Reference 4

N-4080-026 Suppl A Rev 0: LOCA Containment P/T

Southern California Edison Company NON-TECHNICAL DESIGN CHANGE NOTICE (DCN) / CALCULATION CHANGE NOTICE (CCN) COVER SHEET	~~DCN~~/CCN NO. CCNNT 3		DOCUMENT REVISION	
	DOCUMENT NO. N-4080-026, SUPPLEMENT A	SHEET NO. [illegible]	REV. 0	UNIT(S) 2 & 3
	DOCUMENT TITLE CONTAINMENT P-T ANALYSIS FOR DESIGN BASIS LOCA			
	ORIGINATOR Paul Barbour	PAX 88351	DATE 07/16/97	

1. DESCRIPTION OF CHANGE

Change the vertical axis label for Figure ^AFTER 2.1 ON SHEET A-11^ 2-1 from "TEMPERATURE (F)" to "CONTAINMENT PRESSURE (PSIG)" as shown on sheets 2 and 3 of this CCN.

INITIATING DOCUMENT (if any) : N/A

2. OTHER AFFECTED DOCUMENTS:

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

3. SCE DESIGN APPROVALS:

[signature] ORIGINATOR	7/16/97 DATE	[signature] FLS (CCNs only)	7/16/97 DATE
[signature] RE	7/16/97 DATE	OTHER	DATE

4. CONVERSION:

CONVERSION TO DCN/CCN DATE 9-16-97 [signature] SCE, CDM-SONGS OR DOCUMENT CONTROL

Southern California Edison Company **NON-TECHNICAL DESIGN CHANGE NOTICE (DCN) / CALCULATION CHANGE NOTICE (CCN) SUPPLEMENTAL PAGE**	DCN/CCN NO. CCNUT 3	DOCUMENT REVISION	
	DOCUMENT NO. N-4080-026, SUPPLEMENT A	SHEET NO. [handwritten initials] 7/16/97	REV. 0

1. DESCRIPTION OF CHANGE

BEFORE:

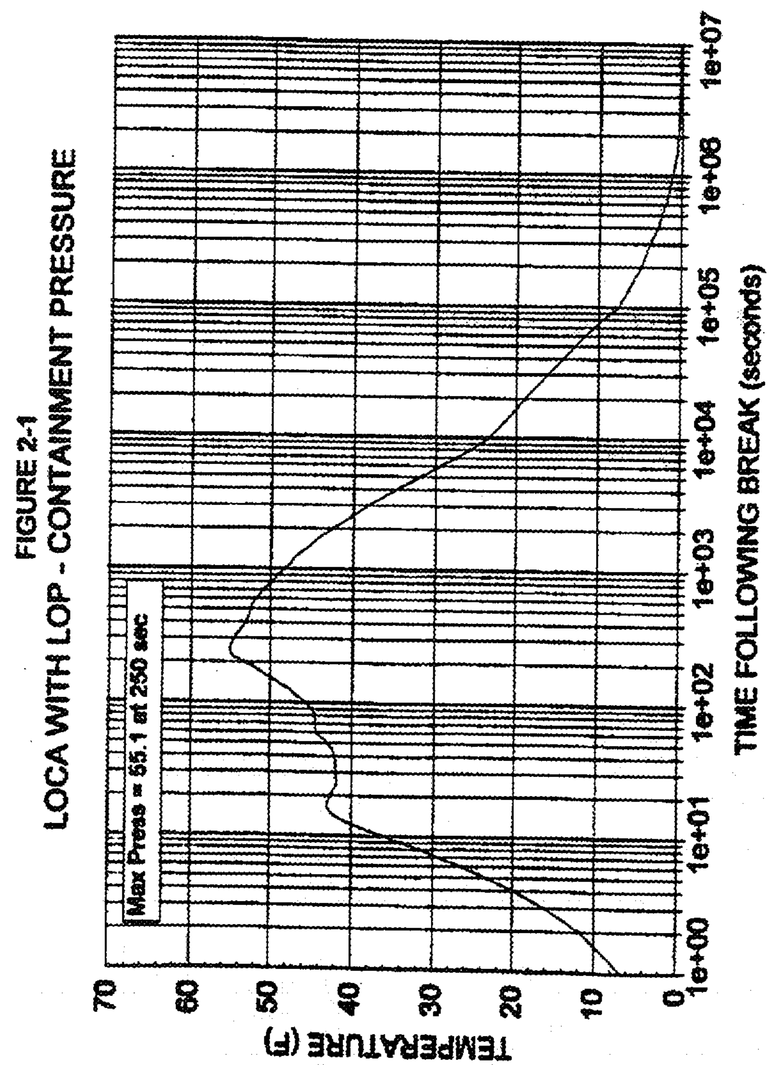
NES&L DEPARTMENT
CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1	PAGE 20 OF 86
	CCN CONVERSION CCN NO. CCN -

