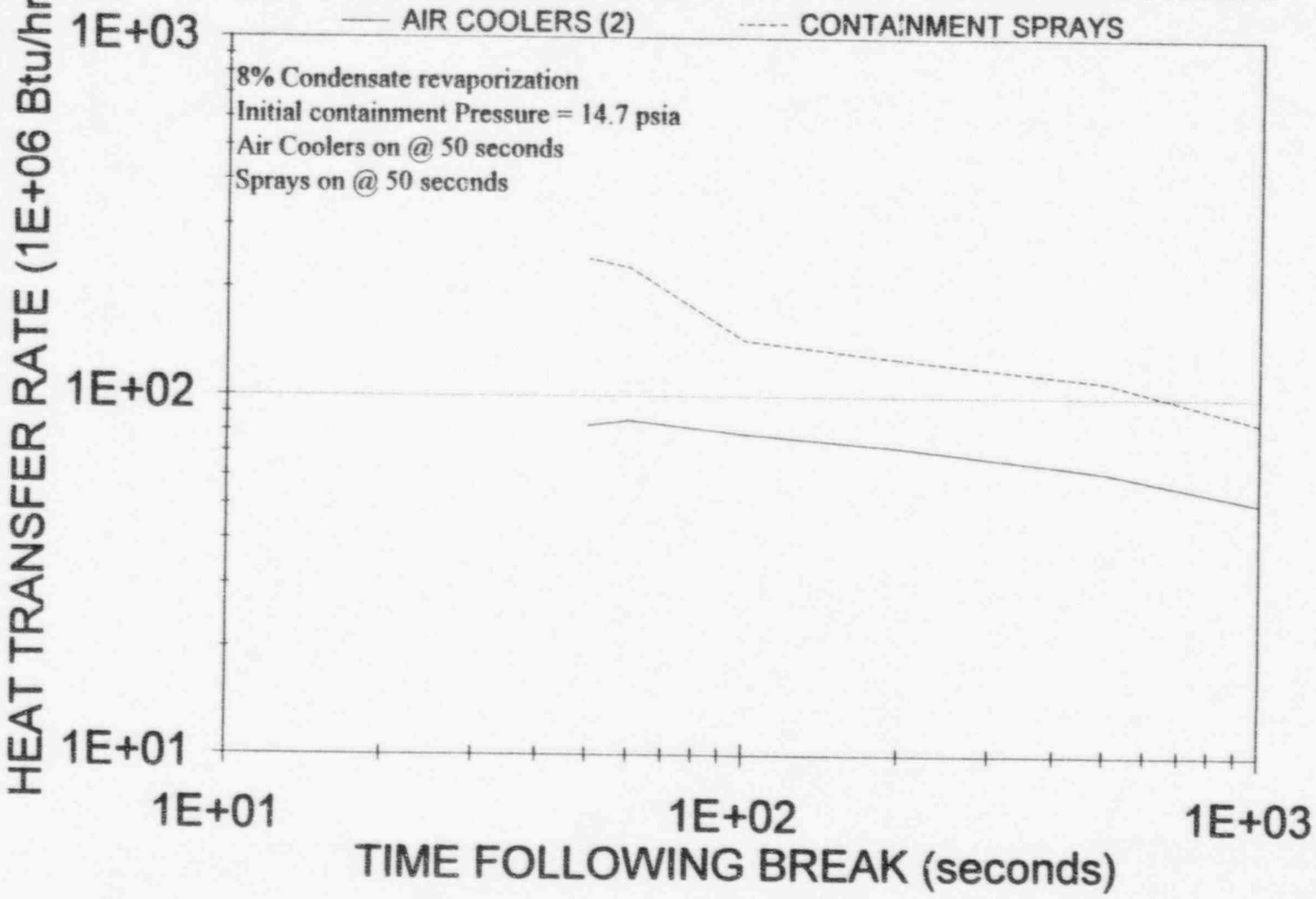
CCN CONVERSION
CCN NO. CCN - 1

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |

# FIGURE 2-5: VAPOR HEAT REMOVAL RATES
## EQ MSLB 102% POWER-7.48 FT2 BREAK AREA



SCE 26-426 NEW 4/90

## 2.2 RECOMMENDATIONS

This Supplement A provides a new analysis of record for the containment pressure and temperature response to the Design Basis MSLB event for Equipment qualification. This analysis replaces the prior containment P/T response analysis contained in N-4080-004 Rev. 1, (Non-Technical CCN to N-4080-004, Rev.1).

Calculation M-DSC-243 (reference 6.10) should be revised to incorporate the new containment temperature response to the Design basis MSLB and to include thermal-lag analysis for those electrical components modelled in reference 6.4 which are still needed to support the SONGS equipment qualification (NEDOTRAK Action Item Number 93030001/3, sub# 5 ).

## 3.0 ASSUMPTIONS

The assumptions used in this calculation are identical to those used in the Containment P/T Analysis for Design Basis MSLB (reference 6.1), except where noted. Reference 6.1 is the analysis of record (AOR) for the DBA MSLB. The assumptions in reference 6.1 are arranged in groups which parallel the COPATTA Code card series data input. The modifications to reference 6.1 assumptions are listed below.

### 3.1 CARD SERIES 1

### 3.1.a ITEM 05: CONTAINMENT INITIAL TEMPERATURE

In both the AOR (reference 6.1) and this analysis, the containment initial temperature was assumed to be 120 °F. This is the SONGS Technical Specification maximum containment average temperature. The containment initial temperature profile at full power operating conditions varies from 140 °F in the upper dome to 80 °F in the basement region. The initiation of MSLB will almost instantaneously homogenize the containment temperature and in less than one half of one second, the containment average initial temperature will be in the vicinity of 120 °F. Henceforth, the use of an initial average temperature of 120 °F is easily justifiable and the results of the calculation are still applicable for the post-accident MSLB containment temperature and pressure profiles.

### 3.1.b ITEM 11: CONTAINMENT HEAT SINK REVAPORIZATION FRACTION

This MSLB analysis is performed for Equipment Qualification Temperature and Pressure profile generation and therefore credit for revaporization of heat sink condensate will be taken. NUREG-0588 (reference 6.9, Appendix B, Section 1.b) allows for up to 8 percent of the condensate to be transferred to vapor region during the performance equipment qualification analysis. Allowing revaporization of heat sink condensate reduces the containment temperature and pressure relative to zero revaporization.

### 3.2 CARD SERIES 5

### 3.2.a ITEM 3: CONTAINMENT EMERGENCY AIR COOLER START TIME

In the AOR (reference 6.1), the containment air cooler start delay time was identified as 15 seconds in the Design Input 4.3.a. In the present analysis the air cooler start time has been increased to 50 seconds to coincide with the containment spray actuation time. The emergency air cooling units have relatively little impact on short-term containment pressure and temperature, and by adding 35 seconds delay to ECU initiation, margin is added to accommodate potential changes in the timing of ECU startup. For example, based on the methodology contained in calculation N-4080-003 (reference 6.15), the 50 second start time for the ECUs is equivalent to assuming a 47-second stroke time for the CCW block valves that supply cooling water to the air coolers, if all other parameters affecting ECU start time were to remain unchanged.

## 4.0 DESIGN INPUT

The design inputs used in this calculation are identical to those used in the Containment P/T Analysis for Design Basis MSLB (reference 6.1), except where noted. Reference 6.1 is the analysis of record for the DBA MSLB. The design inputs in reference 6.1 are arranged in groups which parallel the COPATTA Code card series data input.

### 4.1 CARD SERIES 0

The last four zero entries on this card are deleted. The G1-15 (RISC) version of COPATTA does not utilize these data entry locations.

### 4.2 CARD SERIES 1

a. ITEM 2: PROBLEM RUN TIME

The problem run time will be set to 1E+5 seconds ( ~28 hours ). The pipe break mass and energy release into the containment provided by the Combustion Engineering ( ABB-CE) included on CARD SERIES 301 terminated at 71.08 seconds, when dryout of the affected steam generator is calculated to occur for this Design Basis MSLB event. This run time of 100000 seconds is well past the end of significant mass and energy release into the containment. Generally a run time of 1000 seconds is adequate to show that the containment pressure and temperature are decreasing rapidly and well below the peak values calculated prior to steam generator dryout. For this calculation, however, the run time has been extended to 100,000 seconds to provide insight into the long-term post-MSLB containment depressurization and cooldown to near pre-MSLB conditions.

b. ITEM 3: INITIAL CONTAINMENT PRESSURE

SONGS Units 2 and 3 Technical Specifications limit the containment pressure to between +1.5 psig and -0.3 psig during reactor operations (LCO, 3.6.1.4, references 6.6 and 6.7). Leakage of instrument air from valves and controllers cause containment pressure to normally be greater than 0 psig. Of the calculated post-MSLB containment conditions for equipment qualification, the peak vapor temperature is more limiting than the peak pressure. This is due to the fact that the calculated peak pressure is less than the design value of 60 psig and the short-term peak vapor temperature typically exceeds the containment design value of 300 $^0$F. Based on sensitivity studies reported in the Bechtel Topical Report BN-TOP-3 (reference 6.8), the peak vapor temperature increases with decreasing initial containment pressure. Since the containment pressure is not normally less than atmospheric, an initial containment pressure of 14.7 psia (0 psig) will be used for this analysis.

4.3 CARD SERIES 5

The last two entries on this card ( 0 and 105 ) are deleted. The G1-15 (RISC) version of COPATTA does not utilize these entry locations

4.3.a ITEM 3: CONTAINMENT EMERGENCY AIR COOLER START TIME

In the present analysis, the air cooler start delay time has been increased from 15 seconds to 50 seconds to coincide with the containment spray actuation time. The increase in air cooler start delay time will provide margin to accommodate potential changes in the timing of ECU startup such as an increase in the stroke time of the CCW block valves that isolate the cooling water from the air coolers.

4.4 CARD SERIES 301

No changes are made to card series 301 input which provides the mass flow rate and fluid enthalpy entering the containment from the main steam line break. The data is for the Design basis MSLB at 102% power with a break area of 7.48 $ft^2$.

As documented by CCN 1 to N-4080-004 (reference 6.3) and CCN 1 to N-4080-007 (reference 6.13), single failure of one of the isolation valves ( HV8200 and/or HV8201 ) on the steam line feeding the auxiliary feed water pump turbine could allow cross-flow of steam from the intact steam generator into the containment through the affected steam generator. This cross-flow would come from the 1" diameter bypass lines installed around steam line check valves 1301MU003 and 1301MU005 by the MMP 2 & 3 6869.00SM. This potential additional mass and energy input is not included in this new AOR. The referenced CCNs demonstrate that the effect of the cross-flow on short-term peak containment conditions is not significant. The increase in peak pressure and peak temperature due to this potential cross-flow are less than 0.1 psi and 0.3 $^0F$, respectively.

Similarly, a single failure of the containment isolation valve on instrument air or high/low nitrogen supply lines to close, coupled with a MSLB-induced failure of one of the supply or distribution lines inside the containment would also lead to additional mass and energy release beyond what is provided by ABB-CE. CCN 2 to N-4080-007 (reference 6.13) evaluated this single failure and concluded that there would be no significant impact to the short-term peak containment pressure or temperature. Therefore, the mass and energy releases from a failed air or nitrogen line is not included in this new equipment qualification AOR.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

### 4.5 CARD SERIES 801

No changes are made to card series 801 input except:

a.2(a) Containment Spray Injection Mode Spray Flow Rate

The minimum Containment Pump Spray Flow Rate has been changed to 1606 gpm (reference 6.2). In this calculation we use a value of 1600 gpm for further conservatism. Using the same criteria as in the AOR, this value translates to a flow rate of 7.956E+5 lb/hr.

The containment spray flow is discontinued at 1E4 seconds, consistent with a calculated time to deplete the refueling water storage tank inventory, using a single spray train, of about 1.1E4 seconds (reference 6.1, section 4.5.b.1). Following spray termination, containment heat removal is provided by the continued operation of the single train emergency air cooler units ( 2ECUs ).

### 4.6 CARD SERIES 1101

The G1-15 (RISC) version of COPATTA does not have the option of multiple tables of ECU performance versus containment temperature for various values of cooling water supply temperature. Therefore, following the card series identifier ( $LIST POOL=1101 ), the input consists data pairs of containment saturation temperature and ECU heat removal rate.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

REV. INDICATOR

## 5.0 METHODOLOGY

The MSLB for Equipment Qualification evaluated in this calculation is the design basis 7.48 $ft^2$ steam line break accident at 102% power with off-site power available and with a loss of one train each of containment emergency air coolers and containment sprays.

The evaluation used the Bechtel COPATTA computer code (reference 6.5) to simulate the containment response to the MSLB.

The methodology employed in this calculation is identical to the present AOR (reference 6.1) for the Containment P/T Design Basis MSLB, with the exception that 8 percent condensate revaporization is added to the model to comply with NUREG-0588 design criteria to generate results applicable to equipment qualification evaluations.

In addition, the analysis run time is extended to 100,000 seconds ( ~28 hours ) to provide insight into the long-term deprssurization and cooldown of containment following the dryout of the affected steam generator and termination of containment spray flow at about 3 hours post-MSLB, when the refueling water storage tank has been exhausted. After spray termination, containment heat removal is provided by the continued operation of the single train emergency air cooler units ( 2ECUs ). The long-term analysis is conservative since evaporative and convective heat transfer between the containment sump water and the vapor region is not modelled in this analysis.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## 6.0 REFERENCES

6.1 SONGS Units 2&3 Calculation N-4080-027, Revision 0, "Containment P/T Analysis for Design Basis MSLB", January 13, 1994.

6.2 SONGS Units 2&3 Calculation M-0014-009, Revision 0, Supplement A, "Containment Spray (CSS) In Service Minimum Requirements, July 28, 1994.

6.3 1) NCR 93030001-03

2) NCR 93030002-02

3) NCR 93030003-02

4) NCR 93030004-02

6.4 SONGS Units 2&3 Calculation N-4080-004, Revision 1, "Equipment Qualification Thermal Analysis (MSLB), January 6, 1978 ( includes CCN 1).

6.5 Bechtel Standard Computer Program, NE100, COPATTA, Version G1-15, "Containment Temperature and Pressure Transient Analysis", User and Theory Manuals.

6.6 SONGS Unit 2 Operating License and Technical specifications, up to and including Amendment 101.

6.7 SONGS Unit 3 Operating License and Technical specifications, up to and including Amendment 90.

6.8 Bechtel Topical report BN-TOP-3, Revision 4, "Performance and Sizing of Dry; Pressure Containments", March 1983.

6.9 NUREG-0588, Revision 1, "Interim Staff Position On Environmental Qualification of Safety-Related Electrical Equipment", July 1981.

6.10 SONGS Units 2 and 3 Calculation M-DSC-243, Revision 0, "Thermal Lag Analysis of Electrical Equipment at SONGS 2 & 3 due to MSLB", December 23, 1991.

6.11 SONGS Units 2 and 3 CCN 1 to Calculation M-DSC-243, Revision 0, "Thermal Lag Analysis of Electrical Equipment at SONGS 2 & 3 due to MSLB", January 15, 1992.

6.12 SONGS Units 2 and 3 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification", December 9, 1993.

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CCN CONVERSION CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-23

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

6.13 SONGS Units 2 and 3 Calculation N-4080-007, Revision 2, "Containment Pressure and Temperature from MSLB at various Power Levels", April 21, 1983 ( includes CCNs 1 and 2 ).

6.14 Memo from J.l. Rainsberry to A.J. Brough, "Peak Containment Pressure Calculations, San Onofre Nuclear Generating Station, Units 2 and 3", May 12, 1994.

6.15 SONGS Units 2 and 3 Calculation N-4080-003, Revision 5, "Containment Spray (CSS) and Emergency Cooling Unit (ECU) Actuation Times", December 23, 1993

6.16 SONGS Units 2&3 Calculation N-40806027, Revision 0, "Containment P/T Analysis for Design Basis LOCA", January 28, 1994.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## 7.0 NOMENCLATURE

Abbreviations are defined when first used within the body of the text.

## 8.0 CALCULATION

### 8.1 COPATTA CODE INPUT DATA

COPATTA input data for the Containment P/T Design Basis MSLB Analysis for Equipment Qualification uses the Containment P/T Design Basis MSLB Analysis (reference 6.1) input data with modifications to reflect changes in containment spray flow rate (reference 6.2), initial containment pressure and condensate revaporization fraction to generate containment temperature and pressure profiles for the Equipment Qualification Thermal Analysis. Only the changes to the reference 6.1 input data will be presented in the following subsections.

### 8.1.1 TITLE CARD

```
*EQMSLB 102P, Pi=14.7, EV=8%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-A
```

### 8.1.2 CARD SERIES 0

No changes made to Card Series 0 of reference 6.1 other than the deletion of the last four zero entries on the Bechtel input file as non-applicable to COPATTA version G1-15.

### 8.1.3 CARD SERIES 1: General Problem Information

```
&LIST POOL=1,1E5,14.7,2.305E6,120,0.6,20,582.945,1,1,0.08,14.7,0,0.50 $END
```

ITEM 2: TNFL = 2E4 seconds ( per 4.2.a )

ITEM 3: PAIR = 14.7 psia

The initial containment pressure before the MSLB mass and energy release is set to 14.7 psia for EQ calculations, as discussed in the Design Input Item 4.2.b.

Card Series input ITEMS 4 through 10 remain unchanged from that of reference 6.1.

ITEM 11: EVAP = 0.08

The fraction of heat sink condensate which will be allowed to revaporize is set to 0.08. Credit for revaporization will be taken for the purposes of EQ analysis per assumption 3.1.a.

8.1.4 CARD SERIES 5: Air Cooler Information

```
$LIST POOL=5,2,50,1E7,0,0 $END
```

ITEM 3: This item reflect the change of Containment Air Cooler start time from 15 seconds to 50 seconds as discussed in Design Input Item 4.3.a. No other changes have been made to this card data.

8.1.5 CARD SERIES 801: ( Table 9 )

This Card Series reflect the change of Containment Spray System (CSS) Flow Rate from 1612 gpm to 1600 gpm and the termination of containment spray flow at 10,000 seconds.

```
$LIST POOL=801,
      0,       0,   0,   0,   100,   100,
     50,       0,   0,   0,   100,   100,
     50, 7.956E5,   0,   0,   100,   100,
    1E4, 7.956E5,   0,   0,   100,   100,
    1E4,     0.0,   0,   0,   100,   100,
    2E7,     0.0,   0,   0,   100,   100 $END
```

8.1.6 CARD SERIES 1101

Items 2,3 and 4 of reference 6.1 input are deleted as not applicable to the G1-15 (RISC) version of COPATTA.

All other input used in this calculation remain unchanged from that of Reference 6.1, as described in Sections 8.1.1 through 8.1.33, except as changed in the preceding paragraphs.

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## CALCULATION SHEET

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Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027-Sup-A**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION** Sheet No. A-27

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

### 9.0 COPATTA INPUT FILE

```
*EQMSLB 102P, Pi=14.7, EV=8%, CT=1, TC=50, LOP=0, CS=1600, N-4080-027-SUP-A
 $LIST POOL=0,0,1,0,1 $END
 $LIST POOL=1,1E5,14.7,2.305E6,120,0.6,20,582.945,1,1,0.08,14.7,0.5 $END
 $LIST POOL=2,0,0,0,0,0,120,2E7 $END
 $LIST POOL=3,0,0,0,0,0,2E7,0,0,0,0 $END
 $LIST POOL=4,0,0,0,0,0,0,0,0,0,0,0,0 $END
 $LIST POOL=5,2,50,1E7,0,0 $END
 $LIST POOL=6,0,0,0 $END
 $LEAK NOPEN=0 $END
 $LIST POOL=101,
          0,      0,
        2E7,      0 $END
 $LIST POOL=201,
          0,      0,
        2E7,      0 $END
 $LIST POOL=301,
                   0,    5.145520E7,    1.195589E3,
                0.22,    4.869032E7,    1.197482E3,
                0.42,    4.622234E7,    1.198466E3,
                0.62,    4.405936E7,    1.199410E3,
                1.08,    4.003276E7,    1.201595E3,
                1.58,    3.688855E7,    1.201757E3,
                2.08,    3.445970E7,    1.202018E3,
                2.58,    3.326288E7,    1.200986E3,
                3.58,    3.152606E7,    1.201058E3,
                4.58,    3.028468E7,    1.201655E3,
                5.58,    2.940080E7,    1.201123E3,
                6.58,    2.874870E7,    1.201126E3,
                7.58,    2.706574E7,    1.204404E3,
                8.58,    2.468326E7,    1.204367E3,
                9.58,    2.294968E7,    1.204238E3,
               10.58,    2.160122E7,    1.203908E3,
               12.58,    1.943143E7,    1.203195E3,
               14.58,    1.765940E7,    1.202277E3,
               16.58,    1.637240E7,    1.201556E3,
               18.58,    1.544720E7,    1.200963E3,
               20.58,    1.473293E7,    1.200422E3,
               25.58,    1.327525E7,    1.198820E3,
               30.58,    1.221858E7,    1.197825E3,
               35.58,    1.146406E7,    1.196753E3,
               40.58,    1.059131E7,    1.195307E3,
               45.58,    9.801216E6,    1.194165E3,
               50.58,    9.132588E6,    1.193086E3,
```

```
                  60.58,    8.280324E6,     1.190935E3,
                  61.08,    7.245576E6,     1.190949E3,
                  62.08,    5.803344E6,     1.189165E3,
                  62.58,    3.238704E6,     1.184658E3,
                  64.58,    3.948840E5,     1.179953E3,
                  68.58,    1.074240E5,     1.251072E3,
                  71.08,             0,              0,
                    2E7,             0,              0 $END
    $LIST POOL=401,
             0,      0,      0,
           2E7,      0,      0 $END
    $LIST POOL=501,
             0,      0,      0,
           2E7,      0,      0 $END
    $LIST POOL=601,
             0,      7.2E4,      7.2E6,
          0.05,      7.2E4,      7.2E6,
          0.05,        0.0,        0.0,
           2E7,      0,      0 $END
    $LIST POOL=701,
             0,      0,      0,      0,
           2E7,      0,      0,      0 $END
    $LIST POOL=801,
           0,        0,   0,   0,   100,   100,
          50,        0,   0,   0,   100,   100,
          50, 7.956E5,    0,   0,   100,   100,
         1E4, 7.956E5,    0,   0,   100,   100,
         1E4,     0.0,    0,   0,   100,   100,
         2E7,     0.0,    0,   0,   100,   100 $END
    $LIST POOL=901,
             0,      0,      0,
           2E7,      0,      0 $END
    $LIST POOL=1001,
             0,    100,    2.0,
            24,    100,    2.0 $END
    $LIST POOL=1101,
               105,           0,
               120,   1.670E6,
               130,   3.020E6,
               140,   4.570E6,
               150,   6.320E6,
               160,   8.270E6,
               170,   1.040E7,
               180,   1.273E7,
               190,   1.523E7,
               200,   1.788E7,
```

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-1

CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027-Sup-A**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION** Sheet No. **A-29**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

```
                210,  2.068E7,
                220,  2.361E7,
                230,  2.664E7,
                240,  2.974E7,
                250,  3.291E7,
                260,  3.611E7,
                270,  3.931E7,
                280,  4.252E7,
                287,  4.474E7,
                290,  4.569E7,
                300,  4.882E7 $END
   $LIST POOL=1201,
                  0,  0.729,
                0.1,  0.737,
                0.2,  0.747,
                0.3,  0.757,
                0.4,  0.771,
                0.5,  0.788,
                0.6,  0.809,
                0.7,  0.832,
                0.8,  0.863,
                0.9,  0.912,
                1.0,  0.961,
                1.1,  0.983,
                1.2,  0.995,
                1.3,  1.000 $END
   $LIST POOL=9001,
                   5,  0.05,    1.0,   5,
                  10,  0.05,    1.0,   5,
                  15,  0.05,    1.0,   5,
                  20,  0.05,    1.0,   5,
                 100,   0.1,    1.0,   5,
                 200,   1.0,    5.0,   5,
                 600,   1.0,   10.0,   5,
                 800,   2.0,   20.0,   5,
                 1E3,   5.0,   50.0,   1,
                 1E4,  50.0,   1000,   2,
                 1E4,  50.0,    500,   2,
                 5E4,  50.0,   5000,   2,
                 2E5,  50.0,  10000,    2 $END
   $LIST POOL=9999 $END
  * HS #1 - REACTOR BUILDING DOME
   $LIST POOL=101001, 100, 7, 0, 0, 0, 0, 34693.22 $END
   $LIST POOL=101101, 5, 0.00075,   3,   0.02158,
                      3, 0.02193,  10,   0.06360,
                     20, 0.23028,  37,   1.00110,
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

```
                    21, 4.06363 $END
  $LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2 $END
  $LIST POOL=101300, 0, 0 $END
  $LIST POOL=101400, 9, 2, 1, 1 $END
 * HS #2 - CYLINDER WALL BETWEEN El. 29'6" AND 112'0"
  $LIST POOL=102001, 100, 7, 0, 0, 0, 0, 38120 $END
  $LIST POOL=102101, 5, 0.00075,    3,  0.02158,
                     3, 0.02193,   10,  0.06360,
                    20, 0.14694,   37, 0.917761,
                    21, 4.35526 $END
  $LIST POOL=102201, 4, 1, 5, 2, 2, 2, 2 $END
  $LIST POOL=102300, 0, 0 $END
  $LIST POOL=102400, 9, 2, 1, 1 $END
 * HS #3 - CYLINDER WALL BETWEEN El. 15'0" AND El. 29'6"
  $LIST POOL=103001, 100, 7, 0, 0, 0, 0, 6667.38 $END
  $LIST POOL=103101, 5, 0.00075,    3,  0.02158,
                     3, 0.02193,   10,  0.06360,
                    20, 0.14694,   37, 0.917761,
                    21, 4.35526 $END
  $LIST POOL=103201, 4, 1, 5, 2, 2, 2, 2 $END
  $LIST POOL=103300, 0, 0 $END
  $LIST POOL=103400, 9, 2, 0, 2 $END
 * HS #4 - BASEMAT (OTHER THAN REACTOR BASEMAT)
  $LIST POOL=104001, 53, 5, 0, 0, 0, 0, 12800 $END
  $LIST POOL=104101, 3,  0.00067,   7,     0.1,
                    20,  1.52698,   2, 1.54781,
                    20, 11.02150 $END
  $LIST POOL=104201, 4, 2, 2, 1, 2 $END
  $LIST POOL=104300, 0, 0 $END
  $LIST POOL=104400, 3, 3, 0, 3 $END
 * HS #5 - REACTOR BASEMAT & S.G. PEDESTALS
  $LIST POOL=105001, 70, 4, 0, 0, 0, 0, 1644 $END
  $LIST POOL=105101, 4, 0.00158,   10,     0.1,
                    30,    2.00,   25, 8.43092 $END
  $LIST POOL=105201, 4, 2, 2, 2 $END
  $LIST POOL=105300, 0, 0 $END
  $LIST POOL=105400, 3, 3, 0, 3 $END
 * HS #6 - REACTOR CAVITY WALLS BELOW El. 15'0"
  $LIST POOL=106001, 93, 5, 1, 11.75, 0, 0, 21.5 $END
  $LIST POOL=106101, 5, 11.75192,    7, 11.77292,
                    30, 13.29923,   30, 19.29923,
                    20, 25.25192 $END
  $LIST POOL=106201, 4, 2, 2, 2, 2 $END
  $LIST POOL=106300, 0, 0 $END
  $LIST POOL=106400, 3, 3, 0, 3 $END
 * HS #7 - REACTOR CAVITY WALLS ABOVE El. 15'0"
```

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CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027-Sup-A**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION** Sheet No. **A-31**

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

```
  $LIST POOL=107001, 68, 5, 0, 0, 0, 0, 2810 $END
  $LIST POOL=107101, 5, 0.00192,   7, 0.02292,
                    15, 0.40192,  20,    2.00,
                    20, 4.00192 $END
  $LIST POOL=107201, 4, 2, 2, 2, 2 $END
  $LIST POOL=107300, 0, 0 $END
  $LIST POOL=107400, 9, 2, 0, 2 $END
 * HS #8 - LINED REFUELING CANAL WALLS
  $LIST POOL=108001, 86, 6, 0, 0, 0, 0, 9200 $END
  $LIST POOL=108101, 5, 0.01563,    20,     0.1,
                    15, 0.41563,    20,    2.00,
                    20, 4.01563,     5, 4.01755 $END
  $LIST POOL=108201, 3, 2, 2, 2, 2, 4 $END
  $LIST POOL=108300, 0, 0 $END
  $LIST POOL=108400, 9, 2, 9, 2 $END
 * HS #9 - S.G. CMPRTMNT WALLS, UNLINED REFL CNL WALLS/OTH INT WALLS
  $LIST POOL=109001, 78, 4, 0, 0, 0, 0, 41976 $END
  $LIST POOL=109101, 5, 0.00192,    10, 0.04233,
                    12,     0.1,    50, 1.71876 $END
  $LIST POOL=109201, 4, 2, 2, 2 $END
  $LIST POOL=109300, 0, 0 $END
  $LIST POOL=109400, 9, 2, 0, 2 $END
 * HS #10 - FLOOR SLABS (OTHER THAN BASEMATS)
  $LIST POOL=110001, 67, 6, 0, 0, 0, 0, 17474 $END
  $LIST POOL=110101, 3, 0.00014, 5, 0.005348,
                    20, 0.105348, 15, 0.505348,
                    20, 1.505348, 3, 1.506015 $END
  $LIST POOL=110201, 4, 1, 2, 2, 2, 4 $END
  $LIST POOL=110300, 0, 0 $END
  $LIST POOL=110400, 9, 2, 9, 2 $END
 * HS #11 - LIFTING DEVICES (EXCEPT STAINLESS STEEL PARTS)
  $LIST POOL=111001, 17, 2, 0, 0, 0, 0, 57286 $END
  $LIST POOL=111101, 6, 0.00125, 10, 0.042917 $END
  $LIST POOL=111201, 4, 1 $END
  $LIST POOL=111300, 0, 0 $END
  $LIST POOL=111400, 9, 2, 0, 2 $END
 * HS #12 - MISCELLANEOUS CARBON STEEL - THICKNESS > 2.50 INCHES
  $LIST POOL=112001, 64, 4, 0, 0, 0, 0, 516 $END
  $LIST POOL=112101, 6, 0.0005, 17, 0.084,
                    15, 0.20, 25, 0.310849 $END
  $LIST POOL=112201, 4, 1, 1, 1 $END
  $LIST POOL=112300, 0, 0 $END
  $LIST POOL=112400, 9, 2, 0, 2 $END
 * HS #13 - MISCELLANEOUS CARBON STEEL: 1.00"<THICKNESS<2.50"
  $LIST POOL=113001, 32, 2, 0, 0, 0, 0, 12042 $END
  $LIST POOL=113101, 6, 0.00063, 25, 0.16967 $END
```

```
 $LIST POOL=113201, 4, 1 $END
 $LIST POOL=113300, 0, 0 $END
 $LIST POOL=113400, 9, 2, 0, 2 $END
* HS #14 - MISCELLANEOUS CARBON STEEL: 0.50"<THICKNESS<1.00"
 $LIST POOL=114001, 19, 2, 0, 0, 0, 0, 64693 $END
 $LIST POOL=114101, 5, 0.000674, 13, 0.038607 $END
 $LIST POOL=114201, 4, 1 $END
 $LIST POOL=114300, 0, 0 $END
 $LIST POOL=114400, 9, 2, 0, 2 $END
* HS #15 - MISCELLANEOUS CARBON STEEL: THICKNESS<0.5"
 $LIST POOL=115001, 17, 2, 0, 0, 0, 0, 98913.6 $END
 $LIST POOL=115101, 6, 0.000606, 10, 0.012833 $END
 $LIST POOL=115201, 4, 1 $END
 $LIST POOL=115300, 0, 0 $END
 $LIST POOL=115400, 9, 2, 0, 2 $END
* HS #16 - ELECTRICAL EQUIPMENT
 $LIST POOL=116001, 8, 1, 0, 0, 0, 0, 37644.5 $END
 $LIST POOL=116101, 7, 0.0054 $END
 $LIST POOL=116201, 1 $END
 $LIST POOL=116300, 0, 0 $END
 $LIST POOL=116400, 9, 2, 0, 2 $END
* HS #17 - MISCELLANEOUS STAINLESS STEEL
 $LIST POOL=117001, 16, 1, 0, 0, 0, 0, 24048 $END
 $LIST POOL=117101, 15, 0.01747 $END
 $LIST POOL=117201, 3 $END
 $LIST POOL=117300, 0, 0 $END
 $LIST POOL=117400, 9, 2, 0, 2 $END
* HS #18 - UNLINED REFUELING CANAL WALLS BELOW El. 63'6"
 $LIST POOL=118001, 48, 4, 0, 0, 0, 0, 3700 $END
 $LIST POOL=118101, 5, 0.00192, 7, 0.02292,
                   15, 0.40192, 20, 2.00192 $END
 $LIST POOL=118201, 4, 2, 2, 2 $END
 $LIST POOL=118300, 0, 0 $END
 $LIST POOL=118400, 9, 2, 0, 2 $END
* HS #19 - REACTOR BLDG CYLINDER #3: SECTIONS WITH STIFFENERS
 $LIST POOL=119001, 100, 7, 0, 0, 0, 0, 1590.68 $END
 $LIST POOL=119101, 5, 0.00075,   20,  0.66742,   3,   0.66777,
                   15, 0.70944,   20,  0.79278,  16,  1.44278,
                   20, 4.87885 $END
 $LIST POOL=119201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=119300, 0, 0 $END
 $LIST POOL=119400, 9, 2, 1, 1 $END
* HS #20 - VENT TUNNELS
 $LIST POOL=120001, 23, 2, 0, 0, 0, 0, 2827 $END
 $LIST POOL=120101, 10, 0.0005,  12, 0.03175 $END
 $LIST POOL=120201, 4, 1 $END
```