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-11

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					



Southern California Edison Company NON-TECHNICAL DESIGN CHANGE NOTICE (DCN) / CALCULATION CHANGE NOTICE (CCN) SUPPLEMENTAL PAGE	DCN/CCN NO. CCNNT 3	DOCUMENT REVISION	
	DOCUMENT NO. N-4080-026, SUPPLEMENT A	SHEET NO. [signature] 7/16/97	REV. 0

1. DESCRIPTION OF CHANGE

AFTER:

NES&L DEPARTMENT
CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1	PAGE 20 OF 86
CCN CONVERSION CCN NO. CCN -	

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-11

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

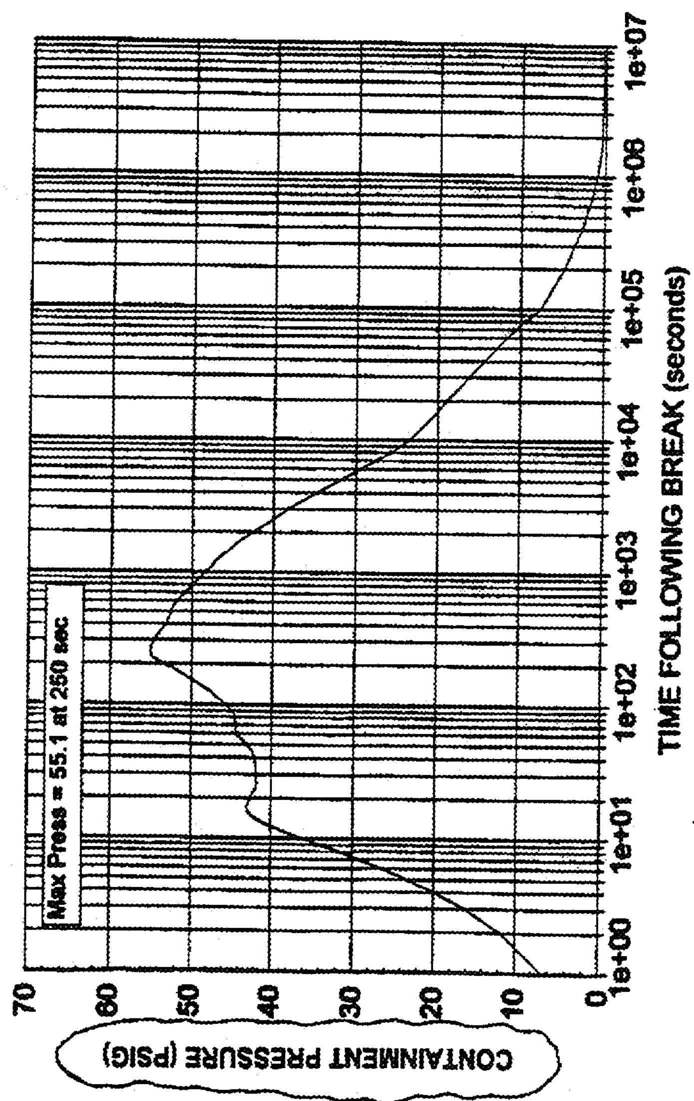


FIGURE 2-1
LOCA WITH LOP - CONTAINMENT PRESSURE

N-4080-026 Suppl A Rev 0: LOCA Containment P/T

Southern California Edison Company **INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN)**	CALC NO. N-4080-026	ICCN NO./ PRELIM. CCN NO. N-1	PAGE 1	TOTAL NO. OF PAGES 86
	BASE CALC. REV. 0 / UNIT 2 & 3	CCN CONVERSION: CCN NO. CCN- 1		CALC. REV. 0
	CALCULATION SUBJECT: Containment P/T Analysis for Design Basis LOCA - SUPPLEMENT A			
CALCULATION CROSS-INDEX ☒ New/Updated Index Included ☐ Existing Index is Complete	ENGINEERING SYSTEM NUMBER/PRIMARY STATION SYSTEM DESIGNATOR 1201 / BBB		Q-CLASS II	
1. BRIEF DESCRIPTION OF ICCN/CCN:	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	

Revise sheets 8 through 15 of the base calculation to refer to the Supplement A Results & Conclusions.

Add Supplement A to the base calculation.

Supplement A provides a new Analysis of Record (AOR) for the Containment Building pressure and temperature reaponse to the Design Basis Loss of Coolant Accident (LOCA) 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 containment initial pressure is at the Technical Specification maximum value of 1.5 psig (16.2 psia) to demonstrate that the peak post LOCA pressure remains below the 60 psig containment design value. The results of this new analysis are applicable to containment functional design and in-containment equipment qualification.

This new analysis employs slightly lower containment spray flow rates than were used in the base calculation to bound the lowest spray flow rates 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 60 seconds to provide margin to accomodate future 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.

INITIATING DOCUMENT (DCP/MMP, FCN, OTHER) N/A 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 — [signature] ES (Signature) — OTHER (Signature)

PAUL BARBOUR [initials] 51379 — IRE (Print name/initial) PAX — [signature] NES&L DM (Signature) — 2/6/95 Date

4. ASSIGNED SUPPLEMENT ALPHA DESIGNATOR: A

CONVERSION TO CCN DATE 3/17/95 — Tanya Castello — SCE CDM-SONGS

SCE 26-122-1 REV. 9/91

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Evinay	01/31/95	P. Barbour	01/31/95					

THIS SECTION IS REPLACED BY SECTION 2 IN SUPPLEMENT A

2 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

2.1 RESULTS/CONCLUSIONS

The purpose of this calculation has been to evaluate the short and long term effects of the containment pressure-temperature transient resulting from a design basis LOCA with a loss of offsite power.

Figure 2-1 presents the containment gauge pressure versus time for the DBA LOCA. The plot in Figure 2-1 is generated using the data presented in Table 8.3-1.

Figure 2-2 presents the sump and vapor temperatures versus time for the DBA LOCA. The plots in Figure 2-2 are generated using the data presented in Table 8.3-1.

Figure 2-3 presents the condensing heat transfer coefficient used by the COPATTA Code versus time for the DBA LOCA. The plot in Figure 2-3 is generated using the data presented in Table 8.3-1.

Figures 2-4A and 2-4B present the energy content of a number of different components of the LOCA model versus time for the DBA LOCA. The plots in Figures 2-4A and 2-4B are generated using the data presented in Table 8.3-2. For further discussion on heat sink energies, refer to Section 8.3.2.

Figure 2-5 presents surface temperatures versus time for five heat sinks for the DBA LOCA. The plots in Figure 2-5 are generated using the data presented in Table 8.3-3. The heat sink data plotted is for the following heat sinks:

- HS 2 Containment Building Cylinder above grade
- HS 8 Lined refueling canal walls
- HS 9 Steam Generator compartment walls, unlined refueling canal walls & other internal walls
- HS 15 Miscellaneous carbon steel: thickness < 0.5"
- HS 16 Electrical equipment

Figures 2-1 and 2-2 show that the containment peak pressure (56.9 psig) is below the design pressure of 60 psig and the peak vapor temperature (294 °F) is below the design temperature of 300 °F. Therefore, General Design Criteria 16 and 50 (See Section 1.2) are met. The containment pressure at 24 hours (86400 seconds) is less than 12.5 psig (the pressure from the COPATTA output at 80000 seconds). This is considerably less than half of the peak pressure. Therefore, General Design Criterion 38 (See Section 1.2) is also met.

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CALCULATION SHEET

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CCN CONVERSION: CCN NO. CCN – 1

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026

Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 9

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Evinay	01/31/95	P. Barbour	01/31/95					

THIS TABLE IS REPLACED BY TABLE 2-1 IN SUPPLEMENT A

Table 2-1 presents the accident chronology for the DBA LOCA.