```
$LIST POOL=120300, 0, 0 $END
$LIST POOL=120400, 9, 2, 0, 2 $END
$LIST POOL=410001,
           25,     54,
          0.8,     30,
           10,     54,
          0.1,     20,
       0.0174, 0.0103 $END
$LIST POOL=500000 $END
```

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-1

PAGE 35 OF 41

CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP **SONGS UNITS 2 and 3** Calc No. **N-4080-027-Sup-A**

Subject **CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION** Sheet No. A-34

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

## 10.0 SELECTED OUTPUT DATA

The tabulated data presented in Sections 10.1 and 10.2 consists of partial output of the COPATTA calculation made for this analysis.

### 10.1

| | CONTAINMENT | CONTAINMENT | CONTAINMENT | HEAT SINK 1 |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMP | SUMP TEMP | (LEFT BOUND) |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| | | | | |
| 0 | 0.00 | 120.00 | 120.00 | 118.4 |
| 1 | 3.59 | 179.50 | 136.10 | 118.4 |
| 2 | 6.50 | 218.40 | 151.70 | |
| 3 | 9.05 | 246.80 | 162.70 | |
| 4 | 11.42 | 269.40 | 171.40 | |
| 5 | 13.67 | 288.00 | 178.80 | 136.0 |
| 6 | 15.81 | 303.70 | 185.20 | |
| 7 | 17.86 | 317.20 | 190.80 | |
| 8 | 19.79 | 328.70 | 195.90 | |
| 9 | 21.54 | 338.30 | 200.30 | |
| 10 | 23.13 | 346.20 | 204.20 | 153.4 |
| 11 | 24.59 | 352.90 | 207.70 | |
| 12 | 25.96 | 358.70 | 211.00 | |
| 13 | 27.24 | 363.70 | 213.80 | |
| 14 | 28.43 | 368.00 | 216.40 | |
| 15 | 29.55 | 371.80 | 218.70 | 166.6 |
| 16 | 30.61 | 375.10 | 220.90 | |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

REV. INDICATOR

| | CONTAINMENT | CONTAINMENT | CONTAINMENT | HEAT SINK 1 |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMP | SUMP TEMP | (LEFT BOUND) |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| 17 | 31.61 | 378.10 | 223.00 | |
| 18 | 32.56 | 380.70 | 224.90 | |
| 19 | 33.47 | 383.00 | 226.60 | |
| 20 | 34.37 | 385.14 | 228.30 | 178.4 |
| 22 | 36.05 | 388.86 | 231.30 | |
| 24 | 37.60 | 391.95 | 233.90 | |
| 25 | 38.34 | 393.10 | 235.20 | |
| 26 | 39.06 | 394.37 | 236.30 | |
| 28 | 40.46 | 396.56 | 238.50 | |
| 30 | 41.80 | 398.44 | 240.50 | 195.9 |
| 32 | 43.07 | 400.06 | 242.30 | |
| 33 | 43.69 | 400.80 | 243.20 | |
| 34 | 44.29 | 401.47 | 244.00 | |
| 36 | 45.47 | 402.70 | 245.60 | |
| 38 | 46.60 | 403.76 | 247.00 | |
| 40 | 47.68 | 404.64 | 248.40 | 209.9 |
| 42 | 48.71 | 405.36 | 249.70 | |
| 44 | 49.69 | 405.95 | 250.90 | |
| 45 | 50.16 | 406.20 | 251.50 | |
| 46 | 50.63 | 406.42 | 252.10 | |
| 48 | 51.52 | 406.78 | 253.20 | |
| 50 | 52.38 | 407.07 | 254.20 | 222.2 |
| 52 | 52.93 | 402.84 | 255.20 | |

NES&L DEPARTMENT

# CALCULATION SHEET

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CCN CONVERSION CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-36

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

| | CONTAINMENT | CONTAINMENT | CONTAINMENT | HEAT SINK 1 |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMP | SUMP TEMP | (LEFT BOUND) |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| 54 | 53.46 | 398.66 | 256.20 | |
| 56 | 53.97 | 394.58 | 257.10 | |
| 58 | 54.46 | 390.62 | 258.00 | |
| 60 | 54.93 | 386.75 | 258.80 | 231.8 |
| 62 | 55.27 | 382.72 | 259.50 | |
| 64 | 54.97 | 377.40 | 260.30 | |
| 66 | 54.35 | 371.49 | 260.90 | |
| 68 | 53.71 | 365.60 | 261.40 | |
| 70 | 53.06 | 359.64 | 261.90 | 236.2 |
| 75 | 51.47 | 345.04 | 262.90 | |
| 80 | 50.02 | 331.06 | 263.60 | 238.2 |
| 85 | 48.58 | 317.22 | 264.10 | |
| 90 | 47.21 | 303.72 | 264.40 | 239.6 |
| 95 | 45.89 | 290.55 | 264.70 | |
| 100 | 44.62 | 277.64 | 264.90 | 240.4 |
| 105 | 43.70 | 269.19 | 265.00 | |
| 110 | 43.22 | 268.35 | 265.20 | |
| 115 | 42.80 | 267.75 | 265.30 | |
| 120 | 42.40 | 267.16 | 265.40 | |
| 125 | 42.01 | 266.59 | 265.40 | 242.5 |
| 130 | 41.64 | 266.00 | 265.40 | |
| 135 | 41.28 | 265.51 | 265.40 | |
| 140 | 40.94 | 264.99 | 265.40 | |

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
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CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-37

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

| | CONTAINMENT | CONTAINMENT | CONTAINMENT | HEAT SINK 1 |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMP | SUMP TEMP | (LEFT BOUND) |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| 145 | 40.58 | 264.49 | 265.30 | |
| 150 | 40.28 | 264.00 | 265.20 | 243.5 |
| 155 | 39.97 | 263.52 | 265.20 | |
| 160 | 39.77 | 263.22 | 265.10 | |
| 165 | 39.48 | 262.76 | 265.00 | |
| 170 | 39.19 | 262.32 | 264.90 | |
| 175 | 38.91 | 261.88 | 264.80 | 243.8 |
| 180 | 38.59 | 261.40 | 264.70 | |
| 185 | 38.37 | 261.03 | 264.60 | |
| 190 | 38.11 | 260.62 | 264.50 | |
| 195 | 37.86 | 260.22 | 264.40 | |
| 200 | 37.61 | 259.82 | 264.30 | 243.6 |
| 250 | 35.44 | 256.25 | 263.10 | 242.4 |
| 300 | 33.76 | 253.34 | 261.80 | 241.1 |
| 350 | 32.23 | 250.61 | 260.50 | 239.6 |
| 400 | 30.90 | 248.15 | 259.20 | 238.1 |
| 450 | 29.70 | 245.86 | 258.00 | 236.5 |
| 500 | 28.69 | 243.87 | 256.70 | 235.0 |
| 550 | 27.68 | 241.81 | 255.40 | 233.5 |
| 600 | 26.72 | 239.82 | 254.10 | 232.0 |
| 700 | 24.99 | 236.06 | 251.40 | 228.8 |
| 800 | 23.52 | 232.69 | 248.80 | 225.9 |
| 900 | 22.12 | 229.33 | 246.10 | 223.1 |

NES&L DEPARTMENT

## CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-1

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CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-38

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

| | CONTAINMENT | CONTAINMENT | CONTAINMENT | HEAT SINK 1 |
|---|---|---|---|---|
| TIME | PRESSURE | VAPOR TEMP | SUMP TEMP | (LEFT BOUND) |
| (SEC) | (PSIG) | (F) | (F) | (F) |
| 1000 | 20.85 | 226.13 | 243.50 | 220.3 |
| 2000 | 13.76 | 204.75 | 224.10 | |
| 4000 | 6.19 | 169.41 | 199.70 | 172.3 |
| 8000 | 1.83 | 132.34 | 170.70 | |
| 9000 | 1.499 | 128.58 | 165.90 | |
| 10000 | 1.25 | 125.84 | 161.70 | 141.9 |
| 15000 | 1.17 | 144.67 | 161.50 | |
| 20000 | 0.97 | 143.49 | 161.39 | 140.0 |
| 40000 | 0.79 | 138.57 | 160.94 | 135.9 |
| 60000 | 0.72 | 135.46 | 160.52 | |
| 90000 | 0.57 | 132.61 | 159.94 | 130.4 |
| 1E+5 | 0.63 | 131.95 | 159.75 | |

10.2

| TIME | INTEGRATED ENERGY REMOVED BY CONTAINMENT SPRAYS (a) | INTEGRATED ENERGY REMOVED BY CONTAINMENT AIR COOLERS (b) |
|---|---|---|
| **secs** | **(btu)** | **(btu)** |
| | | |
| 50 | 0.0e+00 | 2.30e+03 |
| 51 | 6.75e+04 | 2.53e+04 |
| 60 | 6.55e+05 | 2.36e+05 |
| 100 | 2.70e+06 | 1.15e+06 |
| 200 | 6.33e+06 | 3.23e+06 |
| 500 | 1.62e+07 | 8.77e+06 |
| 1000 | 2.96e+07 | 1.65e+07 |

(a)Energy is transferred to containment sump water.

(b)Energy is transferred to component cooling water (CCW) system.

| TIME | ENERGY REMOVAL RATE BY CONTAINMENT SPRAYS | TIME | ENERGY REMOVAL RATE BY CONTAINMENT AIR COOLERS |
|---|---|---|---|
| **secs** | **(btu/hr)xE6** | **secs** | **(btu/hr)xE6** |
| | | | |
| 51.5 | 241.5 | 50 | 82.7 |
| 60.0 | 227.8 | 60 | 85.4 |
| 99.5 | 142.2 | 100 | 78.6 |
| 200.0 | 127.0 | 200 | 72.1 |
| 500.0 | 110.3 | 500 | 61.8 |
| 975.0 | 086.0 | 1000 | 50.9 |

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-1

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CCN CONVERSION
CCN NO. CCN - 1

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-027-Sup-A

Subject CONTAINMENT P/T DESIGN BASIS MSLB FOR EQUIPMENT QUALIFICATION Sheet No. A-40

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ALLEN EVINAY | 11/04/94 | PAUL BARBOUR | 11/04/94 | | | | | |
| | | | | | | | | | |

**APPENDIX A (COPATTA Code I/O File)**

The COPATTA Code input file is presented in Section 9 of this calculation.

The COPATTA Code output file is included on Microfiche. The output file name and date are as follows:

FICHE TITLE : EQMSLB J6908 02-Nov-94

JOB TITLE : *MSLB 102%P, CPi=14.7, EVAP=8%, CT=1, LOP=0, CS=1600, N-4080-027-SUP-A

RUN DATE : 11-02-94

LAST SHEET : Page 387

# CALCULATION TITLE PAGE

ICCN NO./
PRELIM CCN NO.

PAGE ___ OF ___

CCN CONVERSION:
CCN NO. CCN

Calc. No. N-4080-027 DCP/MMP/FIDCN/FCN No. & Rev. N/A

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet 1

System Number/Primary Station System Designator ~~BLDG~~ SE 11/12/93 1301 / XB1 SONGS Unit 2&3 Q-Class II

Tech Spec Affecting? ☐ NO ☒ YES, Section No. LCO 3.6.1.1/2/3 & B3.6.1.4/6 Equipment Tag No. N/A

| CONTROLLED COMPUTER PROGRAM/ DATABASE | ☒ PROGRAM<br>☐ DATABASE<br>IN ACCORDANCE WITH NES&L 41-5-1 | PROGRAM/DATABASE NAME(S)<br>☒ ALSO LISTED BELOW<br>'COPATTA" MAP-175 | VERSION/RELEASE NO(S).<br>Version G1/14 |
|---|---|---|---|

RECORD OF ISSUES

| REV. / DISC | DESCRIPTION | TOTAL SHTS / LAST SHT. | PREPARED (Print name/initial) | APPROVED (Signature) | |
|---|---|---|---|---|---|
| 0 | SEE NOTE 1 BELOW<br>ISSUED FOR USE | 155 | ORIG Stephen Oliver SO | GS Barker for AJ-Eckhart | Other IPRG |
| BPC N | | 155 | IRE John Elliott | DM | DATE 1-13-94 |
| --- | | | ORIG | GS | Other |
| --- | | | IRE | DM | DATE |
| --- | | | ORIG | GS | Other |
| --- | | | IRE | DM | DATE |
| --- | | | ORIG | GS | Other |
| --- | | | IRE | DM | DATE |

Space for RPE stamp, identify use of an alternate calc., and notes as applicable.

Note 1:

The purpose of Revision 0 is as follows:

Open Item Reports 92-069, 92-059, 92-057, 92-054, 92-045, and 92-015 indicate discrepancies in Calculation N-4080-007 Revisions 0, 1 and 2. Revision 0 to this calculation (N-4080-027) will incorporate the recommended changes specified by these Open Item Reports in an effort to improve documentation and accuracy of the MSLB P-T calculation.

Disclaimer: This calculation was prepared using Word Perfect 5.1 software. However, WP 5.1 was not used for any computations in the calculation.

This calc. was prepared for the identified DCP/MMP. DCP completion and turnover acceptance to be verified by reciept of a memorandum directing DCN conversion. Upon receipt, this calc. represents the as-built condition. Memo date ________ by ________.

# CALCULATION CROSS INDEX

| ICCN NO./ PRELIM. CCN NO. | PAGE____ OF____ |
|---|---|
| | CCN CONVERSION: CCN NO. CCN- |

Calculation No. N-4080-027

Sheet No. 2

| Calc. rev. number and responsible supervisor initials and date | INPUTS These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation. | | OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents. | | Does the output interface calc/document require revision? | Identify output interface calc/document CCN, DCN TCN/Rev. or FIDCN |
|---|---|---|---|---|---|---|
| | Calc/Document No. | Rev. No. | Calc/Document No. | Rev. No. | YES/NO | |
| 0 P.B. for AJE 1-12-94 | Calculations | | Units 2&3 Updated Final Safety Analysis Report | 9 | YES | SAR23-278 Pky 1-10-94 |
| | C-257-1.06.01 | 1 | | | | |
| | M-0014-009 | 0 | | | | |
| | M-0026-001 | 5 | Calculation N-4080-007 | 2 | YES | NEDOTRAK LOG # AJB-94-003 Pky 1-10-94 |
| | N-4080-007 | 2 | Calculation N-4080-004 | 1 | YES | |
| | M-0072-036 | 0 | Calculation N-4080-005 | 0 | YES | |
| | N-4080-005 | 0 | ~~Calculation M-DFC 243~~ | ~~0~~ | PB 1-10-94 ~~YES~~ | |
| | N-4080-002 | 1 | | | | |
| | N-4080-003 | 5 | DBD-SO23-TR-AA | 0 | YES | NEDOTRAK LOG # AJB-94-004 Pky 1-10-94 |
| | Unit 2 Operating License and Technical Specs | Amend.108 | DBD-SO23-400 | 0 | YES | NEDOTRAK ACTION #0 IR 92-015 SUBACTION 01 Pky 1-11-94 |
| | LCO 3.6.1.4 (page 3/4 6-7, Orig issue) | | | | | |
| | LCO 3.6.1.5 (page 3/4 6-8, Orig issue) | | SONGS Unit 2 Technical Specifications | A. 108 | YES | NEDOTRAK LOG # AJB-94-002 Pky 1-10-94 |
| | Sect. 5.2.2 (page 5-1, Amend. (Orig issue) | | LCO 3.6.1.1 (page 3/4 6-1, Amend. 46) | | | |
| | Unit 3 Operating License and Technical Specs | Amend. 97 | LCO 3.6.1.2 (page 3/4 6-2, Amend. 93) | | | |
| | LCO 3.6.1.4 (page 3/4 6-7, Orig Issue) | | LCO 3.6.1.3 (page 3/4 6-5, Orig Issue) | | | |
| | LCO 3.6.1.5 (page 3/4 6-8, Orig Issue) | | B3.6.1.4 (page B3/4 6-2, Amend. 16) | | | |
| | Section 5.2.2 (page 5-1, Orig Issue) | | B3.6.1.6 (page B3/4 6-2, Amend. 16) | | | |
| | Open Item Reports | | | | | |
| | 92-015 | 0 | SONGS Unit 3 Technical Specifications | A. 97 | YES | |
| | 92-045 | 0 | LCO 3.6.1.1 (page 3/4 6-1, Amend. 35) | | | |
| | 92-054 | 0 | LCO 3.6.1.2 (page 3/4 6-2, Amend. 83) | | | |
| | 92-057 | 0 | LCO 3.6.1.3 (page 3/4 6-5, Orig Issue) | | | |
| | 92-059 | 0 | B3.6.1.4 (page B3/4 6-2, Orig Issue) | | | |
| | 92-069 | 0 | B3.6.1.6 (page B3/4 6-2, Orig Issue) | | | |
| | Non-Conformance Report (NCRs) | | | | | |
| | 93030001 | | | | | |
| | 93030002 | | | | | |
| | 93030003 | | | | | |
| | 93030004 | | | | | |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

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## TABLE OF CONTENTS

# 1 PURPOSE

## 1.1 TASK DESCRIPTION

The purpose of this calculation is to evaluate the containment pressure and temperature response to a design basis Main-Steam-Line-Break (MSLB) for SONGS Units 2 and 3. The results of this calculation supersede the results of Calculation N-4080-007, "Containment Pressure Temperature from MSLB at Various Power Levels", (Reference 6.1.d) with respect only to the Design Basis MSLB event (7.4765 ft$^2$ MSLB @ 102% power with failure of one cooling train). Per the conclusions presented in Calculation N-4080-007, this is the worst case MSLB, and will envelope all the other break types. The changes in design input and assumptions used in this calculation will not alter the relative severity of the different break scenarios, and thus the MSLB @ 102% power with failure of one cooling train will remain the limiting case.

Resolution of the following Open Item Reports require the results of this calculation:

| OIR NO. | PROPOSED RESOLUTION |
|---|---|
| 92-015 | Correct UFSAR Table 6.2-9 to accurately report the time of occurrence of the peak containment pressure. (Reference 6.9.a). |
| 92-045 | Revise the analysis of Calculation N-4080-007 to include the origin of input parameters or, if a source document can not be found, then justify the modeled value. Append copies of computer code input files to this calculation. (Reference 6.9.b). |
| 92-054 | Correct UFSAR Table 6.2-9 to accurately report containment pressures, temperatures and times of occurrence (Reference 6.9.c). |
| 92-057 | Revise the analysis of Calculation N-4040-007 to adequately document the peak containment temperatures (Reference 6.9.d). |
| 92-059 | Revise the analysis of Calculation N-4080-007 to correct a discrepancy in the RWST volume. Verify that the new results do not modify information presented in UFSAR section 6.2.1.1.3.1. (Reference 6.9.e) |
| 92-069 | Revise the analysis of Calculation N-4080-007 using the Uchida HTC instead of the Modified Tagami HTC (Reference 6.9f). |

This calculation also addresses the reduced Containment Spray flowrates as described in disposition step 2 of NCRs 93030001, 93030002, 93030003, and 93030004. (References 6.16). This calculation incorporates the minimum spray flow identified in Calculation M-0014-009 (Reference 6.1.b).

The Bechtel Standard Computer Code MAP-175, Release G1-14 (COPATTA) (Reference 6.5.a) will be used in this calculation to evaluate the pressure-temperature transients.

## 1.2 CRITERIA, CODES AND STANDARDS

The containment structure is to be designed such that it is capable of withstanding the adverse affects of a postulated MSLB. Applicable regulatory design criteria are provided in Appendix A to 10 CFR Part 50 (Reference 6.4.a). These criteria include:

- General Design Criterion 16, "Containment Design"
- General Design Criterion 38, "Containment Heat Removal"
- General Design Criterion 50, "Containment Design Basis"

General Design Criterion 16 requires that a reactor containment and associated systems shall be provided to establish an essentially leak tight barrier to assure that the containment design conditions important to safety are not exceeded for as long as the conditions require. Per Standard Review Plan 6.2.1.1.A (Reference 6.4.c), to satisfy the requirements of this criterion, the calculated containment peak pressure after a MSLB should be less than the design containment peak pressure.

General Design Criterion 38 requires that the containment heat removal systems function to rapidly reduce the containment pressure following any LOCA, and maintain the pressure at an acceptably low level. Although not explicitly applied to the case of the MSLB, the requirements of GDC 38 can be considered to be applicable to the containment peak pressure analyses (be it LOCA or MSLB).

General Design Criterion 50 requires that the reactor containment structure, including access openings, penetrations, and the containment heat removal system, shall be designed so that the containment structure and its internal components can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure condition resulting from a LOCA. As with Criterion 16, per Standard Review Plan 6.2.1.1.A, to satisfy the requirements of Criterion 50, the calculated containment peak pressure after a LOCA should be less than the design containment peak pressure. Although GDC 50 specifically addresses a LOCA, and not an MSLB, SRP 6.2.1.1.A indicates that the requirements of GDC 50 can be considered to be applicable to the containment peak pressure analyses (be it LOCA, steam or feedwater line break).

The containment design pressure is 60 psig and the containment design temperature is 300 °F per the Technical Specifications (References 6.3.a and 6.3.b, Section 5.2.2).

## 2 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

### 2.1 RESULTS/CONCLUSIONS

Figure 2-1 presents the sump and vapor pressures versus time for the DBA MSLB. The plots in Figure 2-1 are generated using the data presented in Section 10.1.

Figure 2-2 presents the containment gauge pressure versus time for the DBA MSLB. The plot in Figure 2-2 is generated using the data presented in Section 10.1.

Figure 2-3 presents the condensing heat transfer coefficient used by the COPATTA Code versus time for the DBA MSLB. The plot in Figure 2-3 is generated using the data presented in Section 10.1.

Figure 2-4 presents the inside surface temperature of heat sink 1 (reactor building dome) to represent the temperature of the containment structure. The plot in Figure 2-4 is generated using the data presented in Section 10.1.

Figure 2-5 presents the instantaneous energy vs. time data used by COPATTA to determine heat transfer in the DBA MSLB. The plots in Figure 2-5 are generated using the data presented in Section 10.2. Included are:

| | |
|---|---|
| VAPOR ENERGY: | Instantaneous steam+air energy. |
| SUMP ENERGY: | Instantaneous energy of sump water. |
| TOTAL ENERGY: | Instantaneous energy inventory. |
| HEAT SINKS: | Instantaneous energy stored in structures. |

Figure 2-6 presents the integrated heat transfer of the air coolers and containment sprays. The plots presented in figure 2-6 are generated using the data in Section 10.2. Included are:

| | |
|---|---|
| AIR COOLERS: | Integrated energy removed by emergency fan coolers. |
| CONT. SPRAY: | Integrated energy transferred to sump by sprays. |

The following table presents the accident chronology for the analysis.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

| TIME (seconds) | EVENT |
|---|---|
| 0.0 | Break occurs |
| 15 | Emergency fan coolers start (at full capacity) |
| 50 | Containment spray nozzles at full discharge flow |
| 50.0 | Peak containment temperature of 421 °F |
| 62.3 | Peak containment pressure of 58.5 psig |
| 71.08 | End of Blowdown |

Note that although the peak vapor temperature of 421 °F is greater than the 300 °F design temperature, the duration of the event is sufficiently small to prevent heating of the containment structural materials beyond the design limits. As indicated by Figure 2-4, the 241 °F peak surface temperature of the containment liner remains well below 300 °F. Because the liner inside surface (actually a layer of organic paint) remains below 300 °F, the containment structure will not exceed design temperatures.

As can be seen from Figures 2-2 and 2-4, the peak pressure (58.5 psig) is below the design pressure of 60 psig and the peak temperature of the containment structure (241 °F) is below the design temperature of 300 °F. Therefore, General Design Criteria 16 and 50 (See Section 1.2) are met. The gauge pressure with respect to the outside atmosphere at 10,000 seconds is less than 3.0 psig. The pressure remaining after 24 hours is therefore expected to be only a small fraction of the 60 psig design pressure; therefore, the requirements of General Design Criterion 38 (See Section 1.2) are met.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

## 2.2 RECOMMENDATIONS

Since this calculation is the new analysis of record for the Design Basis MSLB Pressure Temperature analysis, it should be noted in calculation N-4080-007 (Reference 6.1.d) that the results of the 7.4765 ft$^2$ MSLB at 102% power with one of two cooling trains available and offsite power available have been superseded by the results of this calculation.

NES&L DEPARTMENT

# CALCULATION SHEET

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 9

ICCN NO./
PRELIM. CCN NO.

PAGE __ OF __

CCN CONVERSION:
CCN NO. CCN -

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

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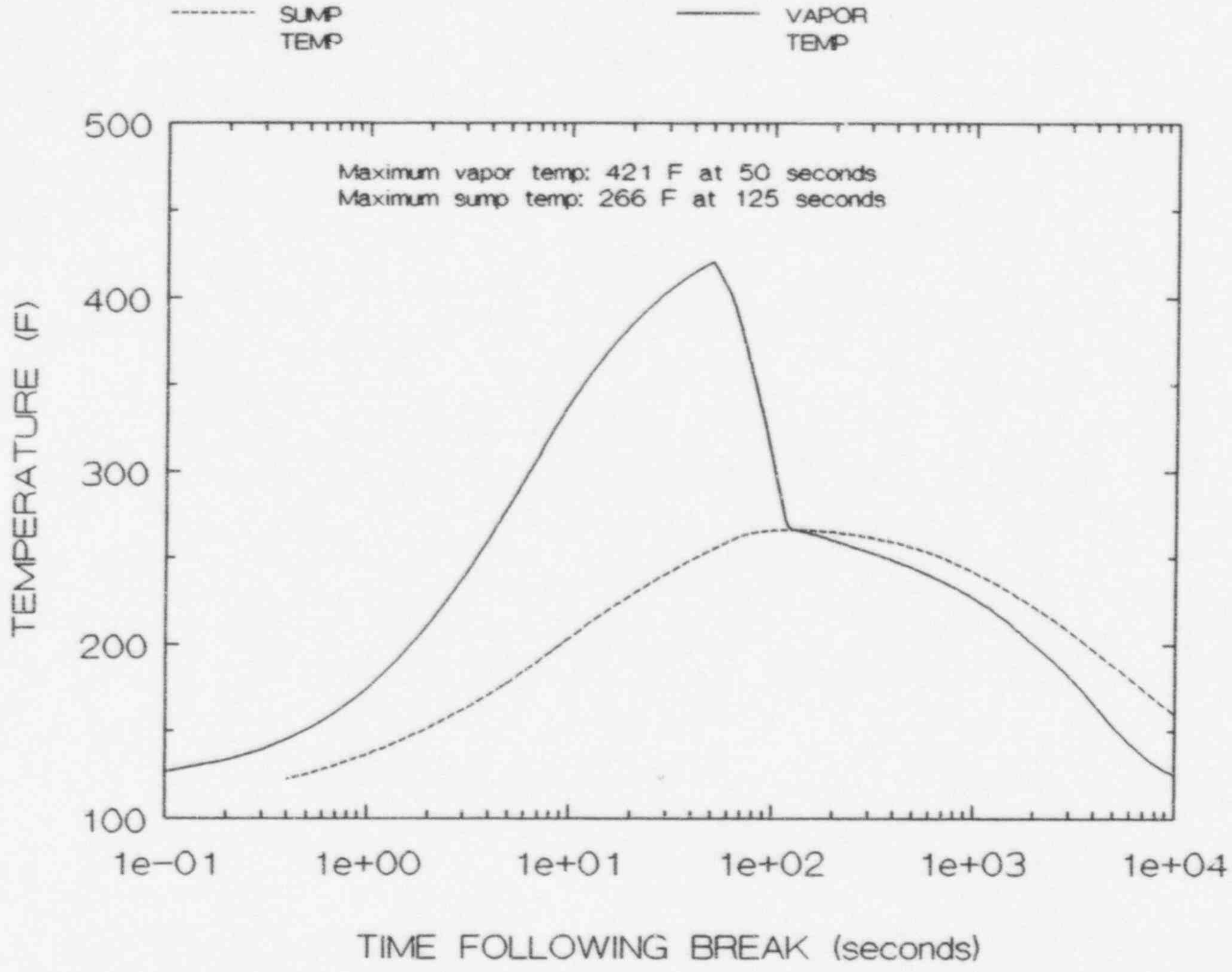
FIGURE 2-1: TEMPERATURE
MSLB 102% POWER, 7.48 $FT^2$ BREAK AREA



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**CALCULATION SHEET**

ICCN NO./
PRELIM. CCN NO.

PAGE __ OF __

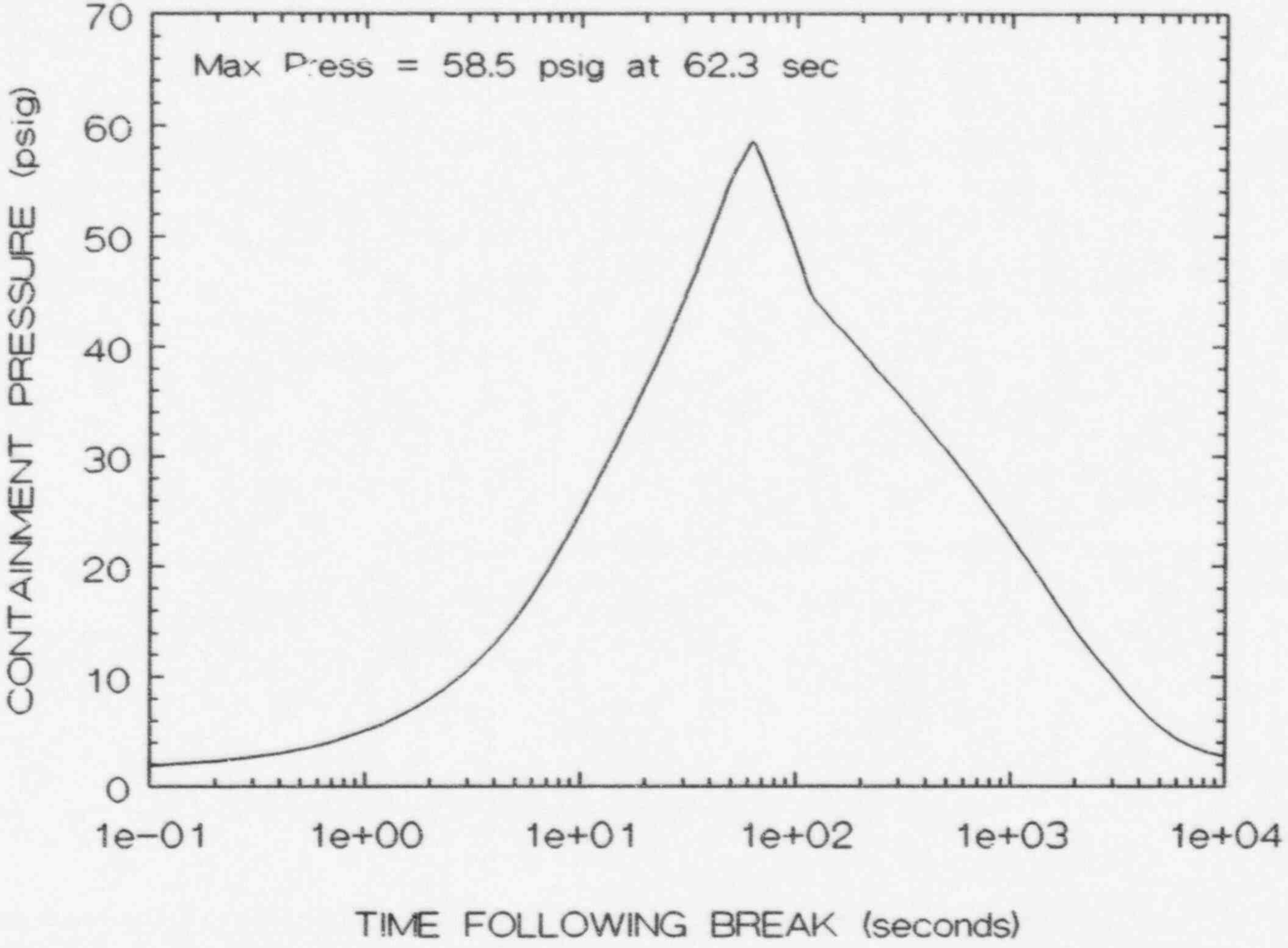
CCN CONVERSION:
CCN NO. CCN --

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 10

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |

FIGURE 2-2: CONTAINMENT PRESSURE
MSLB 102% POWER, 7.48 FT² BREAK AREA



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## CALCULATION SHEET

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 11

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PRELIM. CCN NO.

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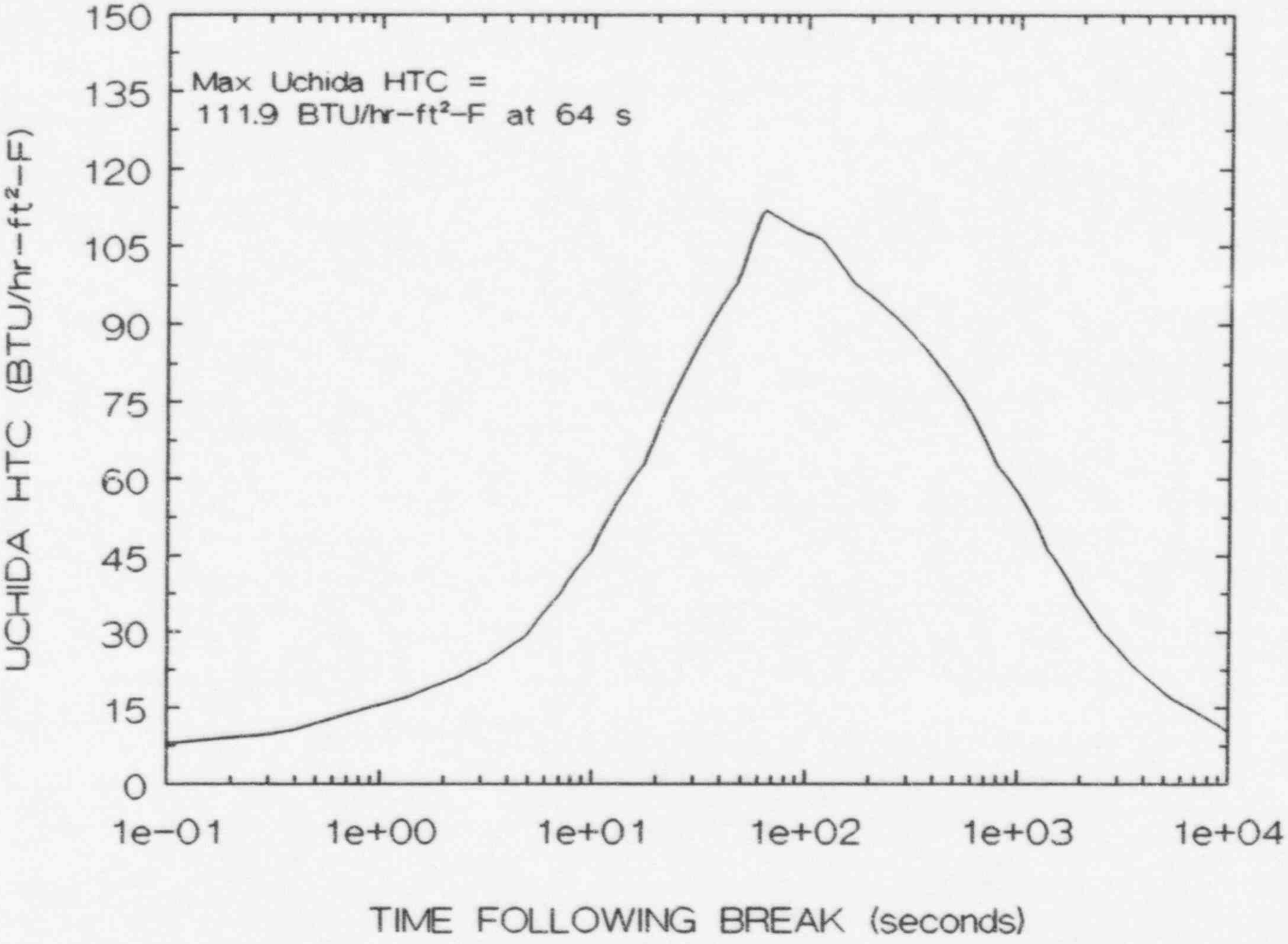
CCN CONVERSION:
CCN NO. CCN --

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |

REV ⇓

FIGURE 2-3: CONDENSING HTC
MSLB 102% POWER, 7.48 $FT^2$ BREAK AREA



Max Uchida HTC =
111.9 BTU/hr-$ft^2$-F at 64 s

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# CALCULATION SHEET

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PRELIM. CCN NO.

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CCN CONVERSION:
CCN NO. CCN --

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 12

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Ellictt | 1/4/94 | | | | | |

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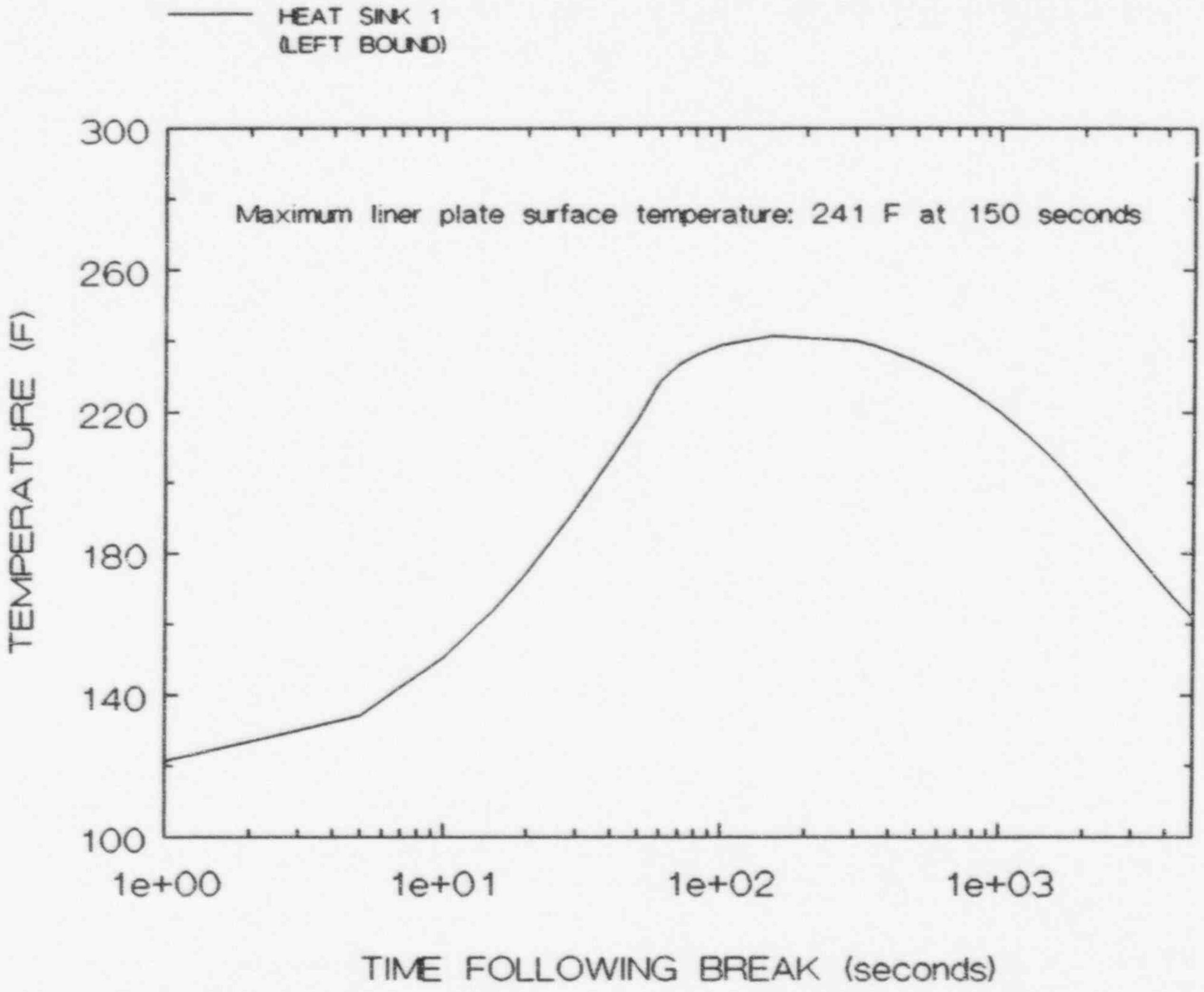
FIGURE 2-4: LINER PLATE SURFACE TEMP.
MSLB 102% POWER, 7.48 FT² BREAK AREA



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## CALCULATION SHEET

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 13

ICCN NO./
PRELIM. CCN NO.

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CCN CONVERSION:
CCN NO. CCN --

| REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 |
| | | | | |

| REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |

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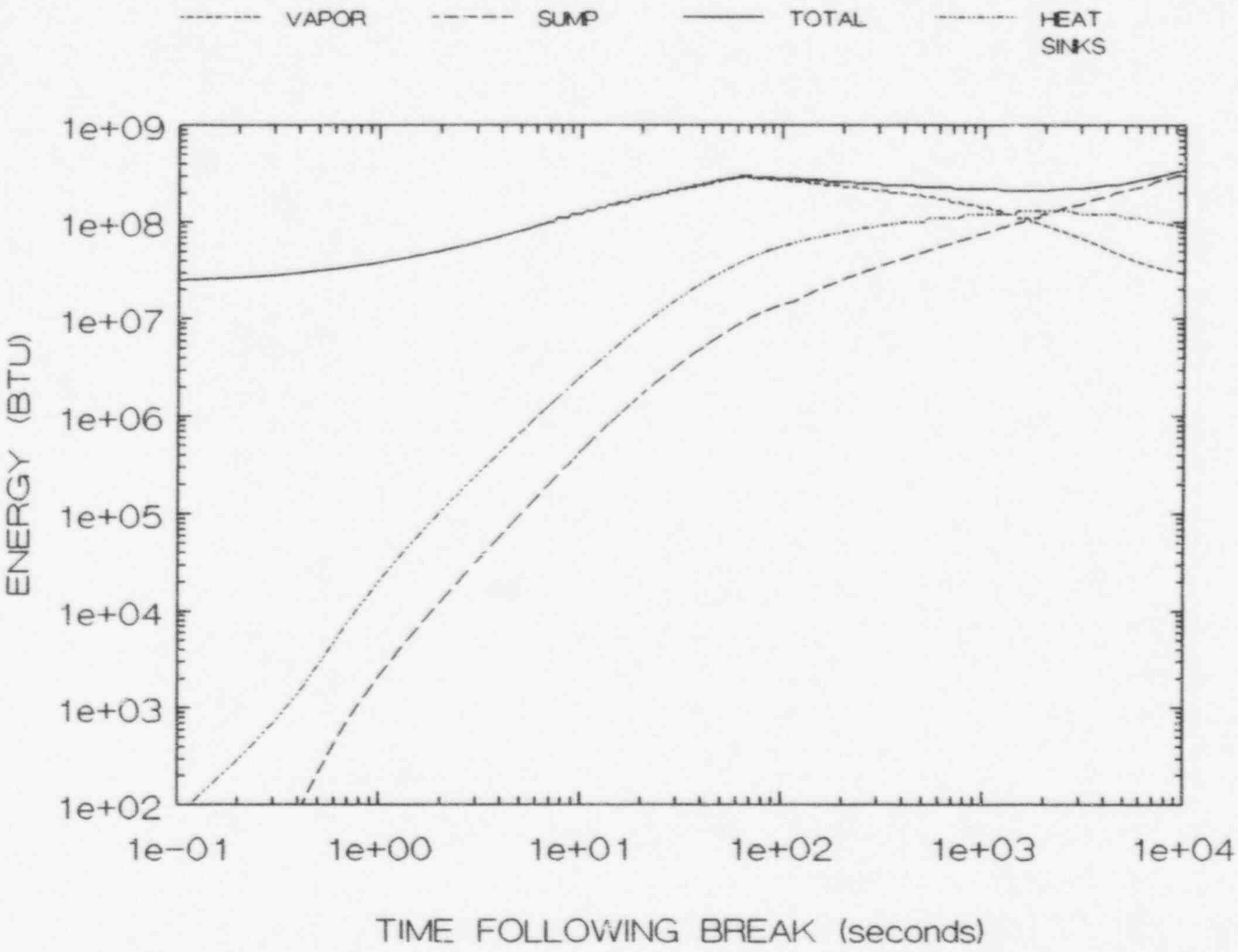
FIGURE 2-5: ENERGY
MSLB 102% POWER, 7.48 FT² BREAK AREA



NES&L DEPARTMENT

## CALCULATION SHEET

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 14

ICCN NO./
PRELIM. CCN NO.

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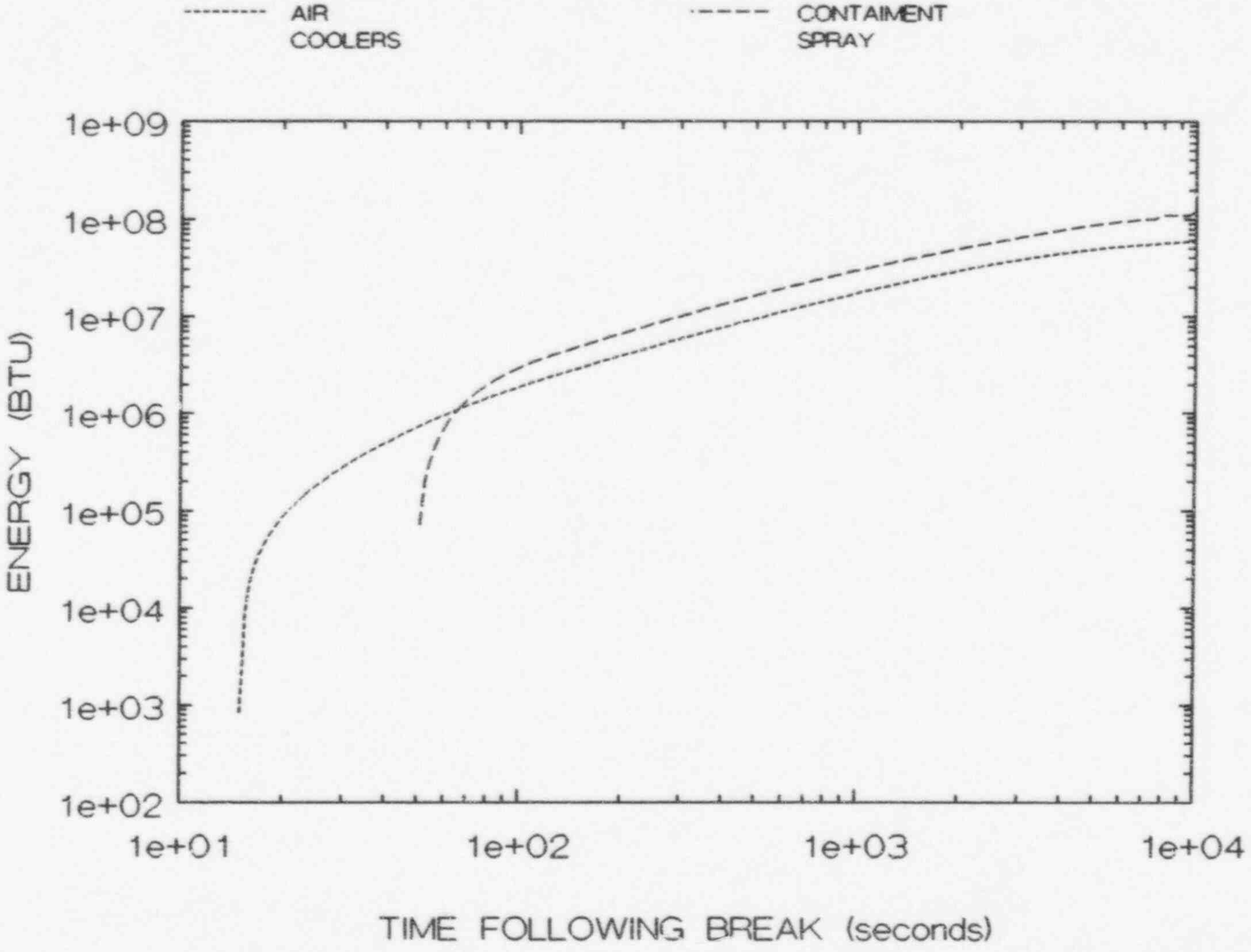
CCN CONVERSION:
CCN NO. CCN --

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

REV ⇓

FIGURE 2-6 ENERGY
MSLB 102% POWER, 7.48 FT² BREAK AREA



## 3 ASSUMPTIONS

This section presents the assumptions that are used in this calculation. The assumptions are arranged in groups which parallel the Card Series data input employed by the COPATTA Code (Reference 6.5.a).

### 3.1 CARD SERIES 1

#### a. ITEM 6: INITIAL CONTAINMENT RELATIVE HUMIDITY

The initial relative humidity inside the containment is assumed to be 60 percent. The COPATTA Code User's Manual (Reference 6.5.a, page 3-1) states that abnormal termination of the code run has been encountered when a relative humidity of 0 percent has been used, and recommends that the minimum relative humidity value should be at least 1 percent. Technically, a higher relative humidity will yield a lower peak pressure. However, the effect is small; per Table 15 of BN-TOP-3 (Reference 6.11) increasing the relative humidity from 1 percent to 100 percent will decrease the containment peak pressure by approximately 0.4 psig. Therefore, the effect of increasing the relative humidity from 1 percent to 60 percent will decrease the containment peak pressure by approximately 0.2 psig. The probability of actually having a low relative humidity of 1 percent in a closed containment with the reactor at power is remote. Experience indicates that containments tend to be hot and humid, not hot and dry. Therefore, use of a higher relative humidity of 60 percent is realistic.

#### b. ITEM 11: CONTAINMENT HEAT SINK REVAPORIZATION FRACTION

Since this MSLB analysis is not an equipment qualification analysis, no credit for revaporization of the heat sink condensate will be taken. Per the COPATTA Code Theory Manual (Reference 6.5.a, Appendix D, Section III.b), when the containment atmosphere is at or below the saturation temperature, all condensate formed on the heat sinks is transferred directly to the sump. When the atmosphere is superheated, revaporization allows for the condensate to be transferred to the vapor region. The introduction of the relatively cold revaporized water mass to the superheated vapor environment reduces the average energy concentration in the vapor space, and consequently reducing the containment pressure and temperature. NUREG-0588 (Reference 6.4.b, Appendix B, Section 1.b) allows for up to 8 percent of the condensate to be transferred to the vapor region during the performance of equipment qualification analyses. The assumption that no sump liquid revaporizes is conservative.

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### c. ITEM 12: TOTAL PRESSURE OUTSIDE CONTAINMENT

The total pressure outside containment is assumed to be 14.7 psia. SONGS Units 2 and 3 are located at sea level. At this elevation, standard atmospheric pressure is approximately 14.7 psia per Table 3 of the ASHRAE Handbook (Reference 6.13). Per the COPATTA Code Theory Manual (Reference 6.5.a), the code uses the outside atmosphere total pressure in evaluating leakage rates between the containment and the outside environment. In this analysis no leakage is postulated and hence no leakage calculations are performed. Therefore, any outside atmosphere total pressure may be modeled with no adverse impact on the analysis results.

### d. ITEM 13: RELATIVE HUMIDITY OF OUTSIDE ATMOSPHERE

The relative humidity of the outside atmosphere is assumed to be 50 percent. Per the COPATTA Code Theory Manual (Reference 6.5.a), the code uses the outside atmosphere relative humidity in evaluating leakage rates between the containment and the outside environment. In this analysis no leakage is postulated and hence no leakage calculations are performed. Therefore, any outside atmosphere relative humidity may be modeled with no adverse impact on the analysis results.

## 3.2 CARD SERIES 2

### a. ITEM 6: HTC BETWEEN CONTAINMENT ATMOSPHERE AND SUMP LIQUID

No heat transfer is being modeled between the sump and the vapor regions of containment; therefore, the total heat transfer coefficient (HTC) for the heat transfer between the liquid (sump) and vapor regions of the containment is assumed to be 0.0 BTU/hr-°F. A typical containment atmosphere to sump liquid HTC of 0.0 BTU/hr-°F is listed in section 3.3.1 and Table 4 of Bechtel Topical Report BN-TOP-3 (Reference 6.11). Use of this value is also recommended by Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 5).

The COPATTA Code uses the containment atmosphere to sump liquid HTC in evaluating heat transfer between the containment atmosphere and the sump liquid. Use of a smaller HTC is conservative because it will inhibit heat transfer from the containment air to the sump liquid, maximize containment air energy, and consequently yield higher containment pressures and temperatures.

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### 3.3 CARD SERIES 5

#### a. ITEM 2: NUMBER OF AIR COOLER TRAINS OPERATING

A review of the results presented in Calculation N-4080-007 (Reference 6.1.d) reveals that a MSLB induced peak containment pressure and temperature occurs in the event of a failure of one of the two cooling trains. The consequences of either a main steam isolation valve (MSIV) or main feedwater isolation valve (MFWIV) failure were found to be bounded by the consequences of a cooling train failure. Therefore, this MSLB analysis will assume a failure of one of the two containment cooling trains due to a single failure in the power system.

As shown on P&ID 40172A-5 (Reference 6.8.a), each train has two air coolers. Therefore, only the two air coolers of one train are assumed to be operational in this MSLB analysis.

#### b. ITEM 4: AIR COOLERS' SHUTOFF TIME

The air coolers will be assumed to operate for the duration of the accident as modeled in this calculation. As discussed in Design Input Item 4.1, calculations for this analysis will be terminated at 10,000 seconds.

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**CALCULATION SHEET**

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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 19

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## 3.4 CARD SERIES 1001

### a. ITEMS 3 and 6: TEMPERATURE OF OUTSIDE ATMOSPHERE

The outside air temperature at SONGS is assumed to be 100 °F. This temperature is conservatively greater than the normal temperatures which are noted in the SONGS Units 2&3 UFSAR (Reference 6.3.c, section 2.3.2.1.2 and Table 2.3-6). Per the UFSAR, San Onofre meteorological data taken during the years 1974 and 1975 may be considered representative of normal conditions at the site. During this two year period, the absolute maximum temperature recorded at the site was 34.3 °C (93.7 °F), occurring with an offshore Santa Ana wind on September 23, 1975.

Per the COPATTA Code Theory Manual (Reference 6.5.a, section 3.2.3), the Code uses the outside atmosphere temperature in evaluating leakage rates between the containment and the outside environment. Per the COPATTA Code User's Manual (Card Series 1001), the Code also uses the outside atmosphere temperature in initializing the outer surface temperature of the containment structure, and in evaluating heat transfer between the outer surface of the containment structure and the outside environment. In this analysis no leakage to the outside atmosphere is postulated, and hence no leakage calculations are performed. Therefore, heat transfer to the environment dictates the modeling choice.

Use of a higher air temperature is conservative because it will reduce heat transfer to the environment. Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 13) states that for a concrete containment structure the effect of heat transfer to the outside air is very small and virtually negligible with respect to the peak containment pressures and temperatures. However, this is true only in the short term following the onset of the accident. Long-term post-accident pressures and temperatures will be slightly maximized by maximizing the ambient temperature of the outside atmosphere.

### b. ITEMS 4 and 7: HTC BETWEEN A HEAT SINK AND OUTSIDE ATMOSPHERE

The heat transfer coefficient between a heat sink and the outside atmosphere is assumed to be 2.0 BTU/hr-ft$^2$-°F. Use of this value is recommended in Bechtel Design Standard N2.3.2 (Reference 6.12, page 13).

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## 4 DESIGN INPUT

This section presents the design inputs used in this calculation. The design inputs are arranged in groups which parallel the Card Series data input employed by the COPATTA Code.

### 4.1 CARD SERIES 0

a. ITEM 2: FLOW PATH THROUGH THE SDCHX

In the event of an MSLB, the source of Containment Spray System (CSS) water transfers from the Refueling Water Storage Tank to the containment sump upon receipt of a Recirculation Actuation Signal (RAS). The Shutdown Cooling Heat Exchanger (SDCHX) is used to cool containment sump water before it is recirculated through the CSS.

Calculations for this analysis will be terminated at 10,000 seconds (2.78 hours). As shown in the summary of results, this analysis termination time is sufficient to ensure determination of the peak pressure and temperature time of occurrence. By this termination time the containment pressure and temperature have also returned to near initial conditions.

If a run time in excess of 10,000 seconds were to be modeled, then the model should also reflect the Recirculation Actuation Signal (RAS) generation. Because the RAS is generated subsequent to the analysis termination time, the SDCHX will not be modeled in this MSLB accident evaluation.

## 4.2 CARD SERIES 1

### a. ITEM 3: INITIAL CONTAINMENT PRESSURE

The maximum allowable containment pressure is 1.5 psig per U23 Technical Specification Limiting Condition for Operation (LCO) 3.6.1.4 (Reference 6.3.a & b). This is equivalent to a pressure of 16.2 psia (1.5 psig + 14.7 psi).

Per the COPATTA Code Theory Manual (Reference 6.5.a, section 3.1.1), the Code uses the initial containment pressure in the determination of the initial mass of air in the containment air space. The effect of varying the initial containment pressure is addressed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, section 4.1.2 and Table 15). Based on the data presented in BN-TOP-3, it is concluded that maximizing the initial containment pressure will maximize the peak containment pressure. Consequently, long-term post-accident pressures will also be maximized.

### b. ITEM 4: CONTAINMENT NET FREE VOLUME

The containment net free volume of 2.305e6 cubic ft is determined by Civil Calculation C-257-1.06.01 (Reference 6.1.a, page 7). This volume is conservatively based on a reduction of the containment gross volume by 110 percent of the components volume. This represents a reduction by a margin of 3.0e4 cubic ft to account for components not considered explicitly in the Civil Calculation.

Per the Copatta Code Theory Manual (Reference 6.5.a, section 3.1.1), the Code uses the containment volume in the determination of the initial masses of air and water in the containment air space. Per Bechtel Topical Report BN-TOP-3 (Reference 6.11, section 4.1.1.1), the containment volume is also used in evaluating the containment pressure, volume and energy relationship. Equations presented in Section 4.1.1.1 of BN-TOP-3 show that the containment pressure is inversely proportional to the containment volume. It is for this reason that Section 3.3.1 and Figure 16 of BN-TOP-3 recommend that the minimum containment net free volume should be modeled. Because the ideal gas law states that pressure is proportional to temperature, minimizing the containment net free volume will also maximize the peak containment temperature. Consequently, long-term post-accident pressures and temperatures will also be maximized.

### c. ITEM 5: INITIAL CONTAINMENT TEMPERATURE

The initial bulk average containment atmosphere temperature is 120 °F. Technical Specification LCO 3.6.1.5 (References 6.3.a & b) indicates that this is the maximum allowable bulk average containment temperature.

Per the COPATTA Code Theory Manual (Reference 6.5.a, section 3.1.1), the Code uses the initial containment temperature in the determination of the initial mass of air in the containment air space. Per sections 3.1.2 and A.3 of the COPATTA Code Theory Manual, the Code also uses the initial containment temperature in the determination of the initial temperature profiles of those heat sinks in contact with the containment air.

The effect of varying the initial containment temperature is addressed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, section 4.1.2 and Table 15). Based on the data presented, it is concluded that maximizing the initial containment temperature will maximize both the peak containment pressure and temperature. This conclusion is consistent with the fact that maximizing the initial containment temperature will increase the initial heat sink temperatures, thereby minimizing the effectiveness of the larger structural heat sinks in removing energy from the containment air space. Consequently, long-term post-accident pressures and temperatures will also be maximized.

### d. ITEM 8: INITIAL AVERAGE REACTOR COOLANT TEMPERATURE

CE Letter S-CE-2604 (Reference 6.2.a) provides the mass and energy release data to be modeled for the LOCA and MSLB scenarios. Appendix H to this CE Letter indicates that an initial average (reactor) coolant temperature of 582.945 °F should be modeled in the containment pressure-temperature analyses. This temperature is similar to the 582.1 °F average Reactor Vessel operating temperature specified in the RCS System Description SD-SO23-360 (Reference 6.7.a, section 2.2.1).

This parameter is used to set the initial temperature of all heat conducting region surfaces in contact with the reactor coolant. Since no heat sinks in contact with the reactor coolant are explicitly modeled in this analysis, the average reactor coolant temperature is not actually used in the COPATTA calculation.

## 4.3 CARD SERIES 5

### a. ITEM 3: TIME OF AIR COOLER INITIATION

Sheet 6 of Calculation N-4080-003 (Reference 6.1.h) indicates that the emergency fan coolers (EFCs) will start 15 seconds after the onset of a MSLB event with offsite power available. Sheet 6 of the analysis presented in Reference 6.1.h notes that this result is specifically applicable to a DBA MSLB (steam line break at 102% power), and the containment high pressure setpoint is currently 5 psig. Sheet 24 of Reference 6.1.h gives a time line for emergency fan cooler operation following the DBA MSLB.

Of note is that the air cooler initiation time modeled in Calculation N-4080-003 is based on two seconds required for the containment pressure to increase to the containment high pressure setpoint of 5.0 psig. Per the results of this calculation, the setpoint pressure of 5.0 psig is reached in less than one second. The difference between the modeled time of occurrence and the actual time of occurrence represents an additional one second of margin in this analysis.

Another conservatism present in the 15 second EFC start time is the availability of the component cooling water (CCW) to the fan cooler. Per sheet 21 of Reference 6.1.h, the CCW block valves will be 83% open at the time the EFCs reach full speed (13 seconds), but the air cooler start time is conservatively modeled as the time at which the CCW block valves are fully opened. The CCW block valves will be passing nearly full flow to the emergency fan coolers for two seconds prior to the assumed 15 second start time; therefore, an additional safety margin is added by a 15 second EFC start time.

Delaying the start of the containment air cooler operation conservatively delays the removal of containment atmosphere energy via the air coolers, thereby maintaining a larger containment air energy inventory that will maximize the containment pressures and temperatures.

### b. ITEM 8: TEMPERATURE OF AIR COOLER HEAT EXCHANGER COOLANT

The air cooler heat exchanger coolant temperature is 105 °F. The maximum inlet temperature of the air cooler HX coolant is no greater than the maximum Component Cooling Water System (CCWS) heat exchanger outlet temperature. Per CCWS Design Basis Document DBD-SO23-400 (Reference 6.6.a, Table 0-1) and Calculation M-0026-001 (Reference 6.1.c, page 6), the maximum CCWS heat exchanger outlet temperature is 105 °F.

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Temperature changes in the uninsulated component cooling water lines between the CCWS heat exchanger outlet and the air coolers are assumed negligible.

Maximizing the air cooler coolant temperature minimizes the heat removed from the containment air circulating through the air cooler, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures.

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## 4.4 CARD SERIES 301

Card Series 301 is a table that is used to input blowdown following pipe rupture. It provides the water addition rate and the enthalpy of the water at various times. The NSSS vendor determines the mass and energy release data that describes a spectrum of break types and break sizes. This "blowdown" data is introduced into the containment air space where it serves to increase both the containment pressure and temperature. Increasing the total mass and energy release will increase the containment pressure and temperature response.

The conclusions presented in Calculation N-4080-007 (Reference 6.1.d) indicate that the worst case MSLB is a 7.4765 $ft^2$ break area at 102 percent power, and a failure of a single cooling train with offsite power available. The mass and energy release data for this worst case MSLB is documented in C-E Letter S-CE-4007 (Reference 6.2.b, Appendix A). C-E Letter S-CE-2604 (Reference 6.2.a) mentions that the availability of offsite power permits continued reactor coolant pump flow. Maintaining reactor coolant pump flow maximizes the rate of primary to secondary heat transfer which maximizes the rate of mass/energy release.

MSLB mass flow rates in C-E Letter S-CE-4007 are presented in units of pounds per second. The water addition rates entered into Card Series 301 are in units of pounds per hour. As shown in the following table, the Card Series 301 input data were calculated by scaling the CE break mass flow rates by the conversion factor of 3600 seconds per hour.

MSLB energy flow rates in C-E Letter S-CE-4007 are presented in units of Million BTU per second. The water enthalpies entered into Card Series 301 are in units of BTU per pound. As shown in the following table, the Card Series 301 input data were calculated by dividing the CE energy flow rates by the CE mass flow rates at each time step, and then multiplying by the conversion factor of $1 \times 10^6$ BTU per Million BTU.

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# CALCULATION SHEET

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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 26

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## MAIN STEAM LINE BREAK MASS AND ENERGY RELEASE DATA [a]
## (7.4765 ft$^2$ break area, 102 percent power, cooling train failure)

| TIME CS 301, Item 1 | NSSS SUPPLIED DATA (C-E Letter S-CE-4007, Reference 6.2.b) | | DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3 | | |
|---|---|---|---|---|---|
| | BREAK MASS FLOW RATE | BREAK ENERGY FLOW RATE | BREAK MASS FLOW RATE | BREAK ENTHALPY | BREAK ENERGY FLOW RATE |
| (sec) | (lbm/sec) | ($10^6$ BTU/sec) | (lbm/hour) | (BTU/lbm) | (BTU/hr) |
| 0 | 14293.11 | 17.088682 | 5.145520E7 | 1.195589E3 | 6.151926E10 |
| 0.22 | 13525.09 | 16.196053 | 4.869032E7 | 1.197482E3 | 5.830579E10 |
| 0.42 | 12839.54 | 15.387747 | 4.622234E7 | 1.198466E3 | 5.539589E10 |
| 0.62 | 12238.71 | 14.679232 | 4 405936E7 | 1.199410E3 | 5.284524E10 |
| 1.08 | 11120.21 | 13.361993 | 4.003276E7 | 1.201595E3 | 4.810317E10 |
| 1.58 | 10246.82 | 12.314189 | 3.688855E7 | 1.201757E3 | 4.433108E10 |
| 2.08 | 9572.14 | 11.505884 | 3.445970E7 | 1.202018E3 | 4.142118E10 |
| 2.58 | 9239.69 | 11.096741 | 3.326288E7 | 1.200986E3 | 3.994827E10 |
| 3.58 | 8757.24 | 10.517954 | 3.152606E7 | 1.201058E3 | 3.786463E10 |
| 4.58 | 8412.41 | 10.108812 | 3.028468E7 | 1.201655E3 | 3.639172E10 |
| 5.58 | 8166.89 | 9.809439 | 2.940080E7 | 1.201123E3 | 3.531398E10 |
| 6.58 | 7985.75 | 9.591895 | 2.874870E7 | 1.201126E3 | 3.453082E10 |
| 7.58 | 7518.26 | 9.055021 | 2.706574E7 | 1.204404E3 | 3.259808E10 |
| 8.58 | 6856.46 | 8.257692 | 2.468326E7 | 1.204367E3 | 2.972769E10 |
| 9.58 | 6374.91 | 7.676909 | 2.294968E7 | 1.204238E3 | 2.763687E10 |
| 10.58 | 6000.34 | 7.223859 | 2.160122E7 | 1.203908E3 | 2.600589E10 |
| 12.58 | 5397.62 | 6.494388 | 1.943143E7 | 1.203195E3 | 2.337980E10 |
| 14.58 | 4905.39 | 5.897638 | 1.765940E7 | 1.202277E3 | 2.123150E10 |
| 16.58 | 4547.89 | 5.464546 | 1.637240E7 | 1.201556E3 | 1.967237E10 |
| 18.58 | 4290.89 | 5.153199 | 1.544720E7 | 1.200963E3 | 1.855152E10 |
| 20.58 | 4092.48 | 4.912703 | 1.473293E7 | 1.200422E3 | 1.768573E10 |

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## MAIN STEAM LINE BREAK MASS AND ENERGY RELEASE DATA [(a)]
## (7.4765 ft$^2$ break area, 102 percent power, cooling train failure)

| TIME<br>CS 301, Item 1 | NSSS SUPPLIED DATA<br>(C-E Letter S-CE-4007, Reference 6.2.b) | | DATA CONVERTED FOR CODE USE<br>Card Series 301, Items 2 & 3 | | |
|---|---|---|---|---|---|
| | BREAK MASS FLOW RATE | BREAK ENERGY FLOW RATE | BREAK MASS FLOW RATE | BREAK ENTHALPY | BREAK ENERGY FLOW RATE |
| (sec) | (lbm/sec) | ($10^6$ BTU/sec) | (lbm/hour) | (BTU/lbm) | (BTU/hr) |
| 25.58 | 3687.57 | 4.420734 | 1.327525E7 | 1.198820E3 | 1.591464E10 |
| 30.58 | 3394.05 | 4.065479 | 1.221858E7 | 1.197825E3 | 1.463572E10 |
| 35.58 | 3184.46 | 3.811012 | 1.146406E7 | 1.196753E3 | 1.371964E10 |
| 40.58 | 2942.03 | 3.516629 | 1.059131E7 | 1.195307E3 | 1.265986E10 |
| 45.58 | 2722.56 | 3.251185 | 9.801216E6 | 1.194165E3 | 1.170427E10 |
| 50.58 | 2536.83 | 3.026656 | 9.132588E6 | 1.193086E3 | 1.089596E10 |
| 60.58 | 2300.09 | 2.739258 | 8.280324E6 | 1.190935E3 | 9.861329E9 |
| 61.08 | 2012.66 | 2.396976 | 7.245576E6 | 1.190949E3 | 8.629114E9 |
| 62.08 | 1612.04 | 1.916982 | 5.803344E6 | 1.189165E3 | 6.901135E9 |
| 62.58 | 899.64 | 1.065766 | 3.238704E6 | 1.184658E3 | 3.836758E9 |
| 64.58 | 109.69 | 0.129429 | 3.948840E5 | 1.179953E3 | 4.659444E8 |
| 68.58 | 29.84 | 0.037332 | 1.074240E5 | 1.251072E3 | 1.343952E8 |
| 71.08 | 0 | 0 | 0 | 0 | 0 |
| 2E7 | 0 | 0 | 0 | 0 | 0 |

a. The mass and energy release rates are assumed to vary linearly between each data point.

## 4.5 CARD SERIES 801

### a. INJECTION MODE CHARACTERISTICS

The results presented in Calculation N-4080-007 indicates that the MSLB induced peak containment pressure and temperatures occur for the circumstance of a failure of one of the two cooling trains. The consequences of either a MSIV or MFWIV failure were found to be bounded by the consequences of a cooling train failure.

### a.1 Injection Mode Start Times

### a.1.(a) Containment Spray System Injection Mode Start Time

With offsite power available, the containment spray is functional within 49 seconds per Calculation N-4080-003 (Reference 6.1.h, sheet 6). To provide margin to address any future changes in system performance, this analysis assumes that the time of containment spray initiation with offsite power available is 50 seconds.

Delaying the start of the containment spray system operation conservatively delays the removal of containment atmosphere energy via the CSS, thereby maintaining a larger containment air energy inventory that will increase the maximum containment pressure and temperature.

### a.1.(b) Safety Injection System Injection Mode Start Time

The Safety Injection System (SIS) supplies water to the reactor via pressurized discharge from the Safety Injection Tanks (SITs) as well as via pumped flow from the Refueling Water Storage Tank (RWST) upon receipt of a Safety Injection Actuation Signal (SIAS). Per the ESFAS System Description (Reference 6.7.d, Section 2.1.2.1.1), a SIAS is generated upon receipt of two out of four low pressurizer pressures or a high containment pressure.

Because no rupture of the primary system exists in the MSLB event, the mass of water added to the Reactor Coolant System by the Safety Injection System (SIS) is only to compensate for inventory shrinkage due to the rapid cooldown. The effect of the safety injection on the mass release into containment is therefore implicitly modeled by Combustion Engineering in C-E Letter S-CE-4007, and not modeled in this calculation.

a.2 Injection Mode Flow Rates

a.2.(a) Containment Spray System Injection Mode Flow Rate

A CSS injection mode volumetric flow rate of 1612 gallons/minute will be modeled beginning at the time that a full flow spray pattern is initiated at the spray nozzles, and continuing until the recirculation mode begins. This flow rate of 1612 gallons/minute represents the minimum CSS injection mode flow rate, and is calculated in M-0014-009 (Reference 6.1.b). This flow rate is for the conditions of a CSS Pump degradation of 7.5 percent, a containment peak pressure of 60 psig, and a minimum RWST water level of 33.35 feet.

Minimizing the CSS injection mode flow rate reduces the amount of spray water available to remove energy from the containment air space, thereby maximizing the containment pressures and temperatures.

At an injection mode water temperature of 100 °F (see following discussion), the containment spray flow rate of 1612 gallons/minute has a specific volume of 0.016130 ft$^3$/pound (Reference 6.14, page 88), and will be modeled in Card Series 801 with a mass flow rate of:

$$\dot{M} = [(1612 \text{ gallons/minute}) \div (0.016130 \text{ ft}^3/\text{lbm})] \times (0.13368 \text{ ft}^3/\text{gallon}) \times (60 \text{ min/hour})$$

$$\dot{M} = 8.02\text{e}5 \text{ pounds/hour}$$

a.3 Injection Mode Water Temperature/Source

The SIS and CSS initially draw water from the RWST upon receipt of a SIAS, and subsequently from the Containment Sump upon receipt of a Recirculation Actuation Signal (RAS). Technical Specification LCO 3.5.4(c) (References 6. 3.a & b) indicates that the maximum allowable RWST temperature is 100 °F. It is assumed that the SIS and CSS flow during the Injection Mode is at this maximum allowable RWST temperature of 100 °F.

Maximizing the RWST water temperature increases the CSS injection mode water droplet temperature. Increasing the spray droplet water temperature reduces the ability of the spray droplets to remove energy from the containment air space, thereby maximizing the containment pressures and temperatures.

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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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b. RECIRCULATION MODE CHARACTERISTICS

b.1 Recirculation Mode Start Time

The Recirculation Actuation Signal (RAS) is designed to change suction of the HPSI and CS pumps from the RWST to the Containment Emergency Sump when the RWST level is low.

The source of CSS and SIS water transfers from the RWST to the containment sump upon receipt of a RAS. Per the ESFAS System Description (Reference 6.7.d, section 2.1.2.1.7), an RAS is generated upon receipt of two out of four RWST low level signals. During the injection mode the RWST water is discharged in the form of containment spray, safety injection, and charging flow. To determine the time of CSS and SIS recirculation mode initiation it is necessary to quantify the useable RWST water volume, the flow rates exiting the RWST during the injection mode, and the time that these flow rates begin their injection mode discharge.

The useful RWST volume is modeled as 300,000 gallons. CE Letter S-CE-6814 (Reference 6.2.c) states that the volume required for injection is 313,706 gallons when instrument error of the RWST low level setpoint and the RAS setpoint are considered, and 300,000 gallons when this instrument error is not considered. In this calculation, the RWST volume is minimized to hasten the start of the recirculation mode.

$$V_{RWST} = 300000 \text{ gallons}$$
$$= [(1612 \text{ gpm}) \times (t_{recirc} - 50 \text{ sec}) / (60 \text{ sec/min})]$$

$$\therefore t_{recirc} = 1.12E4 \text{ seconds}$$

Operation of the High Pressure Safety Injection (HPSI) pumps will also drain the RWST. During the MSLB event, the RCS is maintained at a pressure that is sufficiently high to preclude the delivery of any HPSI flow into the RCS other than that which is necessary to compensate for RCS shrinkage during cooldown. The RWST inventory used by the SIS for RCS shrinkage compensation is minimal and will not significantly reduce the estimated 11,000 second drain time of the RWST.

The time of occurrence of peak containment pressure and temperature is dependent on the start of the CSS injection mode, however the time for CSS recirculation mode initiation will have no impact on the containment peak pressure or temperature for an MSLB. Since the time for the recirculation mode is greater than the analyses run time, CSS recirculation will not be modeled in this MSLB analysis.

4.6 CARD SERIES 1101

a. ITEMS 5 and 6

The air cooler heat removal rate as a function of containment atmosphere saturation temperature is determined in Calculation M-0072-036 (Reference 6.1.e) for the conditions of a CCWS volumetric flow rate at the inlet to a containment emergency air cooler of 2000 gallons/minute at 105 °F, a constant air flow rate through the air cooler of 31000 $ft^3$/minute, and a water side fouling factor of $5 \times 10^{-4}$. The air cooler duty curve determined in Calculation M-0072-036 is plotted and tabulated on sheets 8 and 10 of that calculation.

The air cooler duty curve determined in Calculation M-0072-036 includes performance data for a superheated containment condition when the containment atmosphere saturation temperature exceeds 300 °F (corresponding to a containment atmosphere saturation pressure of 67 psia). The COPATTA Code requires air cooler data for saturated conditions only. Since the containment peak saturation temperature determined by previous MSLB P/T is below 300 °F, data for conditions above 300 °F is considered irrelevant for this calculation.

Card Series 1101 is entered in the input data file as shown in the following table. As an initialization point, when the containment air temperature is equivalent to the CCW temperature of 105 °F at the inlet to the air cooler, then the air cooler will not remove any heat from the containment air.

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### CONTAINMENT AIR COOLER ABILITY TO REMOVE AIR ENERGY

| CONTAINMENT ATMOSPHERE SATURATION TEMPERATURE (Calc M-0072-036, pg 10) Card Series 1101, Item 5 (°F) | AIR COOLER HEAT REMOVAL RATE Card Series 1101, Item 6 (BTU/hour) | CONTAINMENT ATMOSPHERE CONDITIONS |
|---|---|---|
| 105 | 0.000 | Initial Condition |
| 120 | 1.670e+06 | Saturated Condition |
| 130 | 3.020e+06 | Saturated Condition |
| 140 | 4.570e+06 | Saturated Condition |
| 150 | 6.320e+06 | Saturated Condition |
| 160 | 8.270e+06 | Saturated Condition |
| 170 | 1.040e+07 | Saturated Condition |
| 180 | 1.273e+07 | Saturated Condition |
| 190 | 1.523e+07 | Saturated Condition |
| 200 | 1.788e+07 | Saturated Condition |
| 210 | 2.068e+07 | Saturated Condition |
| 220 | 2.361e+07 | Saturated Condition |
| 230 | 2.664e+07 | Saturated Condition |
| 240 | 2.974e+07 | Saturated Condition |
| 250 | 3.291e+07 | Saturated Condition |
| 260 | 3.611e+07 | Saturated Condition |
| 270 | 3.931e+07 | Saturated Condition |
| 280 | 4.252e+07 | Saturated Condition |
| 287 | 4.474e+07 | Saturated Conditions |
| 290 | 4.569e+07 | Saturated Condition |
| 300 | 4.882e+07 | Saturated Condition |
| ≥ 320 | N/A | Superheated Condition |

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## 4.7 CARD SERIES 1201

### a. ITEMS 2 and 3

Containment spray heat transfer efficiency varies as a function of the ratio of water vapor to air mass in the containment atmosphere. Data points listed in the following table are extracted from Bechtel Topical Report BN-TOP-3 (Reference 6.11, Revision 4, Section 3.2.6 and Figure 2). Per BN-TOP-3, this data is for a spray system with a mean spray drop diameter of 1000 microns and a drop fall height of 20 feet, and is standard "for virtually all PWR containment analyses".

Per the UFSAR (Reference 6.3.c, Section 6.2.2.1.2.2.B), the SONGS Units 2&3 mean spray droplet diameter is about 650 microns. Since efficiency is inversely proportional to the diameter, use of spray heat transfer efficiency data applicable to a larger spray drop diameter is conservative. Decreasing the CSS efficiency reduces the ability of the spray droplets to remove energy from the containment air space, thereby maximizing the containment pressures and temperatures.

**CONTAINMENT SPRAY SYSTEM HEAT TRANSFER EFFICIENCY**
**(mean spray drop diameter of 1000 microns and a drop fall height of 20 feet**

| STEAM TO AIR MASS RATIO Card Series 1201, Item 2 (unitless) | SPRAY EFFICIENCY Card Series 1201, Item 3 (percent) |
|---|---|
| 0.0 | 72.9 |
| 0.1 | 73.7 |
| 0.2 | 74.7 |
| 0.3 | 75.7 |
| 0.4 | 77.1 |
| 0.5 | 78.8 |
| 0.6 | 80.9 |
| 0.7 | 83.2 |
| 0.8 | 86.3 |
| 0.9 | 91.2 |
| 1.0 | 96.1 |
| 1.1 | 98.3 |
| 1.2 | 99.5 |
| 1.3 | 100.0 |

## 4.8 HEAT SINK DATA SERIES

A fundamental change in this p/t analysis involves the use of the Uchida condensing heat transfer correlation. BN-TOP-3 (Reference 6.11) page 3-12 indicates that the condensing heat transfer correlation used in main steam line break analysis is the Uchida correlation. This modification represents a deviation from the Modified Tagami heat transfer coefficient used in previous MSLB analyses. The COPATTA User's Manual, page 3-55 also indicates that the Uchida HTC is typically used for MSLB analysis.

The change from a Modified Tagami HTC to a Uchida HTC is required as one step in the resolution of Open Item Report 92-069 (Reference 6.9.f)

### a. CONTAINMENT LINER/CONCRETE AIR GAP INTERFACE

In this analysis the effective thickness of the interface (air gap) will be modeled as 0.00035 feet. This value is based on a containment liner to containment concrete interface conductance of 50 BTU/hr-$ft^2$-°F, and an air thermal conductivity of 0.0174 BTU/hr-ft-°F.

A typical containment liner to containment concrete interface conductance of 50 BTU/hr-$ft^2$-°F will be modeled. This conductance of 50 BTU/hr-$ft^2$-°F is listed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, Section 3.3.1 and Table 4). Appendix A of BN-TOP-3 (page A-4) indicates that an effective one-dimensional interface conductance of this value will ensure a conservative estimate of heat transfer to the containment wall. There will be some resistance to heat transfer from the containment atmosphere to the containment structure at the containment liner-concrete interface due to air gaps or voids between the liner and the concrete. This resistance is accounted for in this interface conductance. Use of a smaller interface conductance is conservative because it will inhibit heat transfer from the containment air to the containment concrete walls, maximize containment air energy, and consequently yield higher containment pressures and temperatures.

At a long-term average post-accident containment air temperature of 200 °F, Engineering Heat Transfer (Reference 6.15, Table A-6, page 577) indicates that the air thermal conductivity is 0.0174 BTU/hr-ft-°F. The thermal conductivity of a material is a measure of the material's ability to conduct heat. Minimizing a heat sink's thermal conductivity will inhibit heat transfer from the containment air to the heat sinks. During the early part of an accident this will maximize containment air energy, and consequently yield higher containment pressures and temperatures.

Based on a containment liner to containment concrete interface conductance (h) of 50 BTU/hr-ft$^2$-°F, and an air thermal conductivity (k) of 0.0174 BTU/hr-ft-°F, the effective thickness of the interface (air gap) will be:

Interface thickness, $\Delta t$ = (0.0174 BTU/hr-ft-°F) ÷ (50 BTU/hr-ft$^2$-°F)
Interface thickness, $\Delta t$ = 0.00035 feet

### b. HS #1 - REACTOR BUILDING DOME

The characteristics of the Reactor Building Dome are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 121 through 125) for Heat Sink 1, except for the thickness of the Containment Liner/Concrete air gap interface.

The thickness of the Containment Liner/Concrete air gap interface is modified to address a change in the containment liner to containment concrete interface conductance, as discussed in Design Input Item 13.a.

### c. HS #2 - REACTOR BUILDING CYLINDER #1 (ABOVE GRADE, BETWEEN EL. 29'6" AND 112'0")

The characteristics of the Reactor Building Cylinder #1 (above grade, between plant elevations 29'6" and 112'0") are as determined in Calculation N-4080-002 (pages 125 through 128) for Heat Sink 2, except for the thickness of the Containment Liner/Concrete air gap interface.

The thickness of the Containment Liner/Concrete air gap interface is modified to address a change in the containment liner to containment concrete interface conductance, as discussed in Design Input Item 13.a.

### d. HS #3 - REACTOR BUILDING CYLINDER #2 (BELOW GRADE, BETWEEN EL. 15'0" AND 29'6")

The characteristics of the Reactor Building Cylinder #2 (below grade, between plant elevations 15'0" and 29'6") are as determined in Calculation N-4080-002 (pages 134 through 136) for Heat Sink 3, except for the thickness of the Containment Liner/Concrete air gap interface.

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The thickness of the Containment Liner/Concrete air gap interface is modified to address a change in the containment liner to containment concrete interface conductance, as discussed in Design Input Item 13.a.

e. HS #4 - BASEMAT (OTHER THAN THE REACTOR BASEMAT)

The characteristics of the Basemat (other than the Reactor Basemat) are as determined in Calculation N-4080-002 (pages 137 through 139) for Heat Sink 4.

f. HS #5 - REACTOR BASEMAT AND STEAM GENERATOR PEDESTALS

The characteristics of the Reactor Basemat and Steam Generator Pedestals are as determined in Calculation N-4080-002 (pages 139 through 141) for Heat Sink 5.

g. HS #6 - REACTOR CAVITY WALLS BELOW EL. 15'0"

The characteristics of the Reactor Cavity Walls below plant elevation 15'0" are as determined in Calculation N-4080-002 (pages 142 through 144) for Heat Sink 6.

h. HS #7 - REACTOR CAVITY WALLS ABOVE EL. 15'0"

The characteristics of the Reactor Cavity Walls above plant elevation 15'0" are as determined in Calculation N-4080-002 (pages 144 through 146) for Heat Sink 7.

i. HS #8 - LINED REFUELING CANAL WALLS

The characteristics of the Lined Refueling Canal Walls are as determined in Calculation N-4080-002 (pages 146 through 149) for Heat Sink 8.

j. HS #9 - STEAM GENERATOR COMPARTMENT WALLS, UNLINED REFUELING CANAL WALLS ABOVE EL. 63'6", AND OTHER INTERIOR WALLS

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Sheet No. 37

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
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The characteristics of the Steam Generator Compartment Walls, Unlined Refueling Canal Walls above plant elevation 63'6", and Other Interior Walls are as determined in Calculation N-4080-002 (pages 149 through 152) for Heat Sink 9.

k. HS #10 - FLOOR SLABS (OTHER THAN BASEMATS)

The characteristics of the Floor Slabs (other than basemats) represent a refinement of the characteristics of determined in Calculation N-4080-002 (pages 152 through 155) for Heat Sink 10.

A review of Calculation N-4080-002 (page 153) indicates that the concrete thickness of the floor slabs is 1.5 feet, and is based on input data provided as Attachment 1 to Calculation N-4080-002 (page 327). When the nodalization of the Concrete Region was performed, Calculation N-4080-002 (page 153) modeled the concrete as Heat Sink 10 Regions 3, 4 and 5, with a total concrete thickness of 2.0 feet. To model the correct concrete thickness requires that the Region 5 thickness be reduced by 0.5 feet.

l. HS #11 - LIFTING DEVICES (EXCEPT STAINLESS STEEL PARTS)

The characteristics of the Lifting Devices (except stainless steel parts) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 42 through 44) for Heat Sink 10. This heat sink description represents a refinement of the characteristics of the Lifting Devices first determined in Calculation N-4080-002 (pages 156 through 158) for Heat Sink 11.

m. HS #12 - MISCELLANEOUS CARBON STEEL (WITH THICKNESS GREATER THAN 2.50 IN)

The characteristics of the Miscellaneous Carbon Steel (with thickness greater than 2.50 in) are as determined in Calculation N-4080-005 (pages 44 through 47) for Heat Sink 11. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (pages 158 through 161) for Heat Sink 12.

n. HS #13 - MISCELLANEOUS CARBON STEEL (WITH THICKNESS BETWEEN 1.00 IN AND 2.50 IN)

The characteristics of the Miscellaneous Carbon Steel (with thickness between 1.00 in and 2.50 in) are as determined in Calculation N-4080-005 (pages 47 through 50) for Heat Sink 12. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (pages 161 through 165) for Heat Sink 13.

o. HS #14 - MISCELLANEOUS CARBON STEEL (WITH THICKNESS BETWEEN 0.50 IN AND 1.00 IN)

The characteristics of the Miscellaneous Carbon Steel (with thickness between 0.50 in and 1.00 in) are as determined in Calculation N-4080-005 (pages 50 through 54) for Heat Sink 13. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (pages 165 through 169) for Heat Sink 14.

p. HS #15 - MISCELLANEOUS CARBON STEEL (WITH THICKNESS LESS THAN 0.50 IN)

The characteristics of the Miscellaneous Carbon Steel (with thickness less than 0.50 in) are as determined in Calculation N-4080-005 (pages 54 through 59) for Heat Sink 14. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (pages 169 through 173) for Heat Sink 15.

q. HS #16 - ELECTRICAL EQUIPMENT

The characteristics of the Electrical Equipment are as determined in Calculation N-4080-005 (pages 59 through 61) for Heat Sink 15. This heat sink description represents a refinement of the characteristics of the Electrical Steel first determined in Calculation N-4080-002 (pages 174 through 176) for Heat Sink 16.

r. HS #17 - MISCELLANEOUS STAINLESS STEEL

The characteristics of the Miscellaneous Stainless Steel are as determined in Calculation N-4080-005 (pages 62 through 65) for Heat Sink 16. This heat sink description represents a refinement of the characteristics of the Miscellaneous Stainless Steel as first determined in Calculation N-4080-002 (pages 176 through 179) for Heat Sink 17.

s. HS #18 - UNLINED REFUELING CANAL WALLS (BELOW EL. 63'6")

The characteristics of the Unlined Refueling Canal Walls (below plant elevation 63'6") are as determined in Calculation N-4080-002 (pages 180 through 182) for Heat Sink 18.

t. HS #19 - REACTOR BUILDING CYLINDER #3 (THE CONTAINMENT SECTION WITH EMBEDDED STIFFENERS BETWEEN EL. 29'6" AND 112'0")

The characteristics of the Reactor Building Cylinder #3 (the Containment Section with Embedded Stiffeners between plant elevations 29'6" and 112'0") are as determined in Calculation N-4080-002 (pages 183 through 189) for Heat Sink 19, except for the thickness of the Containment Liner/Concrete air gap interface, and except for the thickness of the concrete layer.

The thickness of the Containment Liner/Concrete air gap interface is modified to address a change in the containment liner to containment concrete interface conductance, as discussed in Design Input Item 13.a.

Due to an addition error, Calculation N-4080-002 (page 188) improperly modeled the concrete layer as 3.56524 feet thick. In this analysis the concrete layer will be modeled as 4.21108 feet, corresponding to the average thickness that was actually determined in Calculation N-4080-002 (page 186).

u. HS #20 - VENT TUNNELS

The characteristics of the Vent Tunnels are as determined in Calculation N-4080-002 (pages 190 through 192) for Heat Sink 20.

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## 14 CARD SERIES 410001: MATERIAL PROPERTIES

This Card Series provides the thermal conductivity and the volumetric heat capacity of the material used in this analysis. Five materials are utilized by this analysis:

| | |
|---|---|
| Material 1 | Carbon Steel |
| Material 2 | Concrete |
| Material 3 | Stainless Steel |
| Material 4 | Organic Paint Coating |
| Material 5 | Air Gap |

The thermal conductivity of a material is a measure of the material's ability to conduct heat. Minimizing a heat sink's thermal conductivity will inhibit heat transfer from the containment air to the heat sinks. During the early part of an accident this will maximize containment air energy, and consequently yield higher containment pressures and temperatures.

The volumetric heat capacity of a material is a measure of the material's ability to store energy. Minimizing a heat sink's volumetric heat capacity will inhibit heat retention by the heat sink, and consequently maximize energy retention within the containment air. This will yield higher containment pressures and temperatures.

### a. ITEMS 2 and 3: CARBON STEEL

A typical Carbon Steel thermal conductivity of 25 BTU/hr-ft-°F is listed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 14).

A typical Carbon Steel Volumetric Heat Capacity of 54 BTU/ft$^3$-°F is listed in Bechtel Topical Report BN-TOP-3 (Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (sheet 14).

### b. ITEMS 4 and 5: CONCRETE

A typical Concrete thermal conductivity of 0.8 BTU/hr-ft-°F is listed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 14).

A typical Concrete Volumetric Heat Capacity of 30 BTU/ft$^3$-°F is listed in Bechtel Topical Report BN-TOP-3 (Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (sheet 14).

c. ITEMS 6 and 7: STAINLESS STEEL

A typical Stainless Steel thermal conductivity of 10 BTU/hr-ft-°F is listed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, Section 3.3.1 and Table 4). This value is typical for Types 304 and 316 austenitic stainless steel used for inside containment SS piping. Use of a value of 10 BTU/hr-ft-°F is recommended by Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 14).

A typical Stainless Steel Volumetric Heat Capacity of 54 BTU/ft$^3$-°F is listed in Bechtel Topical Report BN-TOP-3 (Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (sheet 14).

d. ITEMS 8 and 9: ORGANIC PAINT COATING

A typical Organic Paint thermal conductivity of 0.1 BTU/hr-ft-°F is listed in Bechtel Topical Report BN-TOP-3 (Reference 6.11, Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 14).

A typical Organic Paint Volumetric Heat Capacity of 20 BTU/ft$^3$-°F is listed in Bechtel Topical Report BN-TOP-3 (Section 3.3.1 and Table 4). Use of this value is recommended by Bechtel Nuclear Standard N2.3.2 (sheet 14).

e. ITEMS 10 and 11: AIR GAP (@ 200 °F)

At a long-term average post-accident containment air temperature of 200 °F, the book Engineering Heat Transfer, by S.T. Hsu, (Reference 6.15, Table A-6, page 577) indicates that the air thermal conductivity is 0.0174 BTU/hr-ft-°F.

The volumetric heat capacity is equal to the product of the air density ($\rho$) and the specific heat of air at constant volume ($C_v$). The air specific heat capacity at constant volume rather than at constant pressure ($C_p$) is employed because the containment air pressure is not constant, it varies greatly during the course of the accident. However, the air volume of the heat sinks is constant. The specific heat of air at constant volume is equal to the product of the specific heat of air at constant pressure and the ratio of specific heats ($k = C_p/C_v$). At a long-term average post-accident containment air temperature of 200 °F, the book Engineering Heat Transfer, by S.T. Hsu, (Table A-6, page 577) indicates that $\rho$ is equal to 0.060 lbm/ft$^3$, and $C_p$ is equal to 0.241 BTU/lbm-°F. Crane Technical Paper 410 (Reference 6.10, page A-22) indicates that k is equal to 1.4. Therefore, the air volumetric heat capacity is:

$$\rho C_v = (0.060 \text{ lbm/ft}^3) \times (0.241 \text{ BTU/lbm-°F}) \div (1.4)$$
$$\rho C_v = 0.0103 \text{ BTU/ft}^3\text{-°F}$$

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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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## 5 METHODOLOGY

The MSLB case evaluated in this calculation is a 7.48 $ft^2$ steam break at 102% power with offsite power available and a loss of one of two cooling trains. The evaluations utilized the Bechtel COPATTA computer code (Reference 6.5.a) model the containment response to the MSLB.

The COPATTA Code is capable of considering the effects of reactor system blowdown, core decay power energy release, metal-water reaction energy release, and sensible heat release from the reactor system piping. In addition, the Code can consider heat absorption by the containment structure and equipment within the structure, and engineered safeguard features including air coolers, containment sprays, and reactor core safety injection.

The COPATTA Code calculates conditions in two separate regions of the containment: the containment atmosphere (vapor region), and the sump (liquid region). Following completion of the primary system blowdown, the program also calculates conditions in a third region, the water contained in the reactor vessel. The three regions are open systems in a thermodynamic sense since the COPATTA Code permits mass flow across the boundaries of all three regions. Mass and energy are transferred between the liquid and vapor regions by boiling, condensation, or liquid dropout. Each region is assumed homogeneous, but a temperature difference can exist between regions. Any moisture condensed in the vapor region during a time increment is assumed to fall immediately into the liquid region. Non-condensible gases are included in the vapor region.

This analysis with the COPATTA Code is presented in four sections:

Section 8.1: COPATTA Code Card Series Input Data
Section 8.2: COPATTA Code Input Files
Section 8.3: COPATTA Code Output
Section 8.4: Mass and Energy Balance

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## 6 REFERENCES

### 6.1 Calculations

a. SONGS Units 2&3 Calculation C-257-1.06.01, Revision 1, "Containment Shell Analysis - Containment Passive Heat Sink" (dated 7/28/77).

b. SONGS Units 2&3 Calculation M-0014-009, Revision 0, "Containment Spray Pumps In Service Testing Minimum Requirements". (dated 3/3/93) PB 1-10-94

c. SONGS Units 2&3 Calculation M-0026-001, Revision 5, "Component Cooling Water Heat Exchangers" (dated 11/15/89).

d. SONGS Units 2&3 Calculation N-4080-007, Revision 2, "Containment Pressure and Temperature From MSLB at Various Power Levels" (dated 4/21/83)

e. SONGS Units 2&3 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification". (dated 12/9/93) PB 1-10-94

f. SONGS Units 2&3 Calculation N-4080-005, Revision 0, "MSLB Analysis for Environmental Qualification". (dated 3/15/78) PB 1-10-94

g. SONGS Units 2&3 Calculation N-4080-002, Revision 1, "Containment Press.-Temp Transient Analysis" (dated 10/19/76).

h. SONGS Units 2&3 Calculation N-4080-003, Revision 5, "Containment Spray (CS) and Emergency Fan (EF) Actuation Times" (dated 12/23/93).

### 6.2 Correspondence

a. Letter from CE to BPC, S-CE-2604, dated March 1, 1976.
(CDM number C760301G-45-2-4SVT).

b. Letter from CE to BPC, S-CE-4007, dated June 29, 1977.
(CDM number C770629G-8-26)

c. Letter from CE to BPC, S-CE-6814 dated August 24, 1981.
(CDM number C810824G).

### 6.3 Licensing Documents

a. San Onofre Unit 2 Operating License and Technical Specifications, up to and including Amendment 101.

b. San Onofre Unit 3 Operating License and Technical Specifications, up to and including Amendment 90.

c. SONGS 2&3 Updated Final Safety Analysis Report (UFSAR), up to and including Revision 9.

### 6.4 Regulatory Documents

a. 10 CFR Part 50, ""Domestic Licensing of Production and Utilization Facilities". Revised as of January 1, 1993.

b. NUREG-0588, Rev 1, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment".

c. NUREG-0800, Standard Review Plan 6.2.1.1.A, Revision 2, July 1981. "PWR Dry Containments, Including Subatmospheric Containments".

### 6.5 Bechtel Computer Programs

a. Bechtel Standard Computer Program, MAP-175, COPATTA, Version G1-14, "Containment Pressure and Temperature Transient Analysis", User & Theory Manuals.

6.6 Design Basis Document Reports

a. DBD-SO23-400, Revision 0, "Component Cooling Water System" (dated 12/27/91).

6.7 System Descriptions

a. SD-SO23-360, Revision 2, "Reactor Coolant System".

6.8 Drawings

a. P&ID 40172A, (Rev 7) Containment HVAC System (Emergency)-System No. 1501

6.9 Open Item Reports

a. Open Item Report 92-015, Accepted 1/15/92.

b. Open Item Report 92-045, Accepted 2/11/92.

c. Open Item Report 92-054, Accepted 2/13/92.

d. Open Item Report 92-057, Accepted 2/20/92

e. Open Item Report 92-059, Accepted 2/20/92

f. Open Item Report 92-069, Accepted 2/25/92

6.10 Crane Technical Paper No.410, "Flow of Fluids", Twenty Fourth Printing-1988.

6.11 Bechtel Topical Report BN-TOP-3, Revision 4, "Performance and Sizing of Dry; Pressure Containments", dated March 1983.

6.12 Bechtel Nuclear Design Standard N2.3.2, Revision 0, "Containment Analysis, dated July 1975.

6.13 1989 ASHRAE Handbook of Fundamentals, I-P Edition, published by the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., Atlanta, Georgia, 1989.

6.14 ASME Steam Tables, Fifth Edition, published by the American Society of Mechanical Engineers".

6.15 Shao Ti Hsu, Engineering Heat Transfer, published by D. Van Nostrand Company, Inc. of Princeton, New Jersey, 1963.

6.16 NCRs 93030001, 93030002, 93030003, and 93030004. All dated 12/21/93.

## 7 NOMENCLATURE

| | |
|---|---|
| CCS | Containment Cooling System (Containment Air Cooling System) |
| CCWS | Component Cooling Water System |
| CE | Combustion Engineering |
| CSAS | Containment Spray Actuation Signal |
| CSS | Containment Spray System |
| CVCS | Chemical and Volume Control System |
| DESLS | Double Ended Suction Leg Slot |
| ESFAS | Engineered Safety Features Actuation Signal |
| HPSI | High Pressure Safety Injection |
| HTC | Heat Transfer Coefficient |
| HVAC | Heating, Ventilation and Air Conditioning |
| LCO | Limiting Condition of Operation |
| LOCA | Loss of Coolant Accident |
| LOOP | Loss of Offsite Power |
| LPSI | Low Pressure Safety Injection |
| MOV | Motor Operated Valve |
| NCR | Non-Conformance Report |
| NSSS | Nuclear Steam Supply System |
| RAS | Recirculation Actuation Signal |
| RB | Reactor Building |
| RCS | Reactor Coolant System |
| RWST | Reactor Water Storage Tank |
| SDCHX | Shutdown Cooling Heat Exchanger |
| SIAS | Safety Injection Actuation Signal |
| SIS | Safety Injection System |
| SIT | Safety Injection Tank |
| UHS | Ultimate Heat Sink |

## 8 CALCULATION

### 8.1 COPATTA CODE INPUT DATA

Section 8.1.1 presents the title card. Sections 8.1.2 through 8.1.25 will provide input data for the variable data series, while Sections 8.1.27 through 8.1.33 will provide input data for the heat sink data series. Section 8.1.26 presents the variable end card, and Section 8.1.33 presents the end card.

Item 1 in all Card Series is the Card Series Identifier, i.e. the Card Series number.

### 8.1.1 TITLE CARD

This card must precede each set of base case data. It must contain an asterisk in Column 1, and any combination of numeric and alphanumeric characters in the remaining 79 columns. The information on this card will appear at the top of each page of output for this prime case problem. This calculation evaluates a 7.4765 $ft^2$ MSLB at 102% power, with the containment heat removal systems affected by a single failure (i.e. only one of two cooling trains is functional) with offsite power available.