Table 2-1
ACCIDENT CHRONOLOGY FOR THE DBA LOCA (DESLS)

TIME (seconds)	EVENT
0.0	Break occurs
17	Peak containment pressure during blowdown phase
22.0	End of Blowdown
22.0	Start of Emergency Core Cooling injection phase
22.0	Start of Core Reflood
35	Start of air cooler fans
60	MAXIMUM CONTAINMENT TEMPERATURE (294 °F)
60	Start of Containment Spray injection phase
211.1	End of Core Reflood
211.1	Start of Post-Reflood
241	MAXIMUM CONTAINMENT PRESSURE (56.9 psig)
573.273	End of Post-Reflood
573.273	End of CE-provided mass and energy release data
573.273	Start of COPATTA Code mass and energy release calculations
2280	End of Emergency Core Cooling injection phase
2280	Start of Emergency Core Cooling recirculation phase
2280	End of Containment Spray injection phase
2280	Start of Containment Spray recirculation phase
7200	HPSI realigned to a 50:50 split between hot and cold leg injection
10^7	End of COPATTA Code Calculations

NES&L DEPARTMENT

CALCULATION SHEET

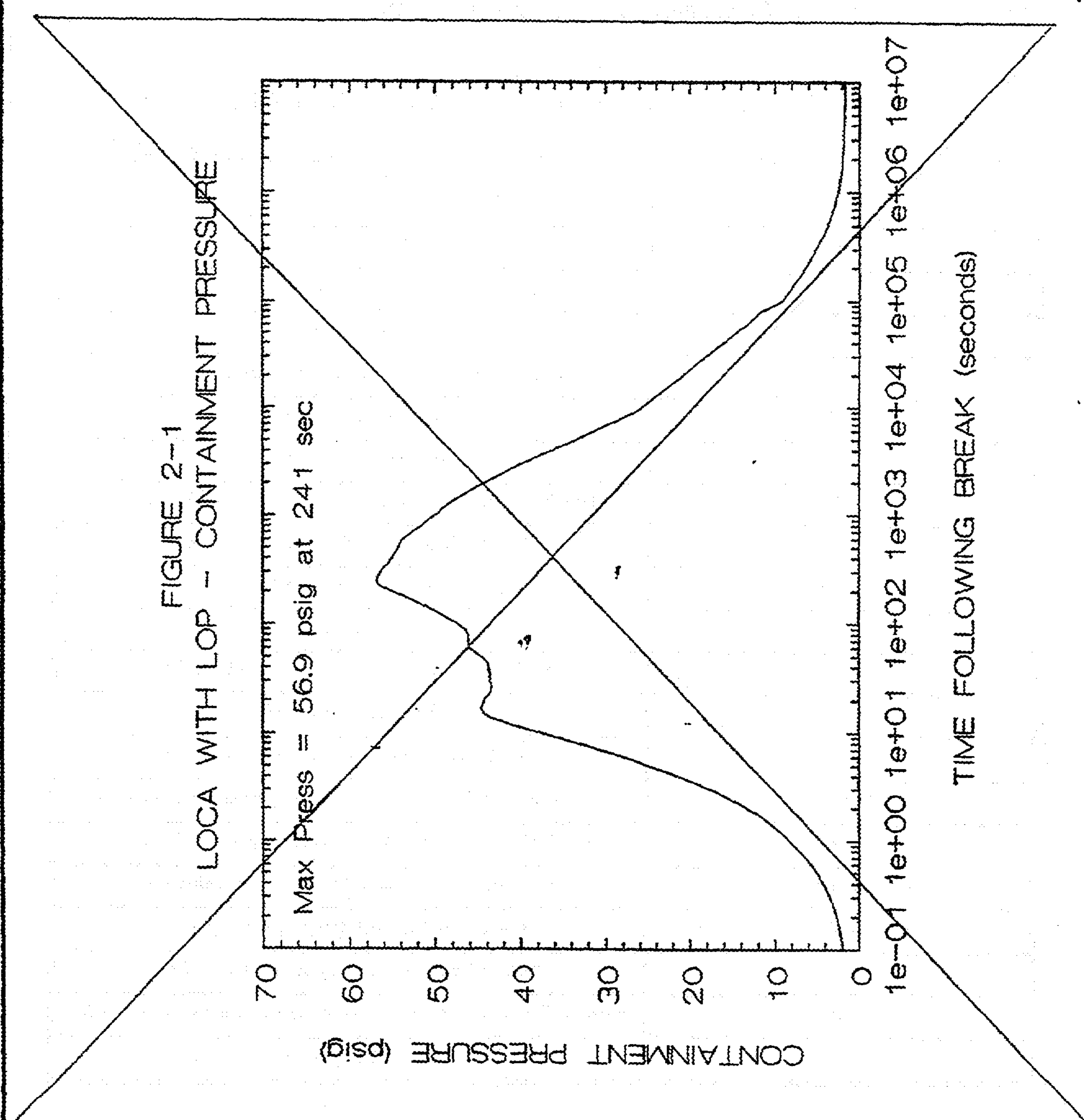
ICCN NO./ PRELIM. CCN NO. N-1	PAGE 4 OF 86
	CCN CONVERSION: CCN NO. CCN – 1

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026

Subject Containment P/T Analysis for Design Basis LOCA Sheet No. 10

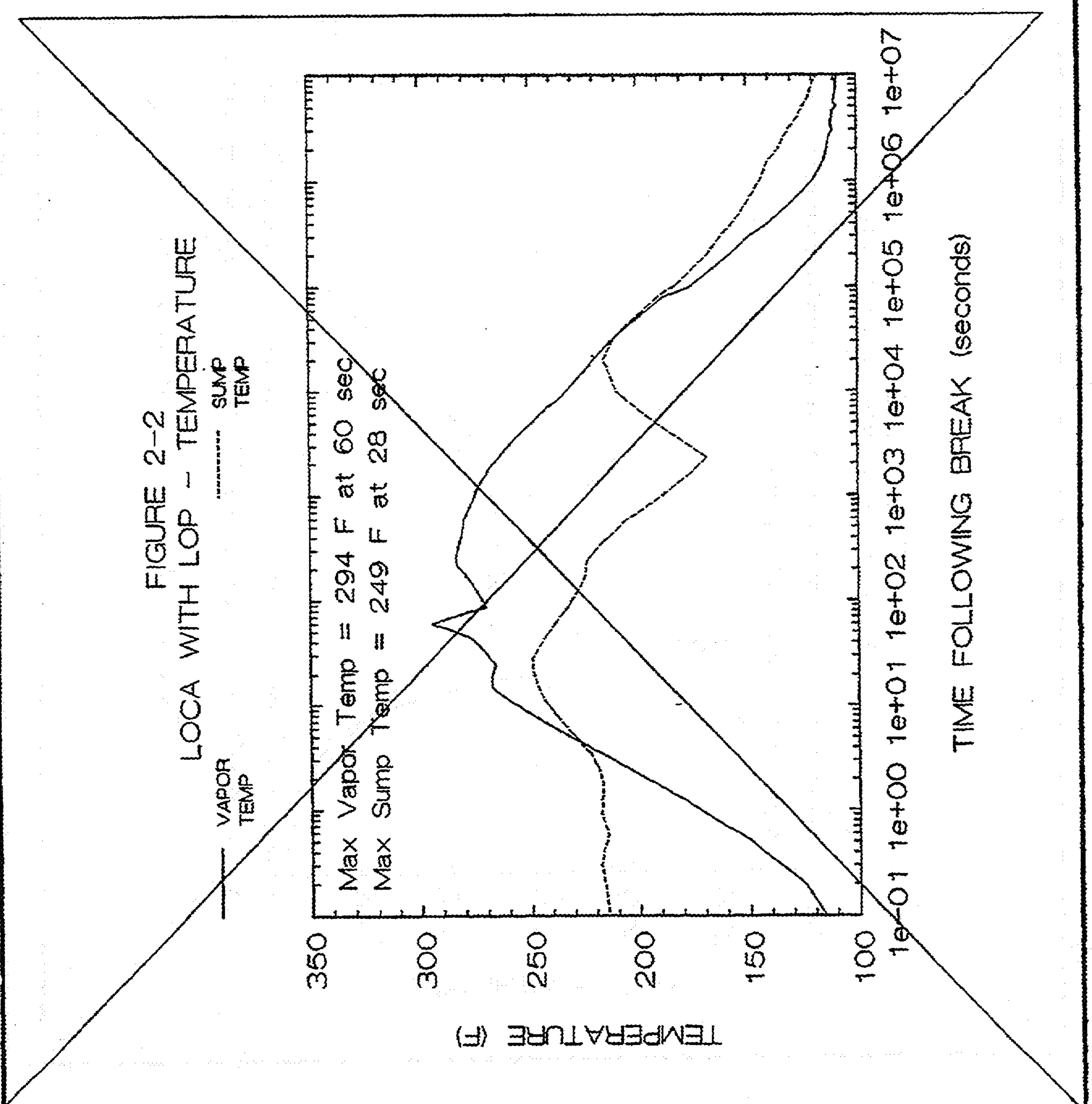
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Evinay	01/31/95	P. Barbour	01/31/95					