```
* MSLB CASE, 102% POWER, LOSS OF ONE COOLING TRAIN, OFFSITE POWER AVAIL.
```

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**CALCULATION SHEET**

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 50

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

### 8.1.2 CARD SERIES 0: Option Information

Card Series 0 provides option information, This Card Series is entered in the input data file as:

```
&LIST POOL=0,0,1,0,1,0,0,0,0/
```

The entries in Card Series 0 include:

Item 2: IHEAT = 0

A value of 0 indicates that no heat exchanger is modeled for containment spray per Design Input Item 4.1.a.

Item 3: NOIT = 1

A value of 0 enables the option to iterate for the estimated time to peak pressure, and a value of 1 disables the option. Per the COPATTA User's Manual (Reference 6.5.a), iteration is not to be requested unless use of the Tagami heat transfer coefficient (HTC) is specified for the HTC control on Heat Sink Card Series 1XX400. As noted in Design Input 4.8, only the Uchida heat transfer coefficient correlation is modeled in an MSLB analysis. Therefore, no iteration for the time to peak pressure is required.

Item 4: NPTOP = 0

A value of 0 requests a normal set of data at each printout time step.

As recommended by sheet 4 of Bechtel Nuclear Standard N2.3.2 (Reference 6.12), a normal set of data should be requested at each printout time step.

Item 5: LAST = 1

A value of 1 indicates that this is the last case in a series of COPATTA Code runs.

As discussed on page 3-11 of the COPATTA User's Manual (Reference 6.5.a), the option to terminate must equal 1 because the change case option is not active.

Item 6: IUHS_TYPE = 0

A value of 0 indicates that no Ultimate Heat Sink (UHS) is to be modeled.

Item 7: IHE_SRC = 0

A value of 0 indicates that the constant temperature and mass flow rate defined in Items 5 and 6 of Card Series 4 will be used for the Shutdown Cooling Heat Exchanger (SDCHX) data.

Item 8: IEX_HE_TYPE = 0

This parameter is used to model external heat loads if the value of IHEAT is greater than or equal to four in Item 2 of Card Series 0. In this analysis IHEAT is assigned a value of 2, so any value may be modeled for IEX_HE_TYPE. Therefore, a value of 0 is arbitrarily chosen to be modeled.

Item 9: IHE_UAMOD = 0

A value of 0 indicates that the COPATTA Code should use the SDCHX overall heat transfer coefficient on Item 4 of Card Series 4 as a constant.

8.1.3 CARD SERIES 1: General Problem Information

Card Series 1 provides general problem information. This Card Series is entered in the input data file as either, for the preliminary run:

```
&LIST POOL=1,1E4,16.2,2.305E6,120,0.6,20,582.945,1,1,0,14.7,0.50/
```

The entries in Card Series 1 include:

ITEM 2: TFINL = 1E4 seconds

Calculations for this analysis will be terminated at 10,000 seconds (2.78 hours). As shown in the summary of results, this analysis termination time is sufficient to ensure determination of the peak pressure and temperature time of occurrence. By this termination time the containment pressure and temperature have also returned to near initial conditions.

As discussed in Design Input Item 4.5.b, if a run time in excess of 10,000 seconds were to be modeled, then the model should also reflect actuation of the containment spray recirculation mode (spray water source transferred from the Refueling Water Storage Tank to the containment sump), and the corresponding use of the Shutdown Cooling Heat Exchanger.

ITEM 3: PAIR = 16.2 psia

The initial pressure inside the Containment prior to the start of the MSLB mass and energy release is 16.2 psia (1.5 psig), as discussed in Design Input Item 4.2.a.

ITEM 4: VOL = 2.305E6 $ft^3$

The containment net free volume is 2.305E6 $ft^3$, as discussed in Design Input Item 4.2.b.

ITEM 5: TAIR = 120 °F

The containment atmosphere temperature prior to the start of the MSLB mass and energy release is 120 °F, as discussed in Design Input Item 4.2.c.

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# CALCULATION SHEET

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|---|---|

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 53

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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ITEM 6: HUM = 0.6

The relative humidity of the atmosphere inside the Containment prior to the start of the MSLB mass and energy release is 60 percent, as discussed in Assumption 3.1.a.

ITEM 7: NSL = 20

As detailed in Section 8.1.27, twenty Heat Sinks are modeled in this calculation.

ITEM 8: TBOIL = 582.945 °F

The temperature of the primary coolant prior to the start of the MSLB mass and energy release is 582.945 °F, as discussed in Design Input 4.2.d. This value sets the initial temperature of all heat conducting region surfaces in contact with the primary coolant.

ITEM 9: TCHECK = 1 second

If the option to iterate for peak pressure is enabled (Item 3 on Card Series 0 is zero), then the variable TCHECK represents the time in seconds up to which the program will search for a second pressure peak after a first one has been located. The time to a second pressure peak is used to determine the condensation heat transfer coefficient; this quantity is used with the modified Tagami condensing heat transfer coefficient.

Per Design Item 4.8, the Uchida value will be used for the heat transfer coefficient in a MSLB. Therefore the option to iterate for peak pressure is disabled (Item 3 on Card Series 0 is one). If the TCHECK variable is not used, Bechtel Nuclear Design Standard N2.3.2 (Reference 6.12, page 5) states that the variable should be assigned a value of 1 second.

ITEM 10: THSDD = 1 second

This variable is only used if Tagami condensation heat transfer coefficient (HTC) calculations are modeled. As noted in Design Input 4.8, only the Uchida HTC correlation is modeled in an MSLB analysis. Therefore, any value may be entered for this variable. In this MSLB analysis the variable THSDD is modeled with an arbitrary value of 1 second.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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ITEM 11: EVAP = 0

The fraction of heat condensate which will be allowed to revaporize is zero. No credit for revaporization is taken in this analysis per Assumption 3.1.b.

ITEM 12: ENVRNP = 14.7 psia

The total pressure outside containment is assumed to be 14.7 psia per Assumption 3.1.c.

ITEM 13: ENVRH = 0.50

The relative humidity of the outside atmosphere is assumed to be 50 percent per Assumption 3.1.d.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

8.1.4 <u>CARD SERIES 2</u> : Additional General Problem Information

Card Series 2 provides additional general problem information. This Card Series is entered in the input data file as:

```
&LIST POOL=2,0,0,0,0,0,120,2E7/
```

The entries in Card Series 2 include:

ITEM 2: MWATR = 0 lbs

No water is to be introduced as a step input at the time blowdown starts.

ITEM 3: UTOT = 0 BTU

The total enthalpy associated with the water entered as variable MWATR is arbitrarily set to 0 BTU (any value is acceptable since variable MWATR is set to 0 pounds).

ITEM 4: MLEFT = 0 lbm

The variable MLEFT is the number of pounds of water left in the primary system available to be evaporated by reactor decay heat (Card Series 101) or metal water reaction heat (Card Series 201). This parameter is required for a LOCA analysis, not a MSLB analysis.

ITEM 5: REVOL = 0 $ft^3$

The reactor volume below the pipe rupture is 0 $ft^3$. This parameter is required for a LOCA analysis, not a MSLB analysis.

ITEM 6: HAB = 0 BTU/hr-°F

The total heat transfer coefficient for the heat transfer between liquid (sump) and vapor regions of the containment is modeled as 0 BTU/hr-°F per Assumption 3.2.a.

ITEM 7: TCONT = 120 °F

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

If the temperature boundary control on Heat Sink Card Series 1XX400 equals zero, then the variable TCONT is used to define the convective heat transfer coefficient and the bulk temperature to which the heat sink surfaces are exposed. Each of the twenty heat sinks modeled in this analysis assigns the temperature boundary control on Heat Sink Card Series 1XX400 a value other than zero. Since the variable TCONT is not used, Bechtel Nuclear Standard N2.3.2 (Reference 6.12, page 5) states that any positive value may be modeled. Since the COPATTA Code input files of Calculation N-4080-007 (Reference 6.1j) employed an arbitrary value of 120 °F, this analysis will also model an arbitrary value of 120 °F.

ITEM 8: PHELP = 2E7 seconds

The time at which mass and energy balance calculations for the water within the reactor vessel will begin is 2E7 seconds. This parameter is required for a LOCA analysis, not a MSLB analysis, therefore any time greater than the analysis run time may be used.

8.1.5 CARD SERIES 3: Leakage from Containment

Card Series 3 allows modeling of the addition and/or deletion of air/steam via containment HVAC operation. No credit is taken for HVAC operation in this MSLB analysis: Therefore, this Card Series is entered in the input data file as:

```
&LIST POOL=3,0,0,0,0,0,2E7,0,0,0,0/
```

The entries in Card Series 3 include:

ITEM 2: 0 seconds

The HVAC start time is 0 seconds.

ITEM 3: 0 $ft^3$/minute

The initial HVAC volume addition rate is 0 $ft^3$/minute.

ITEM 4: 0 °F

The initial temperature of the air added is 0 °F.

ITEM 5: 0 percent

The initial relative humidity of the air added is 0 percent.

ITEM 6: 0 $ft^3$/minute

The initial HVAC volume removal rate is 0 $ft^3$/minute.

ITEM 7: 2E7 seconds

The HVAC stop time is 2E7 seconds. This time must be longer than the analysis run time.

| | |
|---|---|
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| | CCN CONVERSION:<br>CCN NO. CCN -- |

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 58

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

ITEM 8: 0 ft$^3$/minute

The final HVAC volume addition rate is 0 ft$^3$/minute.

ITEM 9: 0 °F

The final temperature of the air added is 0 °F.

ITEM 10: 0 percent

The final relative humidity of the air added is 0 percent.

ITEM 11: 0 ft$^3$/minute

The final HVAC volume removal rate is 0 ft$^3$/minute.

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**CALCULATION SHEET**

| ICCN NO./<br>PRELIM. CCN NO. | PAGE___ OF___ |
|---|---|
| CCN CONVERSION:<br>CCN NO. CCN -- | |

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 59

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

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### 8.1.6 CARD SERIES 4: Heat Exchanger Data

Card Series 4 provides for simulation of heat exchangers for long term analysis of the effectiveness of the containment spray and safety injection systems.

Card Series 4 also provides for a means of starting the containment spray. The COPATTA Code compares two potential starting times for the containment spray, and starts the air coolers at the later of the two times. The first time is specified by the first non-zero spray flow entry in Card Series 801, Item 2. The second time, TNOW, is defined as the sum of the time at which the spray initiation signal (Item 12) is reached, and the instrumentation and equipment delay time (Item 13). In this analysis, the desired containment spray start time is to be the time modeled in Card Series 801. To ensure that the Card Series 801 time is used by the COPATTA Code, the Items 12 and 13 variables are modeled as 0 psia and 0 seconds, respectively. This leads to the calculation of a containment spray start time of 0 seconds for the variable TNOW, and forces the code to employ the larger time specified in Card Series 801.

This Card Series is entered in the input data file as:

```
&LIST POOL=4,0,0,0,0,0,0,0,0,0,0,0,0,0/
```

The entries in Card Series 4 include:

ITEM 2: IHEX = 0

A value of 0 indicates that a primary heat exchanger will not be modeled in this analysis. As discussed in Design Input Item 4.1.a, the Shutdown Cooling Heat Exchanger (SDCHX) will not be modeled in this MSLB analysis.

ITEM 3: HEX (1) = 0 $ft^2$

The primary heat exchanger surface area. Since no primary heat exchanger is modeled, a value of zero is used for this variable.

ITEM 4: HEX (2) = 0 BTU/hr-$ft^2$-°F

The overall heat exchanger heat transfer coefficient. Since no primary heat exchanger is modeled, a value of zero is used for this variable.

ITEM 5: HEX (3) = 0 °F

The primary heat exchanger coolant inlet temperature. Since no primary heat exchanger is modeled, a value of zero is used for this variable.

ITEM 6: HEX (4) = 0 lbm/hr

The primary heat exchanger coolant flow rate. Since no primary heat exchanger is modeled, a value of zero is used for this variable.

ITEM 7: IHIX = 0

A value of 0 indicates that no secondary heat exchanger is modeled in this analysis.

ITEMS 8 through 11: 0, 0, 0, 0

These entries are all zero, since there are no secondary heat exchangers in use.

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-20), if only a primary heat exchanger is used, zeroes should be input for Items 7 through 11, and 14.

ITEM 12: 0 psia

As discussed in the introduction to this Card Series 4, the containment spray pressure initiation signal is modeled as 0 psia.

ITEM 13: 0 seconds

As discussed in the introduction to this Card Series 4, the instrumentation and equipment delay time after receiving the pressure signal is modeled as 0 seconds.

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## CALCULATION SHEET

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 61

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

ITEM 14: DMINL = 0 lb/hr

This entry is zero, since there are no secondary heat exchangers in use.

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-20), if only a primary heat exchanger is used, zeroes should be input for Items 7 through 11, and 14.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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8.1.7 <u>CARD SERIES 5</u>: Air Cooler Information

Card Series 5 provides for the selection of the number of containment air coolers operating, and the period of operation. The air cooler heat removal capability curve is read into the problem in Card Series 1101.

The COPATTA Code compares two potential starting times for the air coolers, and starts the air coolers at the later of the two times. The first time is specified by Item 3. The second time, TNOW, is defined as the sum of the time at which the air cooler initiation signal (Item 5) is reached, and the TDELAY signal processing delay time (Item 6). In this analysis, the desired air cooler start time is to be the time modeled in Item 3. To ensure that the Item 3 time is used by the COPATTA Code, Items 5 and 6 variables are modeled as 0 psia and 0 seconds, respectively. This leads to the calculation of an air cooler start time of 0 seconds for the variable TNOW, and forces the code to employ the larger time specified in Item 3.

Card Series 5 is entered in the input data file as:

```
&LIST POOL=5,2,15,1E4,0,0,0,105/
```

The entries in Card Series 5 include:

ITEM 2: 2

There are two containment air coolers modeled in this analysis as discussed in Assumption 3.3.a.

ITEM 3: 15 seconds for MSLB with offsite power available.

The value represents the air coolers' starting time of 15 seconds as discussed in Design Input Item 4.3.a.

ITEM 4: 1E4 seconds

The shutoff time for the air coolers is modeled as 1E4 seconds. Use of this time will ensure that the containment air coolers will operate for the duration of the accident, as discussed in Assumption 3.3.b.

ITEM 5: 0 psia

As discussed in the introduction to this Card Series 5, the air cooler pressure initiation signal is modeled as 0 psia.

ITEM 6: TDELAY = 0 seconds

As discussed in the introduction to this Card Series 5, the instrumentation delay time after receiving the pressure signal is modeled as 0 seconds.

ITEM 7: IAC_SRC = 0

A value of 0 indicates that the air cooler heat exchanger coolant temperature is the constant value given in Item 8 of this Card Series 5.

ITEM 8: 105 °F

The temperature of the air cooler heat exchanger coolant is 105 °F as discussed in Design Input Item 4.3.b.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.8 CARD SERIES 6: Instantaneous Release of Energy

Card Series 6 provides for the instantaneous release of a specified amount of energy (to the containment atmosphere, containment sump, or to the reactor vessel water) at any one time during the accident. However, other than blowdown, no instantaneous release of energy is modeled in this analysis. Therefore, Card Series 6 is entered in the input data file as:

```
&LIST POOL=6, 0, 0, 0/
```

ITEM 2: TPULSE = 0 seconds

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-23), zeroes may be input for Items 2 through 4 if an instantaneous release of energy is not modeled.

ITEM 3: IPULSE = 0

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-23), zeroes may be input for Items 2 through 4 if an instantaneous release of energy is not modeled.

ITEM 4: UPULSE = 0 BTU

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-23), zeroes may be input for Items 2 through 4 if an instantaneous release of energy is not modeled.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

8.1.9 CARD SERIES LEAK: Leakage Paths Between Containment and Outside Atmosphere.

No leakage from containment to outside containment is modeled in this analysis. This Card Series is entered in the input data file as:

```
&LEAK NOPEN=0/
```

The variable NOPEN is equal to zero because the number of openings in the containment is zero.

Per the COPATTA Code Users Manual (Reference 6.5.a, page 3-25), if NOPEN is equal to zero, then the other variables may be omitted from the Card Series LEAK.

### 8.1.10 CARD SERIES 101: Reactor Core Decay Power (Table 2)

Card Series 101 is a table that is used to input reactor core decay power. This table is used in combination with information provided in Card Series 401 and 701. The reactor core decay power table includes up to 25 sets of the following data entered in columnar form:

1. Time (seconds)
2. Decay Power Generation rate (BTU/hr)

Reactor core decay heat is not modeled in the COPATTA input for this MSLB analysis. Any core decay heat impacting the containment P/T response to the event has already been included by CE in their calculation of the mass and energy release data which are separately input in Card Series 301 data. Therefore, Card Series 101 shall be entered as:

```
&LIST POOL=101,
        0,      0,
      2E7,      0/
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R<br>E<br>V<br>⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.11 CARD SERIES 201: Reactor Metal-Water Reaction (Table 3)

Card Series 201 is a table that is used to input reactor metal-water reaction rate. This table is used in combination with information presented in Card Series 401 and 701. The combined reactor metal-water reaction includes up to 25 sets of the following data, entered in columnar form:

1. time (seconds)
2. energy release rate (Btu/hour)

Since reactor metal-water reaction is not modeled in an MSLB analysis, Card Series 201 shall be entered as:

```
&LIST POOL=201,
          0,       0,
        2E7,       0/
```

### 8.1.12 CARD SERIES 301: Blowdown Following Pipe Rupture (Table 4)

Card Series 301 is a table that is used to input blowdown following the pipe rupture. The blowdown table includes up to 200 sets of the following data entered in columnar form:

1. time (seconds)
2. water addition rate (pounds/hour)
3. enthalpy of the water being added (BTU/pound)

The input data to be used in Card Series 301 is discussed in Design Input Item 4.4. This Card Series is entered in the input data file as shown below. The mass and energy release rates are assumed to vary linearly between each data point.

```
&LIST POOL=301,
    0,  5.145520E7, 1.195589E3,
 0.22,  4.869032E7, 1.197482E3,
 0.42,  4.622234E7, 1.198466E3,
 0.62,  4.405936E7, 1.199410E3,
 1.08,  4.003276E7, 1.201595E3,
 1.58,  3.688855E7, 1.201757E3,
 2.08,  3.445970E7, 1.202018E3,
 2.58,  3.326288E7, 1.200986E3,
 3.58,  3.152606E7, 1.201058E3,
 4.58,  3.028468E7, 1.201655E3,
 5.58,  2.940080E7, 1.201123E3,
 6.58,  2.874870E7, 1.201126E3,
 7.58,  2.706574E7, 1.204404E3,
 8.58,  2.468326E7, 1.204367E3,
 9.58,  2.294968E7, 1.204238E3,
10.58,  2.160122E7, 1.203908E3,
12.58,  1.943143E7, 1.203195E3,
14.58,  1.765940E7, 1.202277E3,
16.58,  1.637240E7, 1.201556E3,
18.58,  1.544720E7, 1.200963E3,
20.58,  1.473293E7, 1.200422E3,
25.58,  1.327525E7, 1.198820E3,
30.58,  1.221858E7, 1.197825E3,
35.58,  1.146406E7, 1.196753E3,
40.58,  1.059131E7, 1.195307E3,
45.58,  9.801216E6, 1.194165E3,
50.58,  9.132588E6, 1.193086E3,
60.58,  8.280324E6, 1.190935E3,
61.08,  7.245576E6, 1.190949E3,
62.08,  5.803344E6, 1.189165E3,
62.58,  3.238704E6, 1.184658E3,
64.58,  3.948840E5, 1.179953E3,
68.58,  1.074240E5, 1.251072E3,
71.08,           0,          0,
  2E7,           0,          0/
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.13 CARD SERIES 401: (Table 5)

Card Series 401 is a table that is used to describe the energy addition to the reactor vessel water from core decay power (Card Series 101) and any metal-water reaction (Card Series 201). This table designates the fraction of each of these energy sources that is added to the energy inventory in the reactor vessel. This table includes up to 20 sets of the following data entered in columnar form:

1. time (seconds)
2. decay power multiplier (dimensionless)
3. metal-water reaction multiplier (dimensionless)

Since reactor core decay energy and reactor metal-water reaction energy are not modeled in an MSLB analysis, Card Series 401 shall be entered as:

```
&LIST POOL=401,
          0,       0,       0,
        2E7,       0,       0/
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

### 8.1.14 CARD SERIES 501: Blowdown Following Pipe Rupture (Table 4)

This Card Series is used only if number of points are more than can fit in Card Series 301. The Card Series 501 table includes up to 200 sets of the following data entered in columnar form:

1. time (seconds)
2. water addition rate (pounds/hour)
3. energy addition rate (BTU/hour)

Card Series 501 is not needed since Card Series 301 had enough space for all data. Therefore, Card Series 501 shall be entered as:

```
&LIST POOL=501,
         0,         0,         0,
       2E7,         0,         0/
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

8.1.15 <u>CARD SERIES 601</u>: (Table 7)

This Card Series is used to add water and/or energy directly to the containment sump, regardless of the enthalpy of the water being added. This card is generally used to describe the spillage of Emergency Core Cooling System (ECCS) injection water that overflows the reactor vessel downcomer when the vessel is full. The Card Series 601 table includes up to 80 sets of the following data entered in columnar form:

1. time (seconds)
2. water addition rate (pounds/hour)
3. energy addition rate (BTU/hour)

Since additional water or energy are not added directly to the containment sump in an MSLB analysis, Card Series 601 shall be entered as:

```
&LIST POOL=601,
         0,       0,       0,
       2E7,       0,       0/
```

### 8.1.16 CARD SERIES 701: (Table 8)

Card Series 701 is a table that is used to describe the energy addition to the containment atmosphere from core decay power (Card Series 101), the metal-water reaction (Card Series 201). This table designates the fraction of each of these energy sources that is added to the energy inventory in the containment atmosphere. Card Series 701 also provides for arbitrary addition of water mass to the containment atmosphere. This table includes up to 20 sets of the following data entered in columnar form:

1. time (seconds)
2. decay power multiplier (dimensionless)
3. metal-water reaction multiplier (dimensionless)
4. water addition rate (pounds/hour)

Since reactor core decay energy or reactor metal-water reaction energy are not modeled in an MSLB analysis and no arbitrary addition of water mass was added to the containment atmosphere, Card Series 701 shall be entered as:

```
&LIST POOL=701,
          0,      0,      0,      0,
        2E7,      0,      0,      0/
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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8.1.17 <u>CARD SERIES 801</u>: (Table 9)

Card Series 801 is a table that provides input of information on the characteristics of the containment spray system, the core safety injection system, and the source of water supply for these systems. The Card Series 801 table includes up to 16 sets of the following data entered in columnar form:

1. time (seconds)
2. containment spray flow rate (pounds/hour)
3. reactor core safety injection water flow rate (pounds/hour)
4. fraction of the safety injection flow poured directly into the containment sump due to injection into a ruptured pipe (dimensionless)
5. water temperature of containment spray (°F)
6. water temperature of safety injection (°F)

This Card Series is discussed in Design Input Item 4.5. Card Series 801 shall be entered in the input data file as:

```
&LIST POOL=801,
      0,        0,        0,        0,      100,      100,
     50,        0,        0,        0,      100,      100,
     50,  8.02E5,        0,        0,      100,      100,
    2E7,  8.02E5,        0,        0,      100,      100/
```

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|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.18 CARD SERIES 901: (Table 10)

Card Series 901 provides for the arbitrary addition of air to the containment atmosphere. The arbitrary air addition table includes up to 20 sets of the following data entered in columnar form:

1. time (seconds)
2. containment air addition rate (pounds/hour)
3. temperature of the added air (°F)

Since no arbitrary air addition is modeled in this analysis, Card Series 901 shall be entered as:

```
&LIST POOL=901,
       0,      0,      0,
     2E7,      0,      0/
```

### 8.1.19 CARD SERIES 1001: (Table 11)

Card Series 1001 is used to determine the effect of cyclic outside temperature variations on long term post-accident temperature and pressure transients within the containment. The time period covered by the data should be from zero to 24 hours. The program will then use the data for succeeding 24 hour periods in very long time problems. The cyclic outside temperature variation table includes up to 25 sets of data entered in columnar form:

1. time (seconds)
2. temperature of the outside air (°F)
3. heat transfer coefficient between a heat sink and the outside atmosphere (BTU/hr-ft$^2$-°F)

In this MSLB model, no time-dependent atmospheric variations are modeled, and therefore the same data values are entered at times 0 and 24 hours. Card Series 1001 is entered in the input data file as:

```
&LIST POOL=1001,
        0,   100,   2.0,
       24,   100,   2.0/
```

The entries in Card Series 1001 include:

ITEM 2: 0 hours

The initial time in hours. The starting time of the first 24 hour cycle is 0 hours.

ITEM 3: 100 °F

The outside air temperature at the start of the first 24 hour cycle is assumed to be 100 °F as discussed in Assumption 3.4.a.

ITEM 4: 2.0 BTU/hr-ft$^2$-°F

The heat transfer coefficient between a heat sink and the outside atmosphere at the start of the first 24 hour cycle is assumed to be 2.0 BTU/hr-ft$^2$-°F as discussed in Assumption 3.4.b.

ITEM 5: 24 hours

The ending time of the first 24 hour cycle is 24 hours.

ITEM 6: 100 °F

The outside air temperature at the end of the first 24 hour cycle is assumed to be 100°F as discussed in Assumption 3.4.a (same as at the start of the cycle).

ITEM 7: 2.0 BTU/hr-ft$^2$-°F

The heat transfer coefficient between a heat sink and the outside atmosphere at the end of the first 24 hour cycle is assumed to be 2.0 BTU/hr-ft$^2$-°F as discussed in Assumption 3.4.b (same as at the start of the cycle).

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|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.20 CARD SERIES 1101: (Table 12)

As defined by Item 2 of Card Series 5, two containment air coolers are modeled in this analysis. Card Series 1101 is used to describe the heat removal capability of one air cooler as a function of containment atmosphere saturation temperature. Card Series 1101 provides for a table of tables, each table representing a discrete air cooler coolant temperature.

Card Series 1101 is entered in the DBA MSLB input data file as:

```
&LIST POOL=1101, 1, 21, 105,
             105,        0,
             120,  1.670E6,
             130,  3.020E6,
             140,  4.570E6,
             150,  6.320E6,
             160,  8.270E6,
             170,  1.040E7,
             180,  1.273E7,
             190,  1.523E7,
             200,  1.788E7,
             210,  2.068E7,
             220,  2.361E7,
             230,  2.661E7,
             240,  2.974E7,
             250,  3.291E7,
             260,  3.611E7,
             270,  3.931E7,
             280,  4.252E7,
             287,  4.474E7,
             290,  4.569E7,
             300,  4.882E7/
```

The entries in Card Series 1101 include:

ITEM 2: INUM=1

The value of 1 indicates that only one table of air cooler heat removal capability as a function of containment atmosphere saturation temperature is modeled. Separate tables are required for each air cooler coolant temperature, and this analysis only models a single air cooler coolant temperature.

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|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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ITEM 3: 21

A value of 21 indicates that there are twenty-one sets of data in the table (Items 5 and 6) describing air cooler heat removal capability as a function of containment atmosphere saturation temperature.

ITEM 4: 105 °F

The table (Items 5 and 6) describing air cooler heat removal capability as a function of containment atmosphere saturation temperature is based on an air cooler inlet temperature of 105 °F, as discussed in Design Input 4.3.b.

ITEMS 5 and 6

Containment atmosphere saturation temperature (°F), and
Corresponding cooler heat removal rate (BTU/hour)

The input data to be used in defining the Items 5 and 6 entries are discussed in Design Input Item 4.6.a.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.21 CARD SERIES 1105: UHS Parameters

Card Series 1105 is used to provide the Ultimate Heat Sink (UHS) parameters as a function of time. Since no UHS are modeled in this analysis (See Item 6 of Card Series 0), Card Series 1105 is not included in the input file.

### 8.1.22 CARD SERIES 1106: External Heat Load/Sink

Card Series 1106 is used to describe the time behavior of an external heat load/sink that is used only when IHEAT Option 5, 6 and 7 is defined for Item 2 of Card Series 0. In this analysis, Item 2 of Card Series 0 is defined as 2, therefore Card Series 1106 is not included in the input file.

### 8.1.23 CARD SERIES 1110: Heat Transfer Coefficient Multipliers

Card Series 1110 describes the time behavior of the overall heat transfer coefficients for the primary and secondary heat exchangers used in the system. These values are multipliers for the values on Items 4 and 9 of Card Series 4, for the primary and secondary heat exchangers, respectively. In this analysis, no heat exchangers are modeled. The overall SDCHX heat transfer coefficient defined in Item 4 of Card Series 4 is a constant value, therefore Card Series 1110 is not included in the input file.

8.1.24 CARD SERIES 1201: Table 13

Card Series 1201 provides for variation in the containment spray efficiency as a function of the ratio of water vapor to air mass in the containment atmosphere. The containment spray efficiency table includes up to 40 sets of the following data entered in columnar form:

1. (RATIO) the containment steam/air mass ratio (dimensionless)
2. (ETANOZ) spray efficiency (fraction)

This Card Series is discussed in Design Input Item 4.7.a. Card Series 1201 is entered in the input data file as:

```
&LIST POOL=1201,
             0,  0.729,
           0.1,  0.737,
           0.2,  0.747,
           0.3,  0.757,
           0.4,  0.771,
           0.5,  0.788,
           0.6,  0.809,
           0.7,  0.832,
           0.8,  0.863,
           0.9,  0.912,
           1.0,  0.961,
           1.1,  0.983,
           1.2,  0.995,
           1.3,  1.000/
```

8.1.25 CARD SERIES 9001: Table 14

Card Series 9001 is used to specify the calculational time intervals and the data printout intervals. The calc/print time table includes up to 50 sets of the following data entered in columnar form:

1. time (seconds)
2. calculational interval (seconds)
3. energy balance printout interval (seconds)
4. heat sink printout frequency (dimensionless)

Card Series 9001 is entered in the input data file as:

```
&LIST POOL=9001,
                   5,  0.05,    0.1,  50,
                  10,  0.05,   0.25,  20,
                  15,  0.05,   0.50,  10,
                  20,  0.05,   0.50,  10,
                 100,   0.1,    1.0,  10,
                 200,   1.0,    5.0,  10,
                 400,   1.0,   10.0,   5,
                 700,   2.0,   20.0,   5,
                 2E3,   5.0,   50.0,   1,
                 1E4,  50.0,    500,   2,
                 1E5,   250,    1E4,   4,
                 1E6,   500,    1E5,   9,
                 1E7,   500,    5E5,   9,
                 2E7,   500,    5E5,   9/
```

The selection of the time steps is based on the guidance given in Bechtel Nuclear Standard N2.3.2 (Reference 6.12, sheet 14 of 24). This analysis uses a higher calculational frequency to get more accurate output data.

As shown in the following tables, for an analysis run time of 10,000 seconds (Card Series 1, Item 2), this data will generate 2070 internal calculation intervals, 267 energy balance printouts and 38 heat sink printouts.

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|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

## INTERNAL CALCULATIONAL FREQUENCY

| TIME INTERVAL (seconds) | TIME INTERVAL DURATION (seconds) | INTERNAL CALCULATION INTERVAL (every # seconds) | NUMBER OF INTERNAL CALCULATIONS |
|---|---|---|---|
| 0 to 5 | 5 | 0.05 | 100 |
| 5 to 10 | 5 | 0.05 | 100 |
| 10 to 15 | 5 | 0.05 | 100 |
| 15 to 20 | 5 | 0.05 | 100 |
| 20 to 100 | 80 | 0.1 | 800 |
| 100 to 200 | 100 | 1.0 | 100 |
| 200 to 400 | 200 | 1.0 | 200 |
| 400 to 700 | 300 | 2.0 | 150 |
| 700 to 2E3 | 1,300 | 5.0 | 260 |
| 2E3 to 1E4 | 8,000 | 50.0 | 160 |
| | | Total Number of Calculations: | 2070 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

## ENERGY BALANCE PRINTOUT FREQUENCY

| TIME INTERVAL<br>(seconds) | TIME INTERVAL DURATION (seconds) | ENERGY BALANCE PRINTOUT INTERVAL (every # seconds) | NUMBER OF ENERGY BALANCE PRINTOUTS |
|---|---|---|---|
| 0 to 5 | 5 | 0.10 | 50 |
| 5 to 10 | 5 | 0.25 | 20 |
| 10 to 15 | 5 | 0.50 | 10 |
| 15 to 20 | 5 | 0.50 | 10 |
| 20 to 100 | 80 | 1 | 80 |
| 100 to 200 | 100 | 5 | 20 |
| 200 to 400 | 200 | 10 | 20 |
| 400 to 700 | 300 | 20 | 15 |
| 700 to 2E3 | 1,300 | 50 | 26 |
| 2E3 to 1E4 | 8,000 | 500 | 16 |
| | Total Number of Energy Balance Printouts: | | 267 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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## HEAT SINK PRINTOUT FREQUENCY

| TIME INTERVAL (seconds) | NUMBER OF ENERGY BALANCE PRINTOUTS | HEAT SINK PRINTOUT INTERVAL (one for every # energy printouts) | NUMBER OF HEAT SINK PRINTOUTS |
|---|---|---|---|
| 0 to 5 | 50 | 50 | 1 |
| 5 to 10 | 20 | 20 | 1 |
| 10 to 15 | 10 | 10 | 1 |
| 15 to 20 | 10 | 10 | 1 |
| 20 to 100 | 80 | 10 | 8 |
| 100 to 200 | 20 | 10 | 2 |
| 200 to 400 | 20 | 5 | 4 |
| 400 to 700 | 15 | 5 | 3 |
| 700 to 2E3 | 26 | 2 | 13 |
| 2E3 to 1E4 | 16 | 4 | 4 |
| | | Total Number of Heat Sink Printouts: | 38 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R<br>E<br>V<br>⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.26 VARIABLE END CARD

This card must follow the group of variable data cards. It contains the following fixed information in Columns 2 through 17:

```
&LIST POOL=9999/
```

## 8.1.27 HEAT SINK DATA SERIES

The heat sink data series are used to describe the characteristics of the structural heat sinks. In this analysis twenty heat sinks are modeled (Card Series 1, Item 7). Each heat sink (number XX) is detailed in the COPATTA Code as a set of heat sink data cards. These data cards include:

Title Card
Card Series 1XX001
Card Series 1XX101
Card Series 1XX201
Card Series 1XX300
Card Series 1XX400

Card Series 1XX001 contains general information on the heat sink. Card Series 1XX101 provides information on heat sink mesh point spacing. Card Series 1XX201 specifies the set of material properties for each region of the heat sink. Card Series 1XX300 selects the type and variation in magnitude of the decay power source within the heat sink. Card Series 1XX400 is used to select the appropriate boundary conditions for the left and right surfaces of each heat sink.

In general, the presence (or increase in size) of a heat sink has two consequences: (1) depressing the peak containment pressure and temperature by absorbing energy released via the break, and (2) extending the duration of above ambient containment pressures and temperatures by releasing energy back into the containment during the latter part of the accident. Beyond these two general consequences, the impact of a change in the modeling of a heat sink (e.g., a change in the heat sink layer thicknesses) is difficult to qualify.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.27.1 HS #1 - Reactor Building Dome

The characteristics of the Reactor Building Dome are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 121 through 125) for Heat Sink 1, except for the thickness of the Containment Liner/Concrete air gap interface.

As discussed in Design Input Item 4.8.a, the effective thickness of the interface (air gap) will be 0.00035 feet. With this change, Heat Sink #1 describes the Reactor Building Dome as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 34693.22 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00075 ft (= 0.009 in) |
| Carbon Steel (material 1) Liner thickness | 0.02083 ft (= 0.25 in) |
| Air Gap Interface (material 5) thickness | 0.00035 ft |
| Concrete (material 2) thickness-Right Boundary | 4.0417 ft (= 48.5 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Exposed to outside environment |

The effect of the change in the air gap thickness is reflected in Card Series 101101. This Card Series defines the location of the right boundary and nodalization of each region. The air gap is the third region of Heat Sink 1. The increase in the modeled air gap thickness from 0.00017 feet to 0.00035 feet requires that the modeled location of the Region 3 right boundary be increased by 0.00018 feet. To maintain the correct thickness of each Region that follows the air gap region necessitates that the modeled locations of the right boundaries of these subsequent regions be increased by the same 0.00018 feet. The changes from the right boundary locations determined in Calculation N-4080-002 are:

1st Region: no change in the right boundary location
2nd Region: no change in the right boundary location
3rd Region: right boundary shifted from 0.02175 to 0.02193 feet
4th Region: right boundary shifted from 0.06342 to 0.06360 feet
5th Region: right boundary shifted from 0.2301 to 0.23028 feet
6th Region: right boundary shifted from 1.000921 to 1.00110 feet
7th Region: right boundary shifted from 4.06345 to 4.06363 feet

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|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

The Card Series set defining Heat Sink 1 is entered in the input data file as:

```
 * HS #1 - REACTOR BUILDING DOME
  &LIST POOL=101001, 100, 7, 0, 0, 0, 0, 34693.22/
  &LIST POOL=101101, 5, 0.00075,   3,   0.02158,
                      3, 0.02193,  10,   0.06360,
                     20, 0.23028,  37,   1.00110,
                     21, 4.06363/
  &LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2/
  &LIST POOL=101300, 0, 0/
  &LIST POOL=101400, 9, 2, 1, 1/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 101400 is 9.

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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.27.2 HS #2 - Reactor Building Cylinder #1 (above grade, between El. 29'6" and 112'0")

The characteristics of the Reactor Building Cylinder #1 (above grade, between plant elevations 29'6" and 112'0") are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 125 through 128) for Heat Sink 2, except for the thickness of the Containment Liner/Concrete air gap interface.

As discussed in Design Input Item 4.8.a, the effective thickness of the interface (air gap) will be 0.00035 feet. With this change, Heat Sink #2 describes the Reactor Building Cylinder 1 as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 38120 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00075 ft (= 0.009 in) |
| Carbon Steel (material 1) Liner thickness | 0.02083 ft (= 0.25 in) |
| Air Gap Interface (material 5) thickness | 0.00035 ft |
| Concrete (material 2) thickness-Right Boundary | 4.33333 ft (= 52 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Exposed to outside environment |

The effect of the change in the air gap thickness is reflected in Card Series 102101. This Card Series defines the location of the right boundary and nodalization of each region. The air gap is the third region of Heat Sink 2. The increase in the modeled air gap thickness from 0.00017 feet to 0.00035 feet requires that the modeled location of the Region 3 right boundary be increased by 0.00018 feet. To maintain the correct thickness of each Region that follows the air gap region necessitates that the modeled locations of the right boundaries of these subsequent regions be increased by the same 0.00018 feet. The changes from the right boundary locations determined in Calculation N-4080-002 are:

| | |
|---|---|
| 1st Region: | no change in the right boundary location |
| 2nd Region: | no change in the right boundary location |
| 3rd Region: | right boundary shifted from 0.02175 to 0.02193 feet |
| 4th Region: | right boundary shifted from 0.06342 to 0.06360 feet |
| 5th Region: | right boundary shifted from 0.14676 to 0.14694 feet |
| 6th Region: | right boundary shifted from 0.917581 to 0.917761 feet |

7th Region:   right boundary shifted from 4.35508 to 4.35526 feet

The Card Series set defining Heat Sink 2 is entered in the input data file as:

```
* HS #2 - CYLINDER WALL BETWEEN El. 29'6" AND 112'0"
 &LIST POOL=102001, 100, 7, 0, 0, 0, 0, 38120/
 &LIST POOL=102101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526/
 &LIST POOL=102201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=102300, 0, 0/
 &LIST POOL=102400, 9, 2, 1, 1/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 102400 is 9.

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### 8.1.27.3 HS #3 - Reactor Building Cylinder #2 (below grade, between El. 15'0" and 29'6")

The characteristics of the Reactor Building Cylinder #2 (below grade, between plant elevations 15'0" and 29'6") are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 134 through 136) for Heat Sink 3, except for the thickness of the Containment Liner/Concrete air gap interface.

As discussed in Design Input Item 4.8.a, the effective thickness of the interface (air gap) will be 0.00035 feet. With this change, Heat Sink #3 describes the Reactor Building Cylinder 2 as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 6667.38 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00075 ft (= 0.009 in) |
| Carbon Steel (material 1) Liner thickness | 0.02083 ft (= 0.25 in) |
| Air Gap Interface (material 5) thickness | 0.00035 ft |
| Concrete (material 2) thickness-Right Boundary | 4.33333 ft (= 52 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer to the ground outside the lower portion of the Reactor Building Cylinder |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The effect of the change in the air gap thickness is reflected in Card Series 103101. This Card Series defines the location of the right boundary and nodalization of each region. The air gap is the third region of Heat Sink 3. The increase in the modeled air gap thickness from 0.00017 feet to 0.00035 feet requires that the modeled location of the Region 3 right boundary be increased by 0.00018 feet. To maintain the correct thickness of each Region that follows the air gap region necessitates that the modeled locations of the right boundaries of these subsequent regions be increased by the same 0.00018 feet. The changes from the right boundary locations determined in Calculation N-4080-002 are:

| | |
|---|---|
| 1st Region: | no change in the right boundary location |
| 2nd Region: | no change in the right boundary location |
| 3rd Region: | right boundary shifted from 0.02175 to 0.02193 feet |
| 4th Region: | right boundary shifted from 0.06342 to 0.06360 feet |
| 5th Region: | right boundary shifted from 0.14676 to 0.14694 feet |
| 6th Region: | right boundary shifted from 0.917581 to 0.917761 feet |
| 7th Region: | right boundary shifted from 4.35508 to 4.35526 feet |

The Card Series set defining Heat Sink 3 is entered in the input data file as:

```
* HS #3 - CYLINDER WALL BETWEEN El. 15'0" AND El. 29'6"
 &LIST POOL=103001, 100, 7, 0, 0, 0, 0, 6667.38/
 &LIST POOL=103101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526/
 &LIST POOL=103201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=103300, 0, 0/
 &LIST POOL=103400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 103400 is 9.

8.1.27.4 HS #4 - Basemat (other than the Reactor Basemat)

The characteristics of the Basemat (other than the Reactor Basemat) are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 137 through 139) for Heat Sink 4.

Heat Sink #4 describes the Basemat (other than Reactor Basemat) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 12800 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00067 ft (= 0.008 in) |
| Concrete #1 (material 2) thickness | 1.52631 ft |
| Carbon Steel (material 1) Liner thickness | 0.02083 ft (= 0.25 in) |
| Concrete #2 (material 2) thickness-Right Boundary | 9.473685 ft |
| Left Boundary condition | Exposed to containment sump water |
| Right Boundary condition | Insulated, no heat transfer to the ground beneath the basemat |

Due to an addition error, Calculation N-4080-002 (page 138) incorrectly modeled the right boundary coordinate of the second Concrete Region at 11.02105 feet. The determination of the right boundary coordinate of the second Concrete region was based on the right boundary coordinate of the Carbon Steel Region of 1.54736 feet, rather than the correct coordinate of 1.54781 feet. In this analysis the right boundary coordinate of the second concrete region will be modeled at the correct position of 11.02150 feet:

Right Boundary Coordinate of Concrete Region #2 = 1.54781 ft + 9.473685 ft
= 11.02150 feet

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment liquid temperature (i.e., Option 3 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 3 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 4 is entered in the input data file as:

```
* HS #4 - BASEMAT (OTHER THAN REACTOR BASEMAT)
 &LIST POOL=104001, 53, 5, 0, 0, 0, 0, 12800/
 &LIST POOL=104101, 3,  0.00067,    7,      0.1,
                   20,  1.52698,    2, 1.54781,
                   20, 11.02150/
 &LIST POOL=104201, 4, 2, 2, 1, 2/
 &LIST POOL=104300, 0, 0/
 &LIST POOL=104400, 3, 3, 0, 3/
```

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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.27.5 HS #5 - Reactor Basemat and Steam Generator Pedestals

The characteristics of the Reactor Basemat and Steam Generator Pedestals are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 139 through 141) for Heat Sink 5.

Heat Sink #5 describes the Reactor Basemat and Steam Generator Pedestals as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 1644 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00158 ft |
| Concrete (material 2) thickness-Right Boundary | 8.42934 ft |
| Left Boundary condition | Exposed to containment sump water |
| Right Boundary condition | Insulated, no heat transfer to the ground beneath the basemat |

In Calculation N-4080-002 (page 141) the heat transfer coefficient control for the left boundary condition was modeled as Option 11 for Item 2 of Card Series 1XX400. This resulted in the use of a user specified heat transfer coefficient entered in Card Series 420001. In Calculation N-4080-002 (page 193) a heat sink to containment sump water heat transfer coefficient of 0.4 BTU/hr-ft$^2$-°F was specified. This same heat transfer coefficient value is available as Option 3 for Item 2 of Card Series 1XX400. To negate the need for input for Card Series 420001, in this calculation the heat transfer coefficient control for the left boundary condition is modeled as Option 3 for Item 2 of Card Series 1XX400.

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment liquid temperature (i.e., Option 3 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 3 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

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The Card Series set defining Heat Sink 5 is entered in the input data file as:

```
* HS #5 - REACTOR BASEMAT & S.G. PEDESTALS
 &LIST POOL=105001, 70, 4, 0, 0, 0, 0, 1644/
 &LIST POOL=105101, 4, 0.00158,   10,     0.1,
                   30,    2.00,   25, 8.43092/
 &LIST POOL=105201, 4, 2, 2, 2/
 &LIST POOL=105300, 0, 0/
 &LIST POOL=105400, 3, 3, 0, 3/
```

### 8.1.27.6 HS #6 - Reactor Cavity Walls below El. 15'0"

The characteristics of the Reactor Cavity Walls below plant elevation 15'0" are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 142 through 144) for Heat Sink 6.

Heat Sink #6 describes the Reactor Cavity Walls below El. 15'0" as modeled:

| | |
|---|---|
| Geometry | Cylindrical |
| Inside Radius | 11.75 ft |
| Height of Cylinder (wall height) | 21.5 ft |
| Surface Area | 1590 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00192 ft (= 0.023 in) |
| Concrete (material 2) thickness-Right Boundary | 13.5 ft (= 162 in) |
| Left Boundary condition | Exposed to containment sump water |
| Right Boundary condition | Insulated, no heat transfer to the ground on the opposite side of the walls |

Due to an addition error, Calculation N-4080-002 (page 143) incorrectly modeled the right boundary coordinate of the Concrete Region at 25.25 feet. The determination of the right boundary coordinate of the Concrete region was based on adding the thickness of the Concrete Region to the inside radius of the cylinder model, and neglecting to add the thickness of the Organic Paint Region. In this analysis the right boundary coordinate of the Concrete Region will be modeled at the correct position of 25.25192 feet:

Right Boundary Coordinate of Concrete Region = 11.75 ft + 0.00192 ft + 13.5 ft
= 25.25192 feet

In Calculation N-4080-002 (page 198) the cylinder height was incorrectly entered into the COPATTA Code input file as 8.5 feet, rather than the 21.5 feet value calculated on page 143. In this analysis the cylinder height will be modeled as 21.5 feet.

In Calculation N-4080-002 (page 144) the heat transfer coefficient control for the left boundary condition was modeled as Option 11 for Item 2 of Card Series 1XX400. This

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resulted in the use of a user specified heat transfer coefficient entered in Card Series 420001. In Calculation N-4080-002 (page 193) a heat sink to containment sump water heat transfer coefficient of 0.4 BTU/hr-ft$^2$-°F was specified. This same heat transfer coefficient value is available as Option 3 for Item 2 of Card Series 1XX400. To negate the need for input for Card Series 420001, in this calculation the heat transfer coefficient control for the left boundary condition is modeled as Option 3 for Item 2 of Card Series 1XX400.

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment liquid temperature (i.e., Option 3 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 3 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 6 is entered in the input data file as:

```
* HS #6 - REACTOR CAVITY WALLS BELOW El. 15'0"
 &LIST POOL=106001, 93, 5, 1, 11.75, 0, 0, 21.5/
 &LIST POOL=106101, 5, 11.75192,    7, 11.77292,
                   30, 13.29923,   30, 19.29923,
                   20, 25.25192/
 &LIST POOL=106201, 4, 2, 2, 2, 2/
 &LIST POOL=106300, 0, 0/
 &LIST POOL=106400, 3, 3, 0, 3/
```

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### 8.1.27.7 HS #7 - Reactor Cavity Walls above El. 15'0"

The characteristics of the Reactor Cavity Walls above plant elevation 15'0" are as determined in Calculation N-4080-002 (Reference 6.1.g), pages 144 through 146) for Heat Sink 7.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center concrete portion is one-half of the actual thickness of the center concrete portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #7 describes the Reactor Cavity Walls above El. 15'0" as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 2810 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00192 ft (= 0.023 in) |
| Concrete (material 2) thickness-Right Boundary | 4.00 ft (= 48 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer is modeled across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./
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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 100

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The Card Series set defining Heat Sink 7 is entered in the input data file as:

```
* HS #7 - REACTOR CAVITY WALLS ABOVE El. 15'0"
 &LIST POOL=107001, 68, 5, 0, 0, 0, 0, 2810/
 &LIST POOL=107101, 5, 0.00192,   7, 0.02292,
                   15, 0.40192,  20,    2.00,
                   20, 4.00192/
 &LIST POOL=107201, 4, 2, 2, 2, 2/
 &LIST POOL=107300, 0, 0/
 &LIST POOL=107400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 107400 is 9.

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### 8.1.27.8 HS #8 - Lined Refueling Canal Walls

The characteristics of the Lined Refueling Canal Walls are as determined in Calculation N-4080-002 (Reference 6.1.g), pages 146 through 149) for Heat Sink 8.

Heat Sink #8 describes the Lined Refueling Canal Walls as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 9200 ft$^2$ |
| Stainless Steel (material 3) thickness-Left Boundary | 0.01563 ft (= 0.1875 in) |
| Concrete (material 2) thickness | 4.00 ft (= 48 in) |
| Organic Paint (material 4) thickness-Right Boundary | 0.00192 ft (= 0.023 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Exposed to containment atmosphere |

The Card Series set defining Heat Sink 8 is entered in the input data file as:

```
* HS #8 - LINED REFUELING CANAL WALLS
 &LIST POOL=108001, 86, 6, 0, 0, 0, 0, 9200/
 &LIST POOL=108101, 5, 0.01563,    20,     0.1,
                   15, 0.41563,    20,    2.00,
                   20, 4.01563,     5, 4.01755/
 &LIST POOL=108201, 3, 2, 2, 2, 2, 4/
 &LIST POOL=108300, 0, 0/
 &LIST POOL=108400, 9, 2, 9, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left and right boundary conditions are modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Items 2 and 4 in Card Series 108400 are 9.

### 8.1.27.9 HS #9 - Steam Generator Compartment Walls, Unlined Refueling Canal Walls above El. 63'6", and Other Interior Walls

The characteristics of the Steam Generator Compartment Walls, Unlined Refueling Canal Walls above plant elevation 63'6", and Other Interior Walls are as determined in Calculation N-4080-002 (Reference 6.1.g), pages 149 through 152) for Heat Sink 9.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center concrete portion is one-half of the actual thickness of the center concrete portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #9 describes the Steam Generator Compartment Walls, Unlined Refueling Canal Walls above El. 63'6", and Other Interior Walls as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 41976 $ft^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00192 ft (= 0.023 in) |
| Concrete (material 2) thickness-Right Boundary | 1.71684 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 9 is entered in the input data file as:

```
* HS #9 - S.G. CMPRTMNT WALLS, UNLINED REFL CNL WALLS/OTH INT WALLS
 &LIST POOL=109001, 78, 4, 0, 0, 0, 0, 41976/
 &LIST POOL=109101, 5, 0.00192,    10, 0.04233,
                   12,     0.1,    50, 1.71876/
 &LIST POOL=109201, 4, 2, 2, 2/
 &LIST POOL=109300, 0, 0/
 &LIST POOL=109400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 109400 is 9.

8.1.27.10 HS #10 - Floor Slabs (other than basemats)

The characteristics of the Floor Slabs (other than basemats) represent a refinement of the characteristics as determined in Calculation N-4080-002 (pages 152 through 155) for Heat Sink 10.

Heat Sink #10 describes Floor Slabs (other than basemats) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 17474 ft$^2$ |
| Organic Paint #1 (material 4) thickness-Left Boundary | 0.00014 ft |
| Carbon Steel (material 1) thickness | 0.005208 ft (= 0.0625 in) |
| Concrete (material 2) thickness | 1.5 ft |
| Organic Paint #2 (material 4) thickness-Right Boundary | 0.000667 ft (= 0.008 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Exposed to containment atmosphere |

The 17474 square foot surface area of the floor slabs modeled in this analysis is equivalent to the concrete side surface area given in Calculation C-257-1.96.01 (Reference 6.1.a, pages 15 and 26). The same calculation gives a metal decking are of 23,240 square feet (page 26). The higher area is due to the metal decking which is corrugated steel while the smaller area is the area of the concrete slab under it. The smaller area of 17474 square foot will be conservatively used here.

Calculation N-4080-002 (Reference 6.1.g, page 152) used a value of 17172 square feet and is based on input data provided as Attachment 1 to Calculation N-4080-002 (page 328). This surface area differs from that described in Calculation N-4080-005 (Reference 6.1.f, page 42), which attempted to refine the floor slab heat sink model by increasing the surface area of the floor slab from 17172 to 23240 square feet. Although the area was to be increased, the actual COPATTA Code runs of Calculation N-4080-005 continued to model the original smaller floor slab surface area of 17172 square feet.

As discussed in Design Input Item 4.8.k, when the nodalization of the Concrete Region was performed, Calculation N-4080-002 (page 153) modeled the concrete as Heat Sink 10 Regions 3, 4 and 5, with a total concrete thickness of 2.0 feet rather than 1.5 feet. To

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model the correct concrete thickness requires that the Region 5 thickness be reduced by 0.5 feet. This is accomplished by shifting the right boundary of Region 5 to the left by 0.5 feet. As a consequence, the right boundary of Region 6 (the second Organic Paint layer) must also be shifted to the left by 0.5 feet. The changes from the right boundary locations determined in Calculation N-4080-002 are:

| | |
|---|---|
| 1st Region: | no change in the right boundary location |
| 2nd Region: | no change in the right boundary location |
| 3rd Region: | no change in the right boundary location |
| 4th Region: | no change in the right boundary location |
| 5th Region: | right boundary shifted from 2.005348 to 1.505348 feet |
| 6th Region: | right boundary shifted from 2.006015 to 1.506015 feet |

The Card Series set defining Heat Sink 10 is entered in the input data file as:

```
* HS #10 - FLOOR SLABS (OTHER THAN BASEMATS)
 &LIST POOL=110001, 67, 6, 0, 0, 0, 0, 17474/
 &LIST POOL=110101, 3,  0.00014,    5, 0.005348,
                   20, 0.105348,   15, 0.505348,
                   20, 1.505348,    3, 1.506015/
 &LIST POOL=110201, 4, 1, 2, 2, 2, 4/
 &LIST POOL=110300, 0, 0/
 &LIST POOL=110400, 9, 2, 9, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left and right boundary conditions are modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Items 2 and 4 in Card Series 110400 are 9.

8.1.27.11 HS #11 - Lifting Devices (except stainless steel parts)

The characteristics of the Lifting Devices (except stainless steel parts) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 42 through 44) for Heat Sink 10. This heat sink description represents a refinement of the characteristics of the Lifting Devices first determined in Calculation N-4080-002 (Reference g.1.g, pages 156 through 158) for Heat Sink 11.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center carbon steel portion is one-half of the actual thickness of the center carbon steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #11 describes the Lifting Devices (except stainless steel parts) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 57286 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00125 ft (= 0.015 in) |
| Carbon Steel (material 1) thickness-Right Boundary | 0.041667 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

The Card Series set defining Heat Sink 11 is entered in the input data file as:

```
* HS #11 - LIFTING DEVICES (EXCEPT STAINLESS STEEL PARTS)
 &LIST POOL=111001, 17, 2, 0, 0, 0, 0, 57286/
 &LIST POOL=111101, 6, 0.00125,    10, 0.042917/
 &LIST POOL=111201, 4, 1/
 &LIST POOL=111300, 0, 0/
 &LIST POOL=111400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 111400 is 9.

### 8.1.27.12 HS #12 - Miscellaneous Carbon Steel (with thickness greater than 2.50 in)

The characteristics of the Miscellaneous Carbon Steel (with thickness greater than 2.50 in) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 44 through 47) for Heat Sink 11. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (Reference 6.1.g, pages 58 through 161) for Heat Sink 12.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center carbon steel portion is one-half of the actual thickness of the center carbon steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #12 describes the Miscellaneous Carbon Steel (with thickness greater than 2.50 in) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 516 $\text{ft}^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.0005 ft (= 0.006 in) |
| Carbon Steel (material 1) thickness-Right Boundary | 0.310349 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Calculation N-4080-005 (page 44) calculates a Miscellaneous Carbon Steel surface area of 516 square feet. However, due to an apparent transcription error, a surface area of 596 square feet was modeled in the Calculation N-4080-005 COPATTA Code input files. This calculation will model the calculated area of 516 square feet.

Calculation N-4080-005 (page 45) calculates a right boundary coordinate of 0.310849 feet for the Carbon Steel Region. However, for unknown reasons, a right boundary coordinate of 0.34414 feet was modeled in the Calculation N-4080-005 COPATTA Code input files. This calculation will model the calculated right boundary coordinate of 0.310849 feet for the Carbon Steel Region.

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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 12 is entered in the input data file as:

```
* HS #12 - MISCELLANEOUS CARBON STEEL - THICKNESS > 2.50 INCHES
 &LIST POOL=112001, 64, 4, 0, 0, 0, 0, 516/
 &LIST POOL=112101, 6, 0.0005,   17,    0.084,
                   15,   0.20,   25, 0.310849/
 &LIST POOL=112201, 4, 1, 1, 1/
 &LIST POOL=112300, 0, 0/
 &LIST POOL=112400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 112400 is 9.

8.1.27.13 HS #13 - Miscellaneous Carbon Steel (with thickness between 1.00 in and 2.50 in)

The characteristics of the Miscellaneous Carbon Steel (with thickness between 1.00 in and 2.50 in) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 47 through 50) for Heat Sink 12. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (Reference 6.1.g, pages 161 through 165) for Heat Sink 13.

An error was made in Calculation N-4080-005 for Heat Sink 12 on page 48. There are four Safety Injections Tanks and the area of only one tank was modeled by Calculation N-4080-005. Correcting this error will change the surface area for Heat Sink 13 in this analysis to 12042 square feet and the effective carbon steel thickness to 0.1692 feet.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center carbon steel portion is one-half of the actual thickness of the center carbon steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #13 describes the Miscellaneous Carbon Steel (with thickness between 1.00 in and 2.50 in) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 12042 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00063 ft |
| Carbon Steel (material 1) thickness-Right Boundary | 0.16924 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of

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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 13 is entered in the input data file as:

```
* HS #13 - MISCELLANEOUS CARBON STEEL: 1.00"<THICKNESS<2.50"
 &LIST POOL=113001, 32, 2, 0, 0, 0, 0, 12042/
 &LIST POOL=113101, 6, 0.00063,   25, 0.16967/
 &LIST POOL=113201, 4, 1/
 &LIST POOL=113300, 0, 0/
 &LIST POOL=113400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 113400 is 9.

8.1.27.14 HS #14 - Miscellaneous Carbon Steel (with thickness between 0.50 in and 1.00 in)

The characteristics of the Miscellaneous Carbon Steel (with thickness between 0.50 in and 1.00 in) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 50 through 54) for Heat Sink 13. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (Reference 6.1.g, pages 165 through 169) for Heat Sink 14.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center carbon steel portion is one-half of the actual thickness of the center carbon steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #14 describes the Miscellaneous Carbon Steel (with thickness between 0.50 in and 1.00 in) as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 64693 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.000674 ft |
| Carbon Steel (material 1) thickness-Right Boundary | 0.037933 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 1[illegible]3

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 14 is entered in the input data file as:

```
* HS #14 - MISCELLANEOUS CARBON STEEL: 0.50"<THICKNESS<1.00"
 &LIST POOL=114001, 19, 2, 0, 0, 0, 0, 64693/
 &LIST POOL=114101, 5, 0.000674,   13, 0.038607/
 &LIST POOL=114201, 4, 1/
 &LIST POOL=114300, 0, 0/
 &LIST POOL=114400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 114400 is 9.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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8.1.27.15 HS #15 - Miscellaneous Carbon Steel (with thickness less than 0.50 in)

The characteristics of the Miscellaneous Carbon Steel (with thickness less than 0.50 in) are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 54 through 59) for Heat Sink 14. This heat sink description represents a refinement of the characteristics of the Miscellaneous Carbon Steel first determined in Calculation N-4080-002 (Reference 6.1.g, pages 169 through 173) for Heat Sink 15.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center carbon steel portion is one-half of the actual thickness of the center carbon steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #15 describes the Miscellaneous Carbon Steel (with thickness less than 0.50 in as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 98913.6 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.000606 ft |
| Carbon Steel (material 1) thickness-Right Boundary | 0.012227 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 15 is entered in the input data file as:

```
* HS #15 - MISCELLANEOUS CARBON STEEL: THICKNESS<0.5"
 &LIST POOL=115001, 17, 2, 0, 0, 0, 0, 98913.6/
 &LIST POOL=115101, 6, 0.000606,     10, 0.012833/
 &LIST POOL=115201, 4, 1/
 &LIST POOL=115300, 0, 0/
 &LIST POOL=115400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 115400 is 9.

8.1.27.16 HS #16 - Electrical Equipment

The characteristics of the Electrical Equipment are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 59 through 61) for Heat Sink 15. This heat sink description represents a refinement of the characteristics of the Electrical Steel first determined in Calculation N-4080-002 (Reference 6.1.g, pages 174 through 176) for Heat Sink 16.

Calculation N-4080-005 (page 61) recommends use of a 37644 square foot surface area. The modeled surface area of 37644.5 square feet possesses the extra significant digit found in an interim calculation step as shown in Calculation N-4080-005 (page 60).

Heat Sink #16 describes the Electrical Equipment as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 37644.5 ft$^2$ |
| Carbon Steel (material 1) thickness-Left and Right boundaries | 0.0054 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer to inside of electrical equipment |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 16 is entered in the input data file as:

```
* HS #16 - ELECTRICAL EQUIPMENT
 &LIST POOL=116001, 8, 1, 0, 0, 0, 0, 37644.5/
 &LIST POOL=116101, 7, 0.0054/
 &LIST POOL=116201, 1/
 &LIST POOL=116300, 0, 0/
 &LIST POOL=116400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 116400 is 9.

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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 118

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.27.17 HS #17 - Miscellaneous Stainless Steel

The characteristics of the Miscellaneous Stainless Steel are as determined in Calculation N-4080-005 (Reference 6.1.f, pages 62 through 65) for Heat Sink 16. This heat sink description represents a refinement of the characteristics of the Miscellaneous Stainless Steel as first determined in Calculation N-4080-002 (Reference 6.1.g, pages 176 through 179) for Heat Sink 17.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center stainless steel portion is one-half of the actual thickness of the center stainless steel portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #17 describes the Miscellaneous Stainless Steel as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 24048 ft$^2$ |
| Stainless Steel (material 3) thickness-Left and Right boundaries | 0.01747 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculations N-4080-002 and N-4080-005, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R<br>E<br>V<br>⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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The Card Series set defining Heat Sink 17 is entered in the input data file as:

```
* HS #17 - MISCELLANEOUS STAINLESS STEEL
 &LIST POOL=117001, 16, 1, 0, 0, 0, 0, 24048/
 &LIST POOL=117101, 15, 0.01747/
 &LIST POOL=117201, 3/
 &LIST POOL=117300, 0, 0/
 &LIST POOL=117400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 117400 is 9.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

8.1.27.18 HS #18 - Unlined Refueling Canal Walls (below El. 63'6")

The characteristics of the Unlined Refueling Canal Walls (below plant elevation 63'6") are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 180 through 182) for Heat Sink 18.

Due to heat sink symmetry, only one-half of the heat sink is modeled. The modeled surface area is the total heat sink surface area, equal to twice the actual surface area of one side of the heat sink. The modeled thickness of the center concrete portion is one-half of the actual thickness of the center concrete portion of the heat sink. And, the modeled outside boundary is the adiabatic (insulated) condition existing at the midplane of the symmetrical heat sink.

Heat Sink #18 describes the Unlined Refueling Canal Walls (below El. 63'6") as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 3700 $ft^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00192 ft (= 0.023 in) |
| Concrete (material 2) thickness-Right Boundary | 2.0 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated, no heat transfer across the heat sink centerline |

Due to an addition error, Calculation N-4080-002 (page 181) incorrectly modeled the right boundary coordinate of the Concrete Region at 2.00 feet. The determination of the right boundary coordinate of the Concrete region neglected to add the thickness of the Organic Paint Region. In this analysis the right boundary coordinate of the Concrete Region will be modeled at the correct position of 2.00192 feet:

Right Boundary Coordinate of Concrete Region = 2.0 ft + 0.00192 ft
= 2.00192 feet

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 18 is entered in the input data file as:

```
* HS #18 - UNLINED REFUELING CANAL WALLS BELOW El. 63'6"
 &LIST POOL=118001, 48, 4, 0, 0, 0, 0, 3700/
 &LIST POOL=118101, 5,  0.00192,     7,  0.02292,
                   15,  0.40192,    20,  2.00192/
 &LIST POOL=118201, 4, 2, 2, 2/
 &LIST POOL=118300, 0, 0/
 &LIST POOL=118400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 118400 is 9.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

### 8.1.27.19 HS #19 - Reactor Building Cylinder #3 (the Containment Section with Embedded Stiffeners between El. 29'6" and 112'0")

The characteristics of the Reactor Building Cylinder #3 (the Containment Section with Embedded Stiffeners between plant elevations 29'6" and 112'0") are as determined in Calculation N-4080-002 (Reference 6.1.f, pages 183 through 189) for Heat Sink 19, except for the thickness of the Containment Liner/Concrete air gap interface, and except for the thickness of the concrete layer.

Due to an addition error, Calculation N-4080-002 (page 188) improperly modeled the concrete layer as 3.56524 feet thick. In this analysis the concrete layer will be modeled as 4.21108 feet, corresponding to the average thickness that was actually determined in Calculation N-4080-002 (page 186). And, as discussed in Design Input Item 4.8.a, the effective thickness of the interface (air gap) will be 0.00035 feet. With these changes, Heat Sink #19 describes the Reactor Building Cylinder 3 as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 1590.68 ft$^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.00075 ft (= 0.009 in) |
| Carbon Steel (material 1) Liner thickness | 0.66667 ft (= 8 in) |
| Air Gap Interface (material 5) thickness | 0.00035 ft |
| Concrete (material 2) thickness-Right Boundary | 4.21108 ft |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Exposed to outside environment |

The effect of the changes in the air gap thickness is reflected in Card Series 119101. This Card Series defines the location of the right boundary and nodalization of each region. The air gap is the third region of Heat Sink 19. The increase in the modeled air gap thickness from 0.00017 feet to 0.00035 feet requires that the modeled location of the Region 3 right boundary be increased by 0.00018 feet. To maintain the correct thickness of each Region that follows the air gap region necessitates that the modeled locations of the right boundaries of these subsequent regions be increased by the same 0.00018 feet.

Due to an addition error, Calculation N-4080-002 (page 188) incorrectly modeled the right boundary coordinate of the Concrete Region at 4.23283 feet. The determination of the right

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 123

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

boundary coordinate of the Concrete region is based on adding the thickness of the Concrete Region to the thicknesses of the Organic Paint, Carbon Steel and Air Gap Interface regions. The original calculations considered a Carbon Steel thickness of 0.02083 feet rather than the correct thickness of 0.66667 feet. Correcting this error, and adjusting for the change in the Air Gap Interface Region thickness, allows for the calculation of a 7th Region right boundary coordinate of 4.87885 feet:

Right Boundary Coordinate = 0.00075 ft + 0.66667 ft + 0.00035 ft + 4.21108 ft
of Concrete Region = 4.87885 feet

The changes from the right boundary locations determined in Calculation N-4080-002 are:

| | |
|---|---|
| 1st Region: | no change in the right boundary location |
| 2nd Region: | no change in the right boundary location |
| 3rd Region: | right boundary shifted from 0.66759 to 0.66777 feet |
| 4th Region: | right boundary shifted from 0.70926 to 0.70944 feet |
| 5th Region: | right boundary shifted from 0.7926 to 0.79278 feet |
| 6th Region: | right boundary shifted from 1.4426 to 1.44278 feet |
| 7th Region: | right boundary shifted from 4.23283 to 4.87885 feet |

The Card Series set defining Heat Sink 19 is entered in the input data file as.

```
* HS #19 - REACTOR BLDG CYLINDER #3: SECTIONS WITH STIFFENERS
 &LIST POOL=119001, 100, 7, 0, 0, 0, 0, 1590.68/
 &LIST POOL=119101, 5, 0.00075,   20,  0.66742,   3,   0.66777,
                   15, 0.70944,   20,  0.79278,  16,  1.44278,
                   20, 4.87885/
 &LIST POOL=119201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=119300, 0, 0/
 &LIST POOL=119400, 9, 2, 1, 1/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 119400 is 9.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
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### 8.1.27.20 HS #20 - Vent Tunnels

The characteristics of the Vent Tunnels are as determined in Calculation N-4080-002 (Reference 6.1.g, pages 190 through 192) for Heat Sink 20.

Heat Sink #20 describes the Vent Tunnels as modeled:

| | |
|---|---|
| Geometry | Slab |
| Surface Area | 2827 $ft^2$ |
| Organic Paint (material 4) thickness-Left Boundary | 0.0005 ft (= 0.006 in) |
| Carbon Steel (material 1) thickness-Right Boundary | 0.03125 ft (= 0.375 in) |
| Left Boundary condition | Exposed to containment atmosphere |
| Right Boundary condition | Insulated (approximating an infinitely thick tunnel wall) |

Because there is no heat transfer across the right boundary, the bulk temperature control for the right boundary condition is not used by the COPATTA Code. Therefore, in this analysis the bulk temperature control for the right boundary condition is modeled as the containment vapor temperature for convective heat transfer or the saturation temperature at the containment steam partial pressure for condensing heat transfer (i.e., Option 2 for Item 5 of Card Series 1XX400). This differs from the modeling of Calculation N-4080-002, which employed Option 0 for Item 5 of Card Series 1XX400. Since the bulk temperature control for the right boundary condition has no meaning for this Heat Sink, the decision to model Item 5 with Option 2 rather than Option 0 has the beneficial consequence of allowing the use of any positive value to be modeled as the variable TCONT in Item 7 of Card Series 2.

The Card Series set defining Heat Sink 20 is entered in the input data file as:

```
* HS #20 - VENT TUNNELS
 &LIST POOL=120001, 23, 2, 0, 0, 0, 0, 2827/
 &LIST POOL=120101, 10, 0.0005,  12, 0.03175/
 &LIST POOL=120201, 4, 1/
 &LIST POOL=120300, 0, 0/
 &LIST POOL=120400, 9, 2, 0, 2/
```

As discussed in Design Input 4.8, the heat transfer coefficient control for the left boundary condition (adjacent to the organic paint) is modeled as the Uchida value. This is a condensing steam value dependent on the ratio of water vapor to air used in MSLB analyses. Therefore Item 2 in Card Series 120400 is 9.

### 8.1.28 CARD SERIES 410001: Table 15

Card Series 410001 is a table that is used to describe the material properties in the heat sink calculations. The Card Series 410001 table includes the following data entered in columnar form:

1. thermal conductivity (BTU/hr-ft-°F)
2. volumetric heat capacity (BTU/ft$^3$-°F)

```
&LIST POOL=410001,
                  25,       54,
                 0.8,       30,
                  10,       54,
                 0.1,       20,
              0.0174,   0.0103/
```

The entries in Card Series 410001 define five materials. These materials include:

ITEMS 2 and 3: Material 1 - Carbon Steel

Material 1 is defined as Carbon Steel. Per Design Input Item 4.14.a, the thermal conductivity and volumetric heat capacity of Carbon Steel are:

$k = 25$ BTU/hr-ft-°F
$\rho C_p = 54$ BTU/ft$^3$-°F

ITEMS 4 and 5: Material 2 - Concrete

Material 2 is defined as Concrete. Per Design Input Item 4.14.b, the thermal conductivity and volumetric heat capacity of Concrete are:

$k = 0.8$ BTU/hr-ft-°F
$\rho C_p = 30$ BTU/ft$^3$-°F

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Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 127

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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ITEMS 6 and 7: Material 3 - Stainless Steel

Material 3 is defined as Stainless Steel. Per Design Input Item 4.14.c, the thermal conductivity and volumetric heat capacity of Stainless Steel are:

k = 10 BTU/hr-ft-°F
$\rho C_p$ = 54 BTU/ft$^3$-°F

ITEMS 8 and 9: Material 4 - Organic Paint Coating

Material 4 is defined as Organic Paint Coating. Per Design Input Item 4.14.d, the thermal conductivity and volumetric heat capacity of Organic Paint Coating are:

k = 0.1 BTU/hr-ft-°F
$\rho C_p$ = 20 BTU/ft$^3$-°F

ITEMS 10 and 11: Material 5 - Air Gap (@ 200 °F)

Material 5 is defined as the Air Gap Interface between the Containment Building walls and the Carbon Steel Liner, at a containment air temperature of 200 °F. Per Design Input Item 4.14.e, the thermal conductivity and volumetric heat capacity of the Air Gap are:

k = 0.0174 BTU/hr-ft-°F
$\rho C_p$ = 0.0103 BTU/ft$^3$-°F

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

### 8.1.29 CARD SERIES 420001: Table 16

Card Series 420001 is used to specify arbitrary constant non-condensing heat transfer coefficients to be assumed at any heat sink surface. This table is required if a heat transfer coefficient control of 10 to 15 is specified for Items 2 or 4 in Card Series 1XX400. In this model, heat transfer coefficient controls other than 10 to 15 are specified for Items 2 and 4 in Card Series 1XX400. Therefore, this Card Series is not used.

### 8.1.30 CARD SERIES 430001: Table 17

Card Series 430001 is used to describe the time-dependent condensing heat transfer coefficients to be assumed at any heat sink surface. This table is required if a heat transfer coefficient control of 5 or 8 is specified for Items 2 or 4 in Card Series 1XX400. In this model, heat transfer coefficient controls other than 5 or 8 are specified for Items 2 and 4 in Card Series 1XX400. Therefore, this Card Series is not used.

### 8.1.31 CARD SERIES 440001: Table 18

Card Series 430001 is used to describe an additional set of time-dependent condensing heat transfer coefficients to be assumed at any heat sink surface. This table is required if a heat transfer coefficient control of 6 is specified for Items 2 or 4 in Card Series 1XX400. In this model, heat transfer coefficient controls other than 6 are specified for Items 2 and 4 in Card Series 1XX400. Therefore, this Card Series is not used.

### 8.1.32 CARD SERIES 450001: Table 19

Card Series 450001 is used to describe the temperature-dependent non-condensing heat transfer coefficients to be assumed at any heat sink surface. This table is required if a heat transfer coefficient control of 7 is specified for Items 2 or 4 in Card Series 1XX400. In this model, heat transfer coefficient controls other than 7 are specified for Items 2 and 4 in Card Series 1XX400. Therefore, this Card Series is not used.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R<br>E<br>V<br>⇓ |
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| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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### 8.1.33 CARD SERIES 500000: End Card

If heat sink data is used, this card must follow the complete set of base case data. Otherwise it may be omitted. In this calculation, heat sink data is used. The card contains the following fixed information in Columns 2 through 19:

```
&LIST POOL=500000/
```

## 9 COPATTA INPUT FILES

### INPUT FILE NAME: MSLB_N01.DAT

```
*MSLB CASE, 102% POWER, LOSS OF ONE COOLING TRAIN, OFFSITE POWER AVAIL.
 &LIST POOL=0,0,1,0,1,0,0,0,0/
 &LIST POOL=1,1E4,16.2,2.305E6,120,0.6,20,582.945,1,1,0,14.7,0.5/
 &LIST POOL=2,0,0,0,0,0,120,2E7/
 &LIST POOL=3,0,0,0,0,0,2E7,0,0,0,0/
 &LIST POOL=4,0,0,0,0,0,0,0,0,0,0,0,0,0/
 &LIST POOL=5,2,15,1E4,0,0,0,105/
 &LIST POOL=6,0,0,0/
 &LEAK NOPEN=0/
 &LIST POOL=101,
          0,      0,
        2E7,      0/
 &LIST POOL=201,
          0,      0,
        2E7,      0/
 &LIST POOL=301,
                    0,    5.145520E7,     1.195589E3,
                 0.22,    4.869032E7,     1.197482E3,
                 0.42,    4.622234E7,     1.198466E3,
                 0.62,    4.405936E7,     1.199410E3,
                 1.08,    4.003276E7,     1.201595E3,
                 1.58,    3.688855E7,     1.201757E3,
                 2.08,    3.445970E7,     1.202018E3,
                 2.58,    3.326288E7,     1.200986E3,
                 3.58,    3.152606E7,     1.201058E3,
                 4.58,    3.028468E7,     1.201655E3,
                 5.58,    2.940080E7,     1.201123E3,
                 6.58,    2.874870E7,     1.201126E3,
                 7.58,    2.706574E7,     1.204404E3,
                 8.58,    2.468326E7,     1.204367E3,
                 9.58,    2.294968E7,     1.204238E3,
                10.58,    2.160122E7,     1.203908E3,
                12.58,    1.943143E7,     1.203195E3,
                14.58,    1.765940E7,     1.202277E3,
                16.58,    1.637240E7,     1.201556E3,
                18.58,    1.544720E7,     1.200963E3,
                20.58,    1.473293E7,     1.200422E3,
                25.58,    1.327525E7,     1.198820E3,
                30.58,    1.221858E7,     1.197825E3,
                35.58,    1.146406E7,     1.196753E3,
                40.58,    1.059131E7,     1.195307E3,
                45.58,    9.801216E6,     1.194165E3,
                50.58,    9.132588E6,     1.193086E3,
                60.58,    8.280324E6,     1.190935E3,
                61.08,    7.245576E6,     1.190949E3,
                62.08,    5.803344E6,     1.189165E3,
                62.58,    3.238704E6,     1.184658E3,
                64.58,    3.948840E5,     1.179953E3,
                68.58,    1.074240E5,     1.251072E3,
                71.08,             0,              0,
                  2E7,             0,              0/
 &LIST POOL=401,
          0,      0,      0,
        2E7,      0,      0/
 &LIST POOL=501.
          0,      0,      0,
```

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Project or DCP/MMP SONGS Units 2 & 3    Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB    Sheet No. 131

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
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```
         2E7,     0,     0/
  &LIST POOL=601,
           0,     0,     0,
         2E7,     0,     0/
  &LIST POOL=701,
           0,     0,     0,     0,
         2E7,     0,     0,     0/
  &LIST POOL=801,
          0,        0,   0,    0,    100,    100,
         50,        0,   0,    0,    100,    100,
         50,  8.02E5,   0,    0,    100,    100,
        2E7,  8.02E5,   0,    0,    100,    100/
  &LIST POOL=901,
           0,     0,     0,
         2E7,     0,     0/
  &LIST POOL=1001,
           0,   100,   2.0,
          24,   100,   2.0/
  &LIST POOL=1101,1,21,105,
              105,         0,
              120,  1.670E6,
              130,  3.020E6,
              140,  4.570E6,
              150,  6.320E6,
              160,  8.270E6,
              170,  1.040E7,
              180,  1.273E7,
              190,  1.523E7,
              200,  1.788E7,
              210,  2.068E7,
              220,  2.361E7,
              230,  2.664E7,
              240,  2.974E7,
              250,  3.291E7,
              260,  3.611E7,
              270,  3.931E7,
              280,  4.252E7,
              287,  4.474E7,
              290,  4.569E7,
              300,  4.882E7/
  &LIST POOL=1201,
                0,  0.729,
              0.1,  0.737,
              0.2,  0.747,
              0.3,  0.757,
              0.4,  0.771,
              0.5,  0.788,
              0.6,  0.809,
              0.7,  0.832,
              0.8,  0.863,
              0.9,  0.912,
              1.0,  0.961,
              1.1,  0.983,
              1.2,  0.995,
              1.3,  1.000/
  &LIST POOL=9001,
                  5,  0.05,    0.1,  50,
                 10,  0.05,   0.25,  20,
                 15,  0.05,   0.50,  10,
                 20,  0.05,   0.50,  10,
                100,   0.1,    1.0,  10,
                200,   1.0,    5.0,  10,
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

```
             400,   1.0,   10.0,   5,
             700,   2.0,   20.0,   5,
             2E3,   5.0,   50.0,   1,
             1E4,  50.0,    500,   2,
             1E5,   250,    1E3,   4,
             1E6,   500,    1E4,   9,
             1E7,   500,    5E4,   9,
             2E7,   500,    5E4,   9/
 &LIST POOL=9999/
* HS #1 - REACTOR BUILDING DOME
 &LIST POOL=101001, 100, 7, 0, 0, 0, 0, 34693.22/
 &LIST POOL=101101, 5, 0.00075,   3,   0.02158,
                    3, 0.02193,  10,   0.06360,
                   20, 0.23028,  37,   1.00110,
                   21, 4.06363/
 &LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=101300, 0, 0/
 &LIST POOL=101400, 9, 2, 1, 1/
* HS #2 - CYLINDER WALL BETWEEN El. 29'6" AND 112'0"
 &LIST POOL=102001, 100, 7, 0, 0, 0, 0, 38120/
 &LIST POOL=102101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526/
 &LIST POOL=102201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=102300, 0, 0/
 &LIST POOL=102400, 9, 2, 1, 1/
* HS #3 - CYLINDER WALL BETWEEN El. 15'0" AND El. 29'6"
 &LIST POOL=103001, 100, 7, 0, 0, 0, 0, 6667.38/
 &LIST POOL=103101, 5, 0.00075,    3,  0.02158,
                    3, 0.02193,   10,  0.06360,
                   20, 0.14694,   37, 0.917761,
                   21, 4.35526/
 &LIST POOL=103201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=103300, 0, 0/
 &LIST POOL=103400, 9, 2, 0, 2/
* HS #4 - BASEMAT (OTHER THAN REACTOR BASEMAT)
 &LIST POOL=104001, 53, 5, 0, 0, 0, 0, 12800/
 &LIST POOL=104101, 3,  0.00067,   7,      0.1,
                   20,  1.52698,   2, 1.54781,
                   20, 11.02150/
 &LIST POOL=104201, 4, 2, 2, 1, 2/
 &LIST POOL=104300, 0, 0/
 &LIST POOL=104400, 3, 3, 0, 3/
* HS #5 - REACTOR BASEMAT & S.G. PEDESTALS
 &LIST POOL=105001, 70, 4, 0, 0, 0, 0, 1644/
 &LIST POOL=105101, 4, 0.00158,   10,      0.1,
                   30,    2.00,   25, 8.43092/
 &LIST POOL=105201, 4, 2, 2, 2/
 &LIST POOL=105300, 0, 0/
 &LIST POOL=105400, 3, 3, 0, 3/
* HS #6 - REACTOR CAVITY WALLS BELOW El. 15'0"
 &LIST POOL=106001, 93, 5, 1, 11.75, 0, 0, 21.5/
 &LIST POOL=106101, 5, 11.75192,    7, 11.77292,
                   30, 13.29923,   30, 19.29923,
                   20, 25.25192/
 &LIST POOL=106201, 4, 2, 2, 2, 2/
 &LIST POOL=106300, 0, 0/
 &LIST POOL=106400, 3, 3, 0, 3/
* HS #7 - REACTOR CAVITY WALLS ABOVE El. 15'0"
 &LIST POOL=107001, 68, 5, 0, 0, 0, 0, 2810/
 &LIST POOL=107101, 5, 0.00192,   7, 0.02292,
```

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

```
                     15, 0.40192,  20,    2.00,
                     20, 4.00192/
  &LIST POOL=107201, 4, 2, 2, 2, 2/
  &LIST POOL=107300, 0, 0/
  &LIST POOL=107400, 9, 2, 0, 2/
 * HS #8 - LINED REFUELING CANAL WALLS
  &LIST POOL=108001, 86, 6, 0, 0, 0, 0, 9200/
  &LIST POOL=108101, 5, 0.01563,    20,     0.1,
                     15, 0.41563,    20,    2.00,
                     20, 4.01563,     5, 4.01755/
  &LIST POOL=108201, 3, 2, 2, 2, 2, 4/
  &LIST POOL=108300, 0, 0/
  &LIST POOL=108400, 9, 2, 9, 2/
 * HS #9 - S.G. CMPRTMNT WALLS, UNLINED REFL CNL WALLS/OTH INT WALLS
  &LIST POOL=109001, 78, 4, 0, 0, 0, 0, 41976/
  &LIST POOL=109101, 5, 0.00192,    10, 0.04233,
                     12,     0.1,    50, 1.71876/
  &LIST POOL=109201, 4, 2, 2, 2/
  &LIST POOL=109300, 0, 0/
  &LIST POOL=109400, 9, 2, 0, 2/
 * HS #10 - FLOOR SLABS (OTHER THAN BASEMATS)
  &LIST POOL=110001, 67, 6, 0, 0, 0, 0, 17474/
  &LIST POOL=110101, 3, 0.00014, 5, 0.005348,
                     20, 0.105348, 15, 0.505348,
                     20, 1.505348, 3, 1.506015/
  &LIST POOL=110201, 4, 1, 2, 2, 2, 4/
  &LIST POOL=110300, 0, 0/
  &LIST POOL=110400, 9, 2, 9, 2/
 * HS #11 - LIFTING DEVICES (EXCEPT STAINLESS STEEL PARTS)
  &LIST POOL=111001, 17, 2, 0, 0, 0, 0, 57286/
  &LIST POOL=111101, 6, 0.00125, 10, 0.042917/
  &LIST POOL=111201, 4, 1/
  &LIST POOL=111300, 0, 0/
  &LIST POOL=111400, 9, 2, 0, 2/
 * HS #12 - MISCELLANEOUS CARBON STEEL - THICKNESS > 2.50 INCHES
  &LIST POOL=112001, 64, 4, 0, 0, 0, 0, 516/
  &LIST POOL=112101, 6, 0.0005, 17, 0.084,
                     15, 0.20, 25, 0.310849/
  &LIST POOL=112201, 4, 1, 1, 1/
  &LIST POOL=112300, 0, 0/
  &LIST POOL=112400, 9, 2, 0, 2/
 * HS #13 - MISCELLANEOUS CARBON STEEL: 1.00"<THICKNESS<2.50"
  &LIST POOL=113001, 32, 2, 0, 0, 0, 0, 12042/
  &LIST POOL=113101, 6, 0.00063, 25, 0.16967/
  &LIST POOL=113201, 4, 1/
  &LIST POOL=113300, 0, 0/
  &LIST POOL=113400, 9, 2, 0, 2/
 * HS #14 - MISCELLANEOUS CARBON STEEL: 0.50"<THICKNESS<1.00"
  &LIST POOL=114001, 19, 2, 0, 0, 0, 0, 64693/
  &LIST POOL=114101, 5, 0.000674, 13, 0.038607/
  &LIST POOL=114201, 4, 1/
  &LIST POOL=114300, 0, 0/
  &LIST POOL=114400, 9, 2, 0, 2/
 * HS #15 - MISCELLANEOUS CARBON STEEL: THICKNESS<0.5"
  &LIST POOL=115001, 17, 2, 0, 0, 0, 0, 98913.6/
  &LIST POOL=115101, 6, 0.000606, 10, 0.012833/
  &LIST POOL=115201, 4, 1/
  &LIST POOL=115300, 0, 0/
  &LIST POOL=115400, 9, 2, 0, 2/
 * HS #16 - ELECTRICAL EQUIPMENT
  &LIST POOL=116001, 8, 1, 0, 0, 0, 0, 37644.5/
  &LIST POOL=116101, 7, 0.0054/
```

```
 &LIST POOL=116201, 1/
 &LIST POOL=116300, 0, 0/
 &LIST POOL=116400, 9, 2, 0, 2/
* HS #17 - MISCELLANEOUS STAINLESS STEEL
 &LIST POOL=117001, 16, 1, 0, 0, 0, 0, 24048/
 &LIST POOL=117101, 15, 0.01747/
 &LIST POOL=117201, 3/
 &LIST POOL=117300, 0, 0/
 &LIST POOL=117400, 9, 2, 0, 2/
* HS #18 - UNLINED REFUELING CANAL WALLS BELOW El. 63'6"
 &LIST POOL=118001, 48, 4, 0, 0, 0, 0, 3700/
 &LIST POOL=118101, 5, 0.00192, 7, 0.02292,
                   15, 0.40192, 20, 2.00192/
 &LIST POOL=118201, 4, 2, 2, 2/
 &LIST POOL=118300, 0, 0/
 &LIST POOL=118400, 9, 2, 0, 2/
* HS #19 - REACTOR BLDG CYLINDER #3: SECTIONS WITH STIFFENERS
 &LIST POOL=119001, 100, 7, 0, 0, 0, 0, 1590.68/
 &LIST POOL=119101, 5, 0.00075,   20,  0.66742,   3,   0.66777,
                   15, 0.70944,   20,  0.79278,  16,  1.44278,
                   20, 4.87885/
 &LIST POOL=119201, 4, 1, 5, 2, 2, 2, 2/
 &LIST POOL=119300, 0, 0/
 &LIST POOL=119400, 9, 2, 1, 1/
* HS #20 - VENT TUNNELS
 &LIST POOL=120001, 23, 2, 0, 0, 0, 0, 2827/
 &LIST POOL=120101, 10, 0.0005,  12, 0.03175/
 &LIST POOL=120201, 4, 1/
 &LIST POOL=120300, 0, 0/
 &LIST POOL=120400, 9, 2, 0, 2/
 &LIST POOL=410001,
            25,     54,
           0.8,     30,
            10,     54,
           0.1,     20,
        0.0174, 0.0103/
 &LIST POOL=500000/
```

## 10 SELECTED OUTPUT DATA

The tabulated data presented in Sections 10.1 and 10.2 consists of partial output of the COPATTA code. This data is then used as the input to the plots in Section 2.

All values are taken directly from output files produced by the COPLOTTA (Ref. 6.5.a pg. E-3) program in conjunction with the COPATTA output file except the gauge pressure with respect to the outside atmosphere (psig w/r 14.7 psia). The COPATTA output file assumes that the initial containment pressure is the reference pressure for determining gauge pressure. Because this analysis is concerned with the pressure differential across the containment structure, 1.5 psi is added to the gauge pressure presented in the COPATTA output (psig w/r 16.2 psia).

10.1

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 0.05 | -1.0e-07 | 123.329 | 16.4013 | 1.701269 | 118.3676 | 7.65926 |
| 0.1 | -1.0e-07 | 126.654 | 16.6006 | 1.900648 | 118.3676 | 8.07424 |
| 0.2 | -1.0e-07 | 133.06 | 16.992 | 2.291994 | 118.3676 | 9.24911 |
| 0.3 | -1.0e-07 | 139.155 | 17.3734 | 2.67341 | 118.3676 | 9.77065 |
| 0.4 | 122.262 | 144.967 | 17.7452 | 3.0452 | 118.3676 | 10.6752 |
| 0.5 | 125.256 | 150.503 | 18.1074 | 3.40736 | 118.3676 | 11.9305 |
| 0.6 | 127.832 | 155.788 | 18.4607 | 3.7607 | 118.3676 | 12.9467 |
| 0.7 | 130.22 | 160.842 | 18.8057 | 4.10575 | 118.3676 | 13.7865 |
| 0.8 | 132.398 | 165.692 | 19.1436 | 4.44364 | 118.3676 | 14.4938 |
| 0.9 | 134.492 | 170.35 | 19.4745 | 4.77447 | 118.3676 | 15.0974 |
| 1 | 136.438 | 174.822 | 19.7982 | 5.09819 | 118.3676 | 15.6182 |
| 1.1 | 138.237 | 179.119 | 20.1149 | 5.41489 | 118.3676 | 16.0718 |
| 1.2 | 139.949 | 183.255 | 20.4256 | 5.72557 | 118.3676 | 16.4719 |
| 1.3 | 141.605 | 187.241 | 20.7308 | 6.03076 | 118.3676 | 16.8278 |
| 1.4 | 143.226 | 191.085 | 21.0305 | 6.33054 | 118.3676 | 17.2929 |
| 1.5 | 144.784 | 194.791 | 21.3248 | 6.62481 | 118.3676 | 17.8663 |
| 1.6 | 146.264 | 198.365 | 21.6137 | 6.9137 | 118.3676 | 18.3849 |
| 1.7 | 147.686 | 201.823 | 21.898 | 7.19796 | 118.3676 | 18.8571 |
| 1.8 | 149.062 | 205.173 | 22.178 | 7.47799 | 118.3676 | 19.2894 |
| 1.9 | 150.401 | 208.42 | 22.4539 | 7.75388 | 118.3676 | 19.6864 |

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CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 136

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 2 | 151.692 | 211.566 | 22.7255 | 8.0255 | 118.3676 | 20.0522 |
| 2.1 | 152.926 | 214.616 | 22.9929 | 8.29293 | 118.3676 | 20.3903 |
| 2.2 | 154.115 | 217.583 | 23.2574 | 8.55742 | 118.3676 | 20.7051 |
| 2.3 | 155.266 | 220.475 | 23.5195 | 8.81948 | 118.3676 | 20.9996 |
| 2.4 | 156.392 | 223.296 | 23.7793 | 9.07927 | 118.3676 | 21.4134 |
| 2.5 | 157.493 | 226.045 | 24.0365 | 9.33651 | 118.3676 | 21.8023 |
| 2.6 | 158.553 | 228.725 | 24.2913 | 9.59132 | 118.3676 | 22.1681 |
| 2.7 | 159.576 | 231.346 | 24.5442 | 9.84423 | 118.3676 | 22.5134 |
| 2.8 | 160.569 | 233.913 | 24.7955 | 10.09545 | 118.3676 | 22.8399 |
| 2.9 | 161.536 | 236.428 | 25.0452 | 10.34519 | 118.3676 | 23.1493 |
| 3 | 162.479 | 238.89 | 25.2931 | 10.59308 | 118.3676 | 23.4427 |
| 3.1 | 163.402 | 241.302 | 25.5393 | 10.8393 | 118.3676 | 23.7214 |
| 3.2 | 164.307 | 243.665 | 25.7839 | 11.08386 | 118.3676 | 23.9864 |
| 3.3 | 165.201 | 245.984 | 26.027 | 11.32699 | 118.3676 | 24.3979 |
| 3.4 | 166.086 | 248.254 | 26.2682 | 11.5682 | 118.3676 | 24.7988 |
| 3.5 | 166.963 | 250.48 | 26.5078 | 11.8078 | 118.3676 | 25.1812 |
| 3.6 | 167.828 | 252.661 | 26.7458 | 12.0458 | 118.3676 | 25.5464 |
| 3.7 | 168.671 | 254.802 | 26.9824 | 12.2824 | 118.3676 | 25.896 |
| 3.8 | 169.494 | 256.909 | 27.218 | 12.518 | 118.3676 | 26.231 |
| 3.9 | 170.3 | 258.978 | 27.4522 | 12.7522 | 118.3676 | 26.5524 |
| 4 | 171.09 | 261.011 | 27.6852 | 12.9852 | 118.3676 | 26.861 |
| 4.1 | 171.866 | 263.009 | 27.917 | 13.217 | 118.3676 | 27.1575 |
| 4.2 | 172.629 | 264.976 | 28.1479 | 13.4479 | 118.3676 | 27.4426 |
| 4.3 | 173.379 | 266.908 | 28.3773 | 13.6773 | 118.3676 | 27.717 |
| 4.4 | 174.119 | 268.809 | 28.6056 | 13.9056 | 118.3676 | 27.9811 |
| 4.5 | 174.848 | 270.678 | 28.8328 | 14.1328 | 118.3676 | 28.2357 |
| 4.6 | 175.568 | 272.516 | 29.0587 | 14.3587 | 118.3676 | 28.4811 |
| 4.7 | 176.279 | 274.324 | 29.284 | 14.584 | 118.3676 | 28.7182 |
| 4.8 | 176.976 | 276.106 | 29.5081 | 14.8081 | 118.3676 | 28.9472 |
| 4.9 | 177.661 | 277.857 | 29.7311 | 15.0311 | 118.3676 | 29.3858 |
| 5 | 178.34 | 279.58 | 29.9531 | 15.2531 | 134.467 | 29.8756 |
| 5.25 | 180.003 | 283.769 | 30.5038 | 15.8038 | 134.467 | 31.0332 |
| 5.5 | 181.623 | 287.798 | 31.0489 | 16.3489 | 134.467 | 32.1034 |
| 5.75 | 183.202 | 291.673 | 31.5878 | 16.8878 | 134.467 | 33.0962 |

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 137

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

R E V ⇓

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 6 | 184.731 | 295.414 | 32.122 | 17.422 | 134.467 | 34.021 |
| 6.25 | 186.201 | 299.03 | 32.6522 | 17.9522 | 134.467 | 34.8847 |
| 6.5 | 187.622 | 302.522 | 33.1773 | 18.4773 | 134.467 | 35.6932 |
| 6.75 | 188.998 | 305.897 | 33.6972 | 18.9972 | 134.467 | 36.4499 |
| 7 | 190.336 | 309.168 | 34.21 | 19.51 | 134.467 | 37.2438 |
| 7.25 | 191.646 | 312.33 | 34.7142 | 20.0142 | 134.467 | 38.2796 |
| 7.5 | 192.93 | 315.39 | 35.2103 | 20.5103 | 134.467 | 39.2477 |
| 7.75 | 194.18 | 318.343 | 35.6973 | 20.9973 | 134.467 | 40.1527 |
| 8 | 195.385 | 321.166 | 36.1733 | 21.4733 | 134.467 | 40.9962 |
| 8.25 | 196.547 | 323.85 | 36.6356 | 21.9356 | 134.467 | 41.7833 |
| 8.5 | 197.67 | 326.407 | 37.0853 | 22.3853 | 134.467 | 42.5188 |
| 8.75 | 198.755 | 328.852 | 37.5235 | 22.8235 | 134.467 | 43.2081 |
| 9 | 199.806 | 331.198 | 37.9523 | 23.2523 | 134.467 | 43.8581 |
| 9.25 | 200.825 | 333.449 | 38.372 | 23.672 | 134.467 | 44.472 |
| 9.5 | 201.814 | 335.613 | 38.7825 | 24.0825 | 134.467 | 45.0522 |
| 9.75 | 202.774 | 337.701 | 39.1862 | 24.4862 | 134.467 | 45.6019 |
| 10 | 203.707 | 339.706 | 39.5807 | 24.8807 | 150.5152 | 46.2353 |
| 10.5 | 205.52 | 343.504 | 40.3475 | 25.6475 | 150.5152 | 48.0698 |
| 11 | 207.262 | 347.04 | 41.0863 | 26.3863 | 150.5152 | 49.7396 |
| 11.5 | 208.921 | 350.35 | 41.801 | 27.101 | 150.5152 | 51.2703 |
| 12 | 210.489 | 353.461 | 42.4941 | 27.7941 | 150.5152 | 52.6774 |
| 12.5 | 211.974 | 356.364 | 43.1615 | 28.4615 | 150.5152 | 53.9735 |
| 13 | 213.384 | 359.092 | 43.8071 | 29.1071 | 150.5152 | 55.1722 |
| 13.5 | 214.727 | 361.661 | 44.4333 | 29.7333 | 150.5152 | 56.2865 |
| 14 | 216.01 | 364.082 | 45.0402 | 30.3402 | 150.5152 | 57.3242 |
| 14.5 | 217.239 | 366.377 | 45.6307 | 30.9307 | 150.5152 | 58.2917 |
| 15 | 218.421 | 368.534 | 46.2014 | 31.5014 | 163.8227 | 59.1971 |
| 15.5 | 219.584 | 370.57 | 46.7556 | 32.0555 | 163.8227 | 60.047 |
| 16 | 220.695 | 372.501 | 47.2956 | 32.5956 | 163.8227 | 60.8486 |
| 16.5 | 221.754 | 374.34 | 47.8222 | 33.1222 | 163.8227 | 61.6054 |
| 17 | 222.766 | 376.092 | 48.3384 | 33.6384 | 163.8227 | 62.3222 |
| 17.5 | 223.738 | 377.784 | 48.8431 | 34.1431 | 163.8227 | 63.0092 |
| 18 | 224.675 | 379.393 | 49.3369 | 34.6369 | 163.8227 | 64.3464 |
| 18.5 | 225.583 | 380.932 | 49.8201 | 35.1201 | 163.3227 | 65.6197 |

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 138

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

REV ⇓

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 19 | 226.464 | 382.404 | 50.2934 | 35.5934 | 163.8227 | 66.8348 |
| 19.5 | 227.319 | 383.825 | 50.7586 | 36.0586 | 163.8227 | 67.998 |
| 20 | 228.15 | 385.179 | 51.2148 | 36.5148 | 174.6759 | 69.1125 |
| 21 | 229.748 | 387.75 | 52.1043 | 37.4043 | 174.6759 | 71.2276 |
| 22 | 231.255 | 390.142 | 52.9661 | 38.2661 | 174.6759 | 73.1655 |
| 23 | 232.673 | 392.223 | 53.7636 | 39.0636 | 174.6759 | 74.9654 |
| 24 | 234.009 | 394.292 | 54.5721 | 39.8721 | 174.6759 | 76.6404 |
| 25 | 235.276 | 396.219 | 55.3554 | 40.6554 | 174.6759 | 78.2016 |
| 26 | 236.482 | 398.013 | 56.1143 | 41.4143 | 174.6759 | 79.66 |
| 27 | 237.633 | 399.702 | 56.854 | 42.154 | 174.6759 | 81.0319 |
| 28 | 238.735 | 401.29 | 57.5755 | 42.8755 | 174.6759 | 82.3258 |
| 29 | 239.787 | 402.783 | 58.2793 | 43.5793 | 174.6759 | 83.5478 |
| 30 | 240.788 | 404.195 | 58.9661 | 44.2661 | 192.9141 | 84.7033 |
| 31 | 241.744 | 405.527 | 59.6363 | 44.9363 | 192.9141 | 85.7976 |
| 32 | 242.662 | 406.791 | 60.2935 | 45.5935 | 192.9141 | 86.84 |
| 33 | 243.545 | 407.992 | 60.9383 | 46.2383 | 192.9141 | 87.8346 |
| 34 | 244.397 | 409.133 | 61.571 | 46.871 | 192.9141 | 88.7846 |
| 35 | 245.219 | 410.217 | 62.1917 | 47.4917 | 192.9141 | 89.6925 |
| 36 | 246.015 | 411.248 | 62.8005 | 48.1005 | 192.9141 | 90.5605 |
| 37 | 246.784 | 412.224 | 63.3963 | 48.6963 | 192.9141 | 91.3895 |
| 38 | 247.525 | 413.15 | 63.979 | 49.279 | 192.9141 | 92.1814 |
| 39 | 248.24 | 414.021 | 64.5484 | 49.8484 | 192.9141 | 92.9385 |
| 40 | 248.932 | 414.84 | 65.1046 | 50.4046 | 206.8357 | 93.6625 |
| 41 | 249.601 | 415.617 | 65.6484 | 50.9484 | 206.8357 | 94.3554 |
| 42 | 250.249 | 416.352 | 66.1804 | 51.4804 | 206.8357 | 95.0197 |
| 43 | 250.876 | 417.052 | 66.7013 | 52.0013 | 206.8357 | 95.657 |
| 44 | 251.484 | 417.717 | 67.211 | 52.511 | 206.8357 | 96.2688 |
| 45 | 252.075 | 418.348 | 67.7096 | 53.0096 | 206.8357 | 96.8561 |
| 46 | 252.65 | 418.943 | 68.197 | 53.497 | 206.8357 | 97.4203 |
| 47 | 253.21 | 419.506 | 68.6747 | 53.9747 | 206.8357 | 97.9638 |
| 48 | 253.756 | 420.041 | 69.1428 | 54.4428 | 206.8357 | 98.9752 |
| 49 | 254.29 | 420.545 | 69.6009 | 54.9009 | 206.8357 | 99.9845 |
| 50 | 254.811 | 421.024 | 70.0495 | 55.3495 | 218.549 | 100.957 |
| 51 | 255.321 | 419.305 | 70.3583 | 55.6583 | 218.549 | 102.008 |

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CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 139

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

R E V ⇓

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 52 | 255.816 | 417.525 | 70.6546 | 55.9546 | 218.549 | 103.028 |
| 53 | 256.299 | 415.765 | 70.9459 | 56.2459 | 218.549 | 104.018 |
| 54 | 256.77 | 414.02 | 71.2315 | 56.5315 | 218.549 | 104.979 |
| 55 | 257.229 | 412.293 | 71.512 | 56.812 | 218.549 | 105.913 |
| 56 | 257.677 | 410.587 | 71.7876 | 57.0876 | 218.549 | 106.821 |
| 57 | 258.115 | 408.899 | 72.0584 | 57.3584 | 218.549 | 107.703 |
| 58 | 258.541 | 407.227 | 72.324 | 57.624 | 218.549 | 108.561 |
| 59 | 258.958 | 405.568 | 72.5841 | 57.8841 | 218.549 | 109.395 |
| 60 | 259.366 | 403.929 | 72.8397 | 58.1397 | 228.8108 | 110.206 |
| 61 | 259.762 | 402.283 | 73.0781 | 58.3781 | 228.8108 | 110.976 |
| 62 | 260.147 | 400.462 | 73.2126 | 58.5126 | 228.8108 | 111.562 |
| 63 | 260.517 | 398.286 | 73.1564 | 58.4564 | 228.8108 | 111.831 |
| 64 | 260.867 | 395.859 | 72.9588 | 58.2588 | 228.8108 | 111.866 |
| 65 | 261.197 | 393.296 | 72.6742 | 57.9742 | 228.8108 | 111.752 |
| 66 | 261.507 | 390.724 | 72.3741 | 57.6741 | 228.8108 | 111.607 |
| 67 | 261.798 | 388.16 | 72.073 | 57.373 | 228.8108 | 111.458 |
| 68 | 262.07 | 385.597 | 71.7707 | 57.0707 | 228.8108 | 111.305 |
| 69 | 262.325 | 383.012 | 71.4651 | 56.7651 | 228.8108 | 111.149 |
| 70 | 262.564 | 380.356 | 71.1533 | 56.4533 | 233.5631 | 110.991 |
| 71 | 262.789 | 377.713 | 70.8425 | 56.1425 | 233.5631 | 110.831 |
| 72 | 263 | 375.124 | 70.5376 | 55.8376 | 233.5631 | 110.672 |
| 73 | 263.198 | 372.544 | 70.2358 | 55.5358 | 233.5631 | 110.517 |
| 74 | 263.384 | 369.976 | 69.9371 | 55.2371 | 233.5631 | 110.365 |
| 75 | 263.559 | 367.413 | 69.6411 | 54.9411 | 233.5631 | 110.216 |
| 76 | 263.724 | 364.856 | 69.3478 | 54.6478 | 233.5631 | 110.071 |
| 77 | 263.879 | 362.311 | 69.0578 | 54.3578 | 233.5631 | 109.929 |
| 78 | 264.025 | 359.771 | 68.7701 | 54.0701 | 233.5631 | 109.79 |
| 79 | 264.162 | 357.242 | 68.4852 | 53.7852 | 233.5631 | 109.654 |
| 80 | 264.292 | 354.72 | 68.2029 | 53.5029 | 235.9147 | 109.521 |
| 81 | 264.413 | 352.21 | 67.9234 | 53.2234 | 235.9147 | 109.391 |
| 82 | 264.528 | 349.706 | 67.6465 | 52.9465 | 235.9147 | 109.265 |
| 83 | 264.636 | 347.211 | 67.3717 | 52.6717 | 235.9147 | 109.141 |
| 84 | 264.737 | 344.724 | 67.0994 | 52.3994 | 235.9147 | 109.019 |
| 85 | 264.833 | 342.246 | 66.8296 | 52.1296 | 235.9147 | 108.901 |

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CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 140

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 86 | 264.923 | 339.777 | 66.5621 | 51.8621 | 235.9147 | 108.785 |
| 87.00001 | 265.007 | 337.316 | 66.2969 | 51.5969 | 235.9147 | 108.673 |
| 88 | 265.087 | 335.017 | 66.0851 | 51.3851 | 235.9147 | 108.562 |
| 89 | 265.163 | 332.568 | 65.8237 | 51.1237 | 235.9147 | 108.454 |
| 90 | 265.233 | 330.128 | 65.5644 | 50.8644 | 237.6333 | 108.349 |
| 91 | 265.3 | 327.691 | 65.3068 | 50.6068 | 237.6333 | 108.246 |
| 92.00001 | 265.363 | 325.265 | 65.0516 | 50.3516 | 237.6333 | 108.145 |
| 93 | 265.421 | 322.843 | 64.798 | 50.0979 | 237.6333 | 108.047 |
| 94 | 265.476 | 320.427 | 64.5461 | 49.8461 | 237.6333 | 107.952 |
| 95 | 265.527 | 317.979 | 64.2839 | 49.5839 | 237.6333 | 107.858 |
| 96 | 265.575 | 315.577 | 64.0356 | 49.3356 | 237.6333 | 107.768 |
| 97 | 265.619 | 313.185 | 63.7894 | 49.0894 | 237.6333 | 107.679 |
| 98 | 265.661 | 310.795 | 63.5444 | 48.8444 | 237.6333 | 107.593 |
| 99 | 265.699 | 308.417 | 63.3017 | 48.6017 | 237.6333 | 107.508 |
| 100 | 265.735 | 306.025 | 63.0538 | 48.3538 | 238.7824 | 107.426 |
| 105 | 265.872 | 294.822 | 61.9142 | 47.2142 | 238.7824 | 107.194 |
| 110 | 265.958 | 283.128 | 60.7529 | 46.0529 | 238.7824 | 106.856 |
| 115 | 266.003 | 272.393 | 59.6665 | 44.9665 | 238.7824 | 106.563 |
| 120 | 266.032 | 267.123 | 58.9567 | 44.2567 | 238.7824 | 105.696 |
| 125 | 266.034 | 266.562 | 58.5725 | 43.8725 | 238.7824 | 104.797 |
| 130 | 266.013 | 266.019 | 58.2038 | 43.5038 | 238.7824 | 103.92 |
| 135 | 265.973 | 265.493 | 57.8489 | 43.1489 | 238.7824 | 103.06 |
| 140 | 265.917 | 264.982 | 57.5066 | 42.8066 | 238.7824 | 102.217 |
| 145 | 265.849 | 264.485 | 57.176 | 42.476 | 238.7824 | 101.391 |
| 150 | 265.769 | 264 | 56.8555 | 42.1555 | 241.4326 | 100.588 |
| 155 | 265.679 | 263.527 | 56.5446 | 41.8446 | 241.4326 | 99.7883 |
| 160 | 265.584 | 263.23 | 56.3501 | 41.6501 | 241.4326 | 99.0251 |
| 165 | 265.484 | 262.777 | 56.0557 | 41.3557 | 241.4326 | 98.204 |
| 170 | 265.377 | 262.333 | 55.7685 | 41.0685 | 241.4326 | 97.7185 |
| 175 | 265.265 | 261.898 | 55.4887 | 40.7887 | 241.4326 | 97.343 |
| 180 | 265.149 | 261.472 | 55.216 | 40.516 | 241.4326 | 96.9662 |
| 185 | 265.029 | 261.054 | 54.95 | 40.25 | 241.4326 | 96.5938 |
| 190 | 264.905 | 260.643 | 54.6903 | 39.9903 | 241.4326 | 96.2254 |
| 195 | 264.779 | 260.241 | 54.4369 | 39.7369 | 241.4326 | 95.861 |

NES&L DEPARTMENT

# CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.

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Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 141

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

REV ⇓

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 200 | 264.65 | 259.845 | 54.1893 | 39.4893 | 241.9631 | 95.5004 |
| 210 | 264.385 | 259.074 | 53.7106 | 39.0106 | 241.9631 | 94.7904 |
| 220 | 264.111 | 258.33 | 53.2533 | 38.5533 | 241.9631 | 94.0954 |
| 230 | 263.83 | 257.612 | 52.8157 | 38.1157 | 241.9631 | 93.4144 |
| 240 | 263.544 | 256.916 | 52.3963 | 37.6963 | 241.9631 | 92.7467 |
| 250 | 263.256 | 256.242 | 51.9936 | 37.2936 | 241.2001 | 92.0912 |
| 260 | 262.965 | 255.589 | 51.6063 | 36.9063 | 241.2001 | 91.4543 |
| 270 | 262.673 | 254.953 | 51.2332 | 36.5332 | 241.2001 | 90.822 |
| 280 | 262.389 | 254.502 | 50.9702 | 36.2702 | 241.2001 | 90.1887 |
| 290 | 262.098 | 253.897 | 50.6201 | 35.9201 | 241.2001 | 89.5724 |
| 300 | 261.806 | 253.308 | 50.2815 | 35.5815 | 240.0503 | 88.9708 |
| 310 | 261.512 | 252.733 | 49.9542 | 35.2542 | 240.0503 | 88.3715 |
| 320 | 261.217 | 252.172 | 49.6368 | 34.9368 | 240.0503 | 87.7787 |
| 330 | 260.922 | 251.623 | 49.3289 | 34.6289 | 240.0503 | 87.193 |
| 340 | 260.626 | 251.086 | 49.0297 | 34.3297 | 240.0503 | 86.6137 |
| 350 | 260.331 | 250.56 | 48.7389 | 34.0389 | 238.6837 | 86.0405 |
| 360 | 260.037 | 250.045 | 48.4561 | 33.7561 | 238.6837 | 85.4731 |
| 370 | 259.743 | 249.541 | 48.1812 | 33.4812 | 238.6837 | 84.9118 |
| 380 | 259.45 | 249.047 | 47.9138 | 33.2138 | 238.6837 | 84.3567 |
| 390 | 259.157 | 248.563 | 47.6533 | 32.9533 | 238.6837 | 83.807 |
| 400 | 258.863 | 248.087 | 47.3994 | 32.6994 | 237.136 | 83.2626 |
| 420 | 258.268 | 247.159 | 46.908 | 32.208 | 237.136 | 82.1913 |
| 440 | 257.666 | 246.256 | 46.4357 | 31.7357 | 237.136 | 81.1311 |
| 460 | 257.06 | 245.375 | 45.9809 | 31.2809 | 237.136 | 80.0729 |
| 480 | 256.455 | 244.684 | 45.6283 | 30.9283 | 237.136 | 79.0063 |
| 500 | 255.847 | 243.838 | 45.201 | 30.501 | 234.1299 | 77.9553 |
| 520 | 255.239 | 243.01 | 44.7876 | 30.0876 | 234.1299 | 76.9162 |
| 540 | 254.63 | 242.2 | 44.3875 | 29.6875 | 234.1299 | 75.8739 |
| 560 | 254.022 | 241.406 | 43.9996 | 29.2996 | 234.1299 | 74.8371 |
| 580 | 253.415 | 240.623 | 43.6215 | 28.9215 | 234.1299 | 73.7976 |
| 600 | 252.809 | 239.85 | 43.2525 | 28.5525 | 231.2043 | 72.7557 |
| 620 | 252.206 | 239.09 | 42.8929 | 28.1929 | 231.2043 | 71.7136 |
| 640 | 251.604 | 238.34 | 42.5425 | 27.8425 | 231.2043 | 70.6714 |
| 660 | 251.005 | 237.602 | 42.2007 | 27.5007 | 231.2043 | 69.6284 |

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# CALCULATION SHEET

ICCN NO./
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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 142

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 680 | 250.409 | 236.873 | 41.8671 | 27.1671 | 231.2043 | 68.5844 |
| 700 | 249.814 | 236.154 | 41.541 | 26.841 | 228.0915 | 67.5469 |
| 750.0001 | 248.347 | 234.391 | 40.7559 | 26.0559 | 226.5721 | 64.9502 |
| 800 | 246.923 | 232.846 | 40.0842 | 25.3842 | 225.1947 | 62.6494 |
| 850 | 245.539 | 231.16 | 39.3675 | 24.6675 | 223.8459 | 61.3454 |
| 900 | 244.191 | 229.51 | 38.6827 | 23.9827 | 222.5382 | 60.0193 |
| 950 | 242.876 | 227.893 | 38.0275 | 23.3275 | 221.2714 | 58.6769 |
| 1000 | 241.595 | 226.316 | 37.403 | 22.703 | 219.9015 | 57.3202 |
| 1050 | 240.35 | 224.778 | 36.8077 | 22.1077 | 218.5336 | 55.9533 |
| 1100 | 239.132 | 223.274 | 36.2384 | 21.5384 | 217.1893 | 54.5785 |
| 1150 | 237.943 | 221.801 | 35.693 | 20.993 | 215.8755 | 53.1855 |
| 1200 | 236.788 | 220.694 | 35.2359 | 20.5359 | 214.6037 | 51.8467 |
| 1250 | 235.657 | 219.11 | 34.7265 | 20.0265 | 213.426 | 50.328 |
| 1300 | 234.555 | 217.706 | 34.2373 | 19.5373 | 212.2342 | 48.8724 |
| 1350 | 233.479 | 216.325 | 33.7663 | 19.0663 | 211.0605 | 47.402 |
| 1400 | 232.427 | 214.967 | 33.3123 | 18.6123 | 209.9121 | 45.9508 |
| 1450 | 231.396 | 213.624 | 32.8725 | 18.1725 | 208.8205 | 45.1444 |
| 1500 | 230.387 | 212.297 | 32.4462 | 17.7462 | 207.7213 | 44.3234 |
| 1550 | 229.398 | 210.992 | 32.0356 | 17.3356 | 206.5757 | 43.4927 |
| 1600 | 228.427 | 209.709 | 31.6396 | 16.9396 | 205.4384 | 42.6519 |
| 1650 | 227.477 | 208.444 | 31.2567 | 16.5567 | 204.3196 | 41.7995 |
| 1700 | 226.545 | 207.308 | 30.9193 | 16.2193 | 203.2474 | 40.93 |
| 1750 | 225.633 | 206.068 | 30.5574 | 15.8574 | 202.1972 | 40.0527 |
| 1800 | 224.737 | 204.843 | 30.2069 | 15.5069 | 201.16 | 39.157 |
| 1850 | 223.858 | 203.634 | 29.8671 | 15.1671 | 200.1397 | 38.2473 |
| 1900 | 222.993 | 202.439 | 29.5373 | 14.8373 | 199.14 | 37.3232 |
| 1950 | 222.143 | 201.258 | 29.2175 | 14.5175 | 198.1405 | 36.6098 |
| 2000 | 221.308 | 200.097 | 28.9088 | 14.2088 | 197.1225 | 36.0083 |
| 2500 | 213.801 | 190.458 | 26.5621 | 11.8621 | 197.1225 | 30.2915 |
| 3000 | 207.362 | 181.754 | 24.7231 | 10.02306 | 181.1839 | 26.7457 |
| 3500 | 201.666 | 173.49 | 23 2008 | 8.50083 | 181.1839 | 23.6625 |
| 4000 | 196.528 | 165.723 | 21.9464 | 7.24638 | 169.9794 | 21.4053 |
| 4500 | 191.848 | 158.642 | 20.9355 | 6.23548 | 169.9794 | 19.6263 |
| 5000 | 187.559 | 152.523 | 20.1542 | 5.45418 | 161.8639 | 17.8988 |

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## CALCULATION SHEET

| ICCN NO./<br>PRELIM. CCN NO. | PAGE___ OF___ |
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| CCN CONVERSION:<br>CCN NO. CCN -- | |

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 143

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | SUMP TEMP (DEG-F) | VAPOR TEMP (DEG-F) | TOTAL PRESSURE (PSIA) | GAUGE PRESSURE PSIG (W/R 14.7 psia) | LEFT BOUNDARY TEMPERATURE HS#1 (DEG-F) | UCHIDA CONDENSING HTC (BTU/FT2-F-HR) |
|---|---|---|---|---|---|---|
| 5500 | 183.616 | 147.184 | 19.5358 | 4.83585 | 161.8639 | 16.6032 |
| 6000 | 179.988 | 142.745 | 19.0641 | 4.3641 | 155.6648 | 15.7554 |
| 6500 | 176.648 | 139.006 | 18.6948 | 3.99481 | 155.6648 | 14.977 |
| 7000 | 173.571 | 135.898 | 18.3979 | 3.69794 | 150.6964 | 14.218 |
| 7500 | 170.733 | 132.916 | 18.1451 | 3.44506 | 150.6964 | 13.5119 |
| 8000 | 168.113 | 130.795 | 17.9567 | 3.25665 | 146.6402 | 12.8586 |
| 8500 | 165.691 | 129.033 | 17.7952 | 3.09517 | 146.6402 | 12.217 |
| 9000 | 163.452 | 127.492 | 17.6548 | 2.95485 | 143.3137 | 11.5736 |
| 9500 | 161.373 | 126.109 | 17.5286 | 2.82862 | 143.3137 | 10.9301 |
| 10000 | 159.437 | 124.908 | 17.4264 | 2.72641 | 140.5415 | 10.3544 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

10.2

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 0.05 | 24175100 | 0 | 24175100 | 0 | 0 | 15.6006 |
| 0.1 | 25014300 | 0 | 25014300 | 0 | 0 | 64.7074 |
| 0.2 | 26662100 | 0 | 26662100 | 0 | 0 | 294.816 |
| 0.3 | 28269200 | 0 | 28269200 | 0 | 0 | 693.704 |
| 0.4 | 29835500 | 73.6082 | 29835500 | 0 | 0 | 1405.75 |
| 0.5 | 31362100 | 213.542 | 31362300 | 0 | 0 | 2755.78 |
| 0.6 | 32852600 | 429.334 | 32853000 | 0 | 0 | 4826.49 |
| 0.7 | 34308800 | 726.789 | 34309500 | 0 | 0 | 7648.92 |
| 0.8 | 35735600 | 1104.78 | 35736700 | 0 | 0 | 11183.1 |
| 0.9 | 37133100 | 1568.27 | 37134600 | 0 | 0 | 15423.2 |
| 1 | 38501100 | 2115.83 | 38503200 | 0 | 0 | 20353.7 |
| 1.1 | 39839700 | 2743.12 | 39842400 | 0 | 0 | 25912 |
| 1.2 | 41154300 | 3452.43 | 41157800 | 0 | 0 | 32083.5 |
| 1.3 | 42447300 | 4246.35 | 42451600 | 0 | 0 | 38866.8 |
| 1.4 | 43718700 | 5130.55 | 43723800 | 0 | 0 | 46272.8 |
| 1.5 | 44968300 | 6110.33 | 44974400 | 0 | 0 | 54359.2 |
| 1.6 | 46196200 | 7180.07 | 46203400 | 0 | 0 | 63078 |
| 1.7 | 47405800 | 8340.82 | 47414100 | 0 | 0 | 72412.1 |
| 1.8 | 48598500 | 9593.98 | 48608100 | 0 | 0 | 82355.4 |
| 1.9 | 49774400 | 10940.9 | 49785400 | 0 | 0 | 92902 |
| 2 | 50933500 | 12378.2 | 50945800 | 0 | 0 | 104033 |
| 2.1 | 52075700 | 13899.8 | 52089600 | 0 | 0 | 115699 |
| 2.2 | 53206800 | 15506.1 | 53222300 | 0 | 0 | 127884 |
| 2.3 | 54329100 | 17198.2 | 54346300 | 0 | 0 | 140585 |
| 2.4 | 55442500 | 18984.7 | 55461500 | 0 | 0 | 153836 |
| 2.5 | 56547100 | 20867 | 56568000 | 0 | 0 | 167665 |
| 2.6 | 57642900 | 22836.1 | 57665700 | 0 | 0 | 182025 |
| 2.7 | 58731600 | 24890.4 | 58756500 | 0 | 0 | 196885 |
| 2.8 | 59813900 | 27030.7 | 59841000 | 0 | 0 | 212243 |
| 2.9 | 60889900 | 29257.7 | 60919200 | 0 | 0 | 228093 |
| 3 | 61959500 | 31571.8 | 61991100 | 0 | 0 | 244432 |
| 3.1 | 63022800 | 33973.6 | 63056800 | 0 | 0 | 261255 |

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 3.2 | 64079700 | 36463.5 | 64116100 | 0 | 0 | 278557 |
| 3.3 | 65130200 | 39053.3 | 65169200 | 0 | 0 | 296386 |
| 3.4 | 66174200 | 41747.5 | 66215900 | 0 | 0 | 314789 |
| 3.5 | 67211700 | 44546 | 67256300 | 0 | 0 | 333759 |
| 3.6 | 68242800 | 47446.5 | 68290300 | 0 | 0 | 353283 |
| 3.7 | 69268700 | 50438.2 | 69319100 | 0 | 0 | 373312 |
| 3.8 | 70290000 | 53520.3 | 70343500 | 0 | 0 | 393823 |
| 3.9 | 71306600 | 56693 | 71363300 | 0 | 0 | 414812 |
| 4 | 72318500 | 59956.8 | 72378500 | 0 | 0 | 436274 |
| 4.1 | 73325800 | 63311.5 | 73389100 | 0 | 0 | 458206 |
| 4.2 | 74328500 | 66757.5 | 74395200 | 0 | 0 | 480601 |
| 4.3 | 75326400 | 70294.9 | 75396700 | 0 | 0 | 503456 |
| 4.4 | 76319800 | 73923.9 | 76393800 | 0 | 0 | 526766 |
| 4.5 | 77308600 | 77644.5 | 77386200 | 0 | 0 | 550527 |
| 4.6 | 78292700 | 81457.1 | 78374200 | 0 | 0 | 574734 |
| 4.7 | 79272900 | 85360.5 | 79358300 | 0 | 0 | 599382 |
| 4.8 | 80249700 | 89347.1 | 80339000 | 0 | 0 | 624442 |
| 4.9 | 81222900 | 93433 | 81316300 | 0 | 0 | 649964 |
| 5 | 82192300 | 97634 | 82290000 | 0 | 0 | 676074 |
| 5.25 | 84600000 | 108629 | 84708600 | 0 | 0 | 743865 |
| 5.5 | 86984700 | 120319 | 87105000 | 0 | 0 | 815127 |
| 5.75 | 89347900 | 132701 | 89480600 | 0 | 0 | 889751 |
| 6 | 91693400 | 145746 | 91839200 | 0 | 0 | 967566 |
| 6.25 | 94021800 | 159403 | 94181200 | 0 | 0 | 1048290 |
| 6.5 | 96333100 | 173669 | 96506800 | 0 | 0 | 1131840 |
| 6.75 | 98622900 | 188539 | 98811500 | 0 | 0 | 1218140 |
| 7 | 100877000 | 204014 | 101081000 | 0 | 0 | 1307130 |
| 7.25 | 103094000 | 220186 | 103314000 | 0 | 0 | 1399240 |
| 7.5 | 105273000 | 237061 | 105510000 | 0 | 0 | 1494540 |
| 7.75 | 107411000 | 254593 | 107666000 | 0 | 0 | 1592800 |
| 8 | 109497000 | 272708 | 109770000 | 0 | 0 | 1693680 |
| 8.25 | 111530000 | 291387 | 111821000 | 0 | 0 | 1797050 |
| 8.5 | 113510000 | 310609 | 113821000 | 0 | 0 | 1902770 |
| 8.75 | 115441000 | 330358 | 115771000 | 0 | 0 | 2010730 |

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# CALCULATION SHEET

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 146

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 9 | 117332000 | 350618 | 117683000 | 0 | 0 | 2120840 |
| 9.25 | 119185000 | 371376 | 119556000 | 0 | 0 | 2233000 |
| 9.5 | 120998000 | 392620 | 121391000 | 0 | 0 | 2347140 |
| 9.75 | 122775000 | 414338 | 123189000 | 0 | 0 | 2463160 |
| 10 | 124521000 | 436529 | 124957000 | 0 | 0 | 2581050 |
| 10.5 | 127918000 | 482700 | 128401000 | 0 | 0 | 2824230 |
| 11 | 131198000 | 531198 | 131729000 | 0 | 0 | 3077050 |
| 11.5 | 134376000 | 581768 | 134957000 | 0 | 0 | 3338350 |
| 12 | 137453000 | 634151 | 138087000 | 0 | 0 | 3606980 |
| 12.5 | 140431000 | 688248 | 141119000 | 0 | 0 | 3882360 |
| 13 | 143316000 | 743961 | 144060000 | 0 | 0 | 4163930 |
| 13.5 | 146119000 | 801207 | 146920000 | 0 | 0 | 4451240 |
| 14 | 148840000 | 859908 | 149700000 | 0 | 0 | 4743850 |
| 14.5 | 151481000 | 919993 | 152401000 | 0 | 0 | 5041400 |
| 15 | 154047000 | 981554 | 155029000 | 815.367 | 0 | 5343480 |
| 15.5 | 156545000 | 1045880 | 157591000 | 9026.82 | 0 | 5649790 |
| 16 | 158983000 | 1111320 | 160094000 | 17335.5 | 0 | 5959740 |
| 16.5 | 161363000 | 1177750 | 162541000 | 25731.7 | 0 | 6272830 |
| 17 | 163690000 | 1245130 | 164935000 | 34213.6 | 0 | 6588840 |
| 17.5 | 165975000 | 1313420 | 167288000 | 42779.9 | 0 | 6907590 |
| 18 | 168215000 | 1382890 | 169598000 | 51428.8 | 0 | 7230250 |
| 18.5 | 170410000 | 1453690 | 171864000 | 60158.6 | 0 | 7557600 |
| 19 | 172564000 | 1525720 | 174090000 | 68967.9 | 0 | 7889250 |
| 19.5 | 174683000 | 1598940 | 176282000 | 77855.2 | 0 | 8224880 |
| 20 | 176766000 | 1673280 | 178440000 | 86819.3 | 0 | 8564220 |
| 21 | 180832000 | 1825250 | 182657000 | 104966 | 0 | 9253060 |
| 22 | 184780000 | 1980910 | 186760000 | 123394 | 0 | 9953310 |
| 23 | 188617000 | 2139630 | 190756000 | 142070 | 0 | 10662500 |
| 24 | 192345000 | 2301040 | 194646000 | 160983 | 0 | 11379000 |
| 25 | 195966000 | 2464970 | 198431000 | 180133 | 0 | 12102000 |
| 26 | 199483000 | 2631190 | 202115000 | 199513 | 0 | 12830400 |
| 27 | 202918000 | 2799460 | 205718000 | 219117 | 0 | 13563200 |
| 28 | 206276000 | 2969620 | 209246000 | 238940 | 0 | 14299600 |
| 29 | 209559000 | 3141290 | 212700000 | 258966 | 0 | 15038500 |

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Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 147

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 30 | 212767000 | 3314200 | 216082000 | 279178 | 0 | 15778700 |
| 31 | 215905000 | 3488210 | 219393000 | 299572 | 0 | 16519900 |
| 32 | 218986000 | 3663190 | 222650000 | 320144 | 0 | 17261500 |
| 33 | 222016000 | 3839070 | 225855000 | 340892 | 0 | 18003100 |
| 34 | 224994000 | 4015740 | 229009000 | 361812 | 0 | 18744400 |
| 35 | 227920000 | 4193140 | 232113000 | 382901 | 0 | 19485100 |
| 36 | 230795000 | 4371170 | 235166000 | 404156 | 0 | 20225000 |
| 37 | 233614000 | 4549590 | 238163000 | 425565 | 0 | 20963300 |
| 38 | 236375000 | 4728170 | 241103000 | 447113 | 0 | 21699300 |
| 39 | 239080000 | 4906840 | 243987000 | 468795 | 0 | 22432800 |
| 40 | 241728000 | 5085560 | 246814000 | 490611 | 0 | 23163600 |
| 41 | 244321000 | 5264260 | 249586000 | 512556 | 0 | 23891600 |
| 42 | 246863000 | 5442890 | 252306000 | 534629 | 0 | 24616500 |
| 43 | 249355000 | 5621400 | 254976000 | 556826 | 0 | 25338300 |
| 44 | 251797000 | 5799760 | 257597000 | 579145 | 0 | 26056900 |
| 45 | 254190000 | 5977910 | 260168000 | 601585 | 0 | 26772200 |
| 46 | 256534000 | 6155820 | 262690000 | 624141 | 0 | 27484000 |
| 47 | 258835000 | 6333460 | 265169000 | 646812 | 0 | 28192200 |
| 48 | 261094000 | 6511090 | 267605000 | 669597 | 0 | 28898000 |
| 49 | 263309000 | 6688890 | 269998000 | 692491 | 0 | 29602200 |
| 50 | 265481000 | 6866780 | 272348000 | 715494 | 0 | 30304500 |
| 51 | 267627000 | 7044660 | 274671000 | 738595 | 71196.4 | 31004300 |
| 52 | 269744000 | 7222390 | 276966000 | 761781 | 142029 | 31701100 |
| 53 | 271836000 | 7399950 | 279236000 | 785051 | 212468 | 32394800 |
| 54 | 273903000 | 7577290 | 281480000 | 808403 | 282518 | 33085100 |
| 55 | 275944000 | 7754370 | 283698000 | 831835 | 352181 | 33772000 |
| 56 | 277960000 | 7931160 | 285892000 | 855347 | 421463 | 34455400 |
| 57 | 279952000 | 8107620 | 288059000 | 878938 | 490367 | 35135200 |
| 58 | 281918000 | 8283710 | 290202000 | 902604 | 558897 | 35811400 |
| 59 | 283860000 | 8459420 | 292320000 | 926344 | 627057 | 36483800 |
| 60 | 285778000 | 8634640 | 294413000 | 950156 | 694849 | 37152300 |
| 61 | 287614000 | 8809240 | 296423000 | 974029 | 762278 | 37816400 |
| 62 | 288969000 | 8982850 | 297952000 | 997951 | 829326 | 38475100 |
| 63 | 289444000 | 9154820 | 298599000 | 1021900 | 895938 | 39126500 |

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Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

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CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 148

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 64 | 289259000 | 9324320 | 298583000 | 1045830 | 962035 | 39767800 |
| 65 | 288659000 | 9490970 | 298150000 | 1069720 | 1027580 | 40397900 |
| 66 | 287978000 | 9654610 | 297633000 | 1093570 | 1092550 | 41016500 |
| 67 | 287288000 | 9815320 | 297104000 | 1117370 | 1156950 | 41623700 |
| 68 | 286589000 | 9973060 | 296563000 | 1141110 | 1220780 | 42219500 |
| 69 | 285880000 | 10127500 | 296008000 | 1164790 | 1284030 | 42804400 |
| 70 | 285161000 | 10279200 | 295440000 | 1188420 | 1346710 | 43379000 |
| 71 | 284442000 | 10428200 | 294870000 | 1211990 | 1408790 | 43943500 |
| 72 | 283732000 | 10574700 | 294307000 | 1235490 | 1470300 | 44498300 |
| 73 | 283034000 | 10718600 | 293753000 | 1258940 | 1531220 | 45043500 |
| 74 | 282349000 | 10860200 | 293209000 | 1282340 | 1591580 | 45579500 |
| 75 | 281674000 | 10999400 | 292673000 | 1305670 | 1651360 | 46106500 |
| 76 | 281010000 | 11136400 | 292146000 | 1328950 | 1710580 | 46624600 |
| 77 | 280357000 | 11271100 | 291629000 | 1352180 | 1769230 | 47134200 |
| 78 | 279715000 | 11403600 | 291119000 | 1375350 | 1827310 | 47635400 |
| 79 | 279083000 | 11534100 | 290617000 | 1398460 | 1884830 | 48128400 |
| 80 | 278462000 | 11662400 | 290124000 | 1421530 | 1941790 | 48613400 |
| 81 | 277850000 | 11788800 | 289639000 | 1444540 | 1998180 | 49090700 |
| 82 | 277248000 | 11913200 | 289161000 | 1467490 | 2054020 | 49560400 |
| 83 | 276655000 | 12035700 | 288691000 | 1490400 | 2109310 | 50022600 |
| 84 | 276072000 | 12156300 | 288228000 | 1513260 | 2164040 | 50477700 |
| 85 | 275497000 | 12275100 | 287772000 | 1536060 | 2218210 | 50925600 |
| 86 | 274932000 | 12392100 | 287324000 | 1558810 | 2271840 | 51366600 |
| 87.00001 | 274375000 | 12507400 | 286882000 | 1581520 | 2324920 | 51800900 |
| 88 | 273826000 | 12621100 | 286447000 | 1604180 | 2377470 | 52228900 |
| 89 | 273285000 | 12733200 | 286018000 | 1626800 | 2429490 | 52650600 |
| 90 | 272751000 | 12843700 | 285595000 | 1649370 | 2480970 | 53066000 |
| 91 | 272225000 | 12952600 | 285178000 | 1671890 | 2531900 | 53475200 |
| 92.00001 | 271708000 | 13059900 | 284768000 | 1694360 | 2582300 | 53878400 |
| 93 | 271197000 | 13165700 | 284363000 | 1716790 | 2632150 | 54275700 |
| 94 | 270694000 | 13270100 | 283964000 | 1739170 | 2681470 | 54667100 |
| 95 | 270198000 | 13372900 | 283570000 | 1761510 | 2730240 | 55052800 |
| 96 | 269709000 | 13474400 | 283183000 | 1783790 | 2778480 | 55432900 |
| 97 | 269227000 | 13574400 | 282801000 | 1806040 | 2826180 | 55807600 |

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 149

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

R E V ⇓

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 98 | 268751000 | 13673100 | 282424000 | 1828230 | 2873360 | 56176900 |
| 99 | 268283000 | 13770500 | 282053000 | 1850390 | 2920000 | 56541100 |
| 100 | 267821000 | 13866500 | 281687000 | 1872490 | 2966110 | 56900100 |
| 105 | 265594000 | 14328300 | 279922000 | 1982510 | 3190500 | 58630900 |
| 110 | 263511000 | 14761200 | 278272000 | 2091460 | 3401930 | 60248100 |
| 115 | 261557000 | 15168300 | 276726000 | 2199390 | 3600570 | 61762200 |
| 120 | 259476000 | 15794300 | 275270000 | 2306400 | 3788520 | 63186400 |
| 125 | 257391000 | 16494200 | 273885000 | 2412810 | 3974100 | 64540900 |
| 130 | 255388000 | 17175100 | 272563000 | 2518710 | 4159070 | 65832400 |
| 135 | 253460000 | 17838800 | 271299000 | 2624110 | 4343450 | 67067300 |
| 140 | 251599000 | 18486900 | 270086000 | 2729030 | 4527240 | 68250500 |
| 145 | 249802000 | 19120400 | 268922000 | 2833500 | 4710430 | 69385900 |
| 150 | 248059000 | 19741100 | 267800000 | 2937520 | 4892980 | 70480000 |
| 155 | 246367000 | 20349800 | 266717000 | 3041110 | 5074910 | 71535400 |
| 160 | 244717000 | 20952200 | 265669000 | 3144320 | 5256300 | 72555300 |
| 165 | 243115000 | 21539400 | 264655000 | 3247230 | 5437220 | 73542800 |
| 170 | 241555000 | 22117500 | 263672000 | 3349740 | 5617570 | 74498200 |
| 175 | 240034000 | 22686300 | 262721000 | 3451870 | 5797350 | 75423600 |
| 180 | 238551000 | 23246100 | 261797000 | 3553630 | 5976570 | 76320600 |
| 185 | 237104000 | 23797400 | 260902000 | 3655010 | 6155260 | 77190600 |
| 190 | 235692000 | 24340600 | 260032000 | 3756040 | 6333410 | 78034600 |
| 195 | 234312000 | 24876000 | 259188000 | 3856720 | 6511050 | 78853900 |
| 200 | 232964000 | 25404000 | 258368000 | 3957060 | 6688170 | 79649500 |
| 210 | 230357000 | 26438700 | 256796000 | 4156740 | 7040680 | 81173500 |
| 220 | 227865000 | 27446000 | 255311000 | 4355040 | 7390920 | 82611500 |
| 230 | 225479000 | 28427900 | 253907000 | 4551960 | 7738980 | 83969900 |
| 240 | 223191000 | 29386400 | 252578000 | 4747580 | 8084930 | 85255300 |
| 250 | 220993000 | 30323300 | 251317000 | 4941950 | 8428870 | 86473400 |
| 260 | 218878000 | 31240400 | 250119000 | 5135110 | 8770850 | 87629800 |
| 270 | 216840000 | 32138800 | 248979000 | 5327100 | 9110940 | 88729300 |
| 280 | 214862000 | 33026300 | 247888000 | 5518170 | 9449580 | 89780000 |
| 290 | 212952000 | 33893600 | 246846000 | 5708270 | 9786150 | 90783600 |
| 300 | 211106000 | 34745400 | 245851000 | 5897310 | 10120600 | 91740800 |
| 310 | 209318000 | 35582300 | 244901000 | 6085340 | 10453100 | 92655000 |

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Project or DCP/MMP SONGS Units 2 & 3

Calc. No. N-4080-027

CCN CONVERSION:
CCN NO. CCN --

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB

Sheet No. 150

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

REV ⇓

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 320 | 207585000 | 36405700 | 243991000 | 6272390 | 10783600 | 93529400 |
| 330 | 205902000 | 37216400 | 243119000 | 6458490 | 11112200 | 94366700 |
| 340 | 204267000 | 38015000 | 242282000 | 6643660 | 11439000 | 95169500 |
| 350 | 202676000 | 38802300 | 241479000 | 6827940 | 11764000 | 95940100 |
| 360 | 201128000 | 39578700 | 240707000 | 7011330 | 12087100 | 96679900 |
| 370 | 199622000 | 40344200 | 239967000 | 7193760 | 12408600 | 97389100 |
| 380 | 198157000 | 41099500 | 239256000 | 7375250 | 12728400 | 98069500 |
| 390 | 196729000 | 41845200 | 238574000 | 7555840 | 13046600 | 98723100 |
| 400 | 195336000 | 42581300 | 237917000 | 7735530 | 13362600 | 99351500 |
| 420 | 192640000 | 44028000 | 236668000 | 8092430 | 13988300 | 100547000 |
| 440 | 190047000 | 45444000 | 235491000 | 8446000 | 14605400 | 101673000 |
| 460 | 187548000 | 46831700 | 234380000 | 8796380 | 15214300 | 102737000 |
| 480 | 185122000 | 48199500 | 233322000 | 9144150 | 15815800 | 103750000 |
| 500 | 182778000 | 49539300 | 232318000 | 9489050 | 16409800 | 104712000 |
| 520 | 180511000 | 50855600 | 231366000 | 9831070 | 16996400 | 105624000 |
| 540 | 178313000 | 52149800 | 230463000 | 10170300 | 17575800 | 106491000 |
| 560 | 176182000 | 53423000 | 229605000 | 10506800 | 18148200 | 107316000 |
| 580 | 174104000 | 54678000 | 228782000 | 10840700 | 18713900 | 108108000 |
| 600 | 172074000 | 55915900 | 227990000 | 11172000 | 19273000 | 108872000 |
| 620 | 170096000 | 57136500 | 227232000 | 11500500 | 19825700 | 109604000 |
| 640 | 168167000 | 58340400 | 226507000 | 11826200 | 20372100 | 110306000 |
| 660 | 166284000 | 59528300 | 225812000 | 12149200 | 20912400 | 110981000 |
| 680 | 164446000 | 60700800 | 225147000 | 12469500 | 21446800 | 111629000 |
| 700 | 162648000 | 61858900 | 224507000 | 12787200 | 21975400 | 112254000 |
| 750.0001 | 158318000 | 64696700 | 223015000 | 13571000 | 23274400 | 113720000 |
| 800 | 154184000 | 67468100 | 221652000 | 14340700 | 24546500 | 115070000 |
| 850 | 150236000 | 70171900 | 220408000 | 15096400 | 25792600 | 116316000 |
| 900 | 146460000 | 72813900 | 219274000 | 15838300 | 27013400 | 117465000 |
| 950 | 142843000 | 75398100 | 218241000 | 16567400 | 28209800 | 118526000 |
| 1000 | 139392000 | 77925500 | 217317000 | 17282800 | 29383700 | 119492000 |
| 1050 | 136100000 | 80400000 | 216500000 | 17983800 | 30537200 | 120366000 |
| 1100 | 132950000 | 82825800 | 215775000 | 18671100 | 31671100 | 121160000 |
| 1150 | 129929000 | 85206300 | 215136000 | 19345300 | 32786100 | 121883000 |
| 1200 | 127047000 | 87524900 | 214572000 | 20007000 | 33882700 | 122543000 |

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CCN CONVERSION:
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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 151

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | REV ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

| TIME (SECONDS) | STEAM+AIR ENERGY (BTU) | SUMP ENERGY (BTU) | TOTAL ENERGY (BTU) | AIR COOLER HT REMOVAL (BTU) | CONT. SPRAY HEAT TRANSFERRED TO SUMP (BTU) | HEAT SINKS (BTU) |
|---|---|---|---|---|---|---|
| 1250 | 124214000 | 89850400 | 214065000 | 20658300 | 34963300 | 123156000 |
| 1300 | 121511000 | 92115300 | 213626000 | 21298300 | 36026500 | 123712000 |
| 1350 | 118906000 | 94344000 | 213250000 | 21927500 | 37073200 | 124216000 |
| 1400 | 116394000 | 96538200 | 212932000 | 22546200 | 38103900 | 124673000 |
| 1450 | 113959000 | 98701100 | 212660000 | 23154900 | 39118800 | 125093000 |
| 1500 | [illegible]1599000 | 100834000 | 212433000 | 23753500 | 40118500 | 125480000 |
| 1550 | 109324000 | 102935000 | 212259000 | 24340800 | 41103100 | 125823000 |
| 1600 | 107129000 | 105006000 | 212135000 | 24917000 | 42073100 | 126128000 |
| 1650 | 105007000 | 107049000 | 212056000 | 25482800 | 43029000 | 126399000 |
| 1700 | 102947000 | 109067000 | 212015000 | 26038900 | 43971900 | 126641000 |
| 1750 | 100945000 | 111062000 | 212007000 | 26586000 | 44902300 | 126860000 |
| 1800 | 99005400 | 113031000 | 212036000 | 27123700 | 45819700 | 127050000 |
| 1850 | 97124600 | 114976000 | 212101000 | 27652400 | 46724500 | 127214000 |
| 1900 | 95299400 | 116899000 | 212198000 | 28172400 | 47616800 | 127354000 |
| 1950 | 93529500 | 118799000 | 212328000 | 28683600 | 48496900 | 127470000 |
| 2000 | 91819800 | 120676000 | 212495000 | 29185200 | 49365100 | 127559000 |
| 2500 | 78724400 | 138268000 | 216992000 | 33820400 | 57537900 | 126000000 |
| 3000 | 68454600 | 154504000 | 222959000 | 37801700 | 64851600 | 123626000 |
| 3500 | 59999000 | 169650000 | 229649000 | 41188700 | 71387400 | 121123000 |
| 4000 | 53155500 | 183835000 | 236991000 | 44069500 | 77214100 | 118474000 |
| 4500 | 47730200 | 197170000 | 244900000 | 46509200 | 82398700 | 115698000 |
| 5000 | 43498500 | 209771000 | 253270000 | 48574200 | 87016100 | 112837000 |
| 5500 | 40245000 | 221767000 | 262012000 | 50324300 | 91141800 | 109919000 |
| 6000 | 37736000 | 233257000 | 270993000 | 51831200 | 94856400 | 107005000 |
| 6500 | 35772200 | 244338000 | 280110000 | 53145700 | 98222100 | 104146000 |
| 7000 | 34200500 | 255095000 | 289295000 | 54299100 | 101299000 | 101381000 |
| 7500 | 32923400 | 265579000 | 298502000 | 55326000 | 104131000 | 98721500 |
| 8000 | 31880000 | 275829000 | 307709000 | 56240600 | 106755000 | 96173900 |
| 8500 | 30988400 | 285900000 | 316888000 | 57054300 | 109209000 | 93754000 |
| 9000 | 30189100 | 295827000 | 326016000 | 57787000 | 111526000 | 91467400 |
| 9500 | 29467900 | 305627000 | 335095000 | 58448400 | 113722000 | 89300700 |
| 10000 | 28881500 | 315308000 | 344189000 | 58988000 | 115810000 | 87240100 |
| | | | | | | |

## 11 MASS AND ENERGY BALANCES

To ensure the reasonableness of the results, mass and energy balances were performed. The following tables show a mass balance at 102% power with offsite power available and a energy balance at 102% power with offsite power available.

A review of these tables indicates that the COPATTA Code mass and energy inventories rarely differ by more than 0.01 percent. This fact verifies that the mass and energy input parameters have been properly conserved within the COPATTA Code logic.

The data in the energy balance table is part of the data that is presented in Table 6.2-15D of the UFSAR.

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE | R E V ⇓ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | | |
| | | | | | | | | | | |

## MSLB MASS BALANCE AT 102% POWER, OFFSITE POWER AVAILABLE

| MASS BALANCE | ELAPSED TIME SINCE BREAK (seconds) | | | |
|---|---|---|---|---|
| | 50[(b)] | 62[(c)] | 71[(d)] | 10,000[(e)] |
| PROGRAM INPUTS[(a)] | | | | |
| Initial Water Vapor | 6.809092 | 6.809092 | 6.809092 | 6.809092 |
| Initial Air | 163.1983 | 163.1983 | 163.1983 | 163.1983 |
| Break Flow (CS 301) | 233.393 | 261.815 | 263.899 | 263.899 |
| Ctmt. Spray Flow (CS 801) | 0.0 | 2.67334 | 4.67834 | 2216.64 |
| Total Program Input | 403.400 | 434.496 | 438.585 | 2650.546 |
| | | | | |
| PROGRAM INVENTORY[(a)] | | | | |
| Steam | 209.460 | 232.036 | 230.336 | 11.9598 |
| Air | 163.198 | 163.198 | 163.198 | 163.198 |
| Sump | 30.7450 | 39.2655 | 45.0539 | 2475.39 |
| Total Program Inventory | 403.403 | 434.500 | 438.588 | 2650.548 |
| | | | | |
| Difference In Totals[(a)] with respect to Program Inputs | -0.003 | -0.004 | -0.003 | -0.002 |
| Percent Difference with respect to Program Inputs | -0.00074 | -0.00092 | -0.00068 | -0.000075 |

Notes:

(a) All mass inputs and inventories are presented in 1000 pound increments.

(b) The time of 50 seconds corresponds to the establishment of a fully developed containment spray injection phase flowrate of 1612 gallons/minute.

(c) The time of 62 seconds corresponds to the nearest output time step for the occurrence of the containment pressure peak of 58.5 psig at time 62.3 seconds. PB 4/10/94

(d) The time of 71 seconds corresponds to the nearest output time step for the occurrence of the end of mass release at 71.08 sec.

(e) The time of 10,000 seconds corresponds to the end of the code run.

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# CALCULATION SHEET

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|---|---|

CCN CONVERSION:
CCN NO. CCN --

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 154

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

R E V ⇓

## MSLB ENERGY BALANCE AT 102% POWER, OFFSITE POWER AVAILABLE

| ENERGY BALANCE | ELAPSED TIME SINCE BREAK (seconds) | | | |
|---|---|---|---|---|
| | 50[b] | 62[c] | 71[d] | 10,000[e] |
| PROGRAM INPUTS[a] | | | | |
| Initial Water Vapor/Air | 23.3257 | 23.3257 | 23.3257 | 23.3257 |
| Break Flow (CS 301) | 280.043 | 313.921 | 316.383 | 316.383 |
| Ctmt. Spray Flow (CS 801) | 0 | 0.181768 | 0.318094 | 150.716 |
| Total Program Input | 303.369 | 337.428 | 340.027 | 490.425 |
| | | | | |
| PROGRAM INVENTORY[a] | | | | |
| Steam | 240.903 | 264.974 | 261.082 | 12.5760 |
| Air | 24.5774 | 23.9952 | 23.3600 | 16.3054 |
| Ctmt Atmosphere (Steam+Air) | 265.48 | 288.97 | 284.44 | 28.88 |
| Sump | 6.86678 | 8.98285 | 10.4282 | 315.308 |
| Structural Heat Sinks | 30.3045 | 38.4751 | 43.9435 | 87.2401 |
| Air Cooler | 0.715494 | 0.997951 | 1.21199 | 58.9880 |
| Total Program Inventory | 303.367 | 337.425 | 340.034 | 490.418 |
| | | | | |
| Difference In Totals[a] with respect to Program Inputs | 0.002 | 0.003 | 0.007 | 0.008 |
| Percent Difference with respect to Program Inputs | 0.00050 | 0.00089 | 0.0021 | 0.0015 |

Notes:

(a) All energy inputs and inventories are presented in one million BTU increments. Reference temperatures for energy inventories are 32 °F for water and steam, 0 °R for air, and 120 °F (initial containment temperature) for structural heat sinks.

(b) The time of 50 seconds corresponds to the establishment of a fully developed containment spray injection phase flowrate of 1612 gallons/minute.

(c) The time of 62 seconds corresponds to the nearest output time step for the occurrence of the containment pressure peak of 58.5 psi~~a~~g at time 62.3 seconds. SB 1-10-94

(d) The time of 71 seconds corresponds to the the nearest output time step for the end of mass release at 71.08 sec.

(e) The time of 10,000 seconds corresponds to the end of the code run.

NES&L DEPARTMENT

# CALCULATION SHEET

| ICCN NO./<br>PRELIM. CCN NO. | PAGE___ OF___ |
|---|---|

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-027

| CCN CONVERSION:<br>CCN NO. CCN -- |
|---|

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS MSLB Sheet No. 155 of 155

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 0 | S. Oliver | 12/30/93 | J. Elliott | 1/4/94 | | | | | |
| | | | | | | | | | |

REV ⇓

## APPENDIX A (COPATTA Code I/O File Information)

The COPATTA Code input file is presented in Section 9 (page 130) of this calculation.

The COPATTA Code output file is included on Microfiche. The output file name and date are as follows:

| | |
|---|---|
| FILE TITLE: | MSLB CASE, 102% POWER, LOSS OF ONE COOLING TRAIN, OFFSITE POWER AVAIL. |
| RUNDATE: | 11-1-93 |
| END OF RUN: | 09:47:46 |
| LAST SHEET: | Page 414 |