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



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Evinay	01/31/95	P. Barbour	01/31/95					

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



NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1	PAGE 6 OF 86

Project or DCP/MMP SONGS Units 2 & 3   Calc. No. N-4080-026

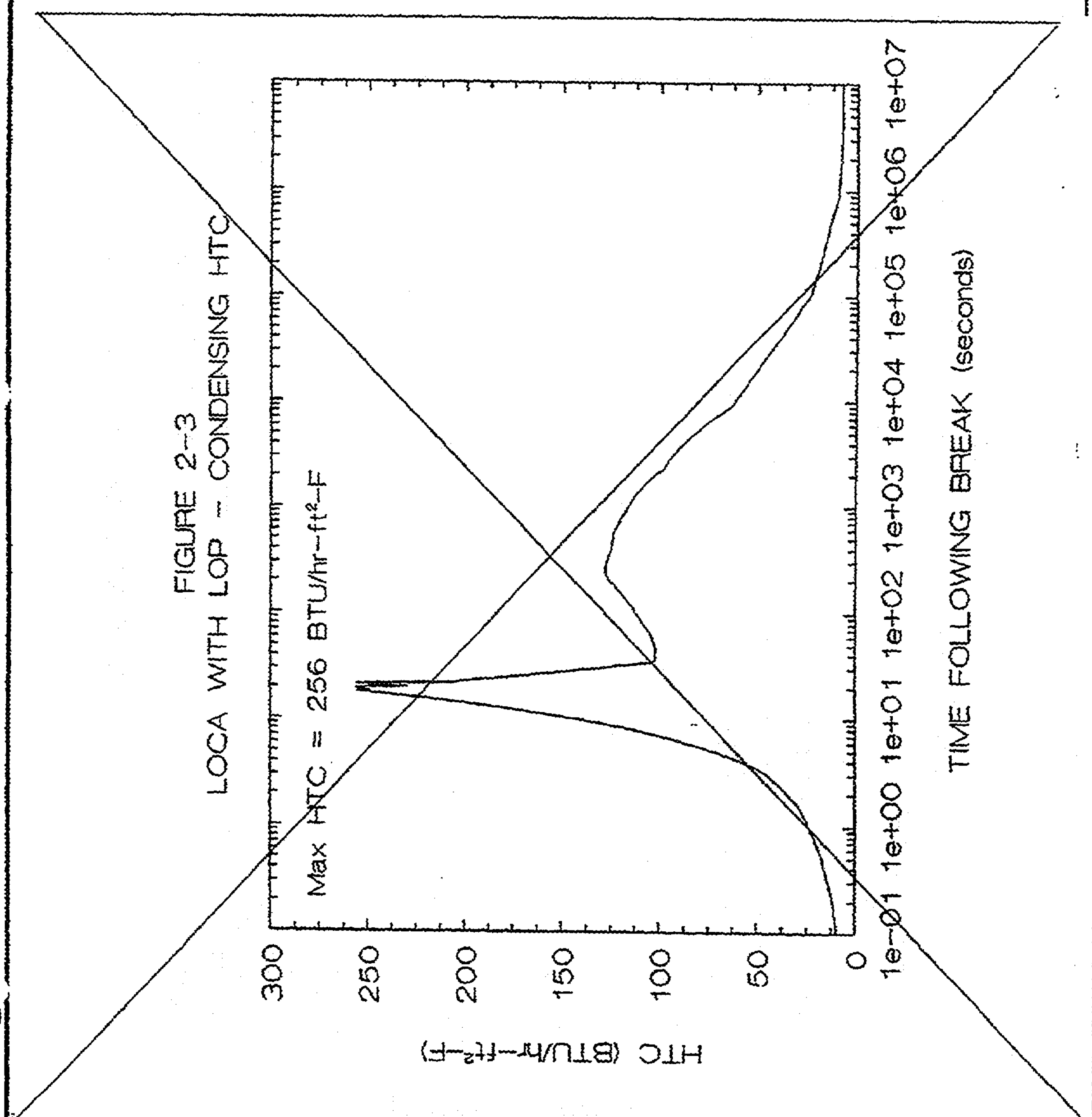
CCN CONVERSION: CCN NO. CCN – 1

Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 12

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Ewnay	01/31/95	P. Barbour	01/31/95					

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



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CALCULATION SHEET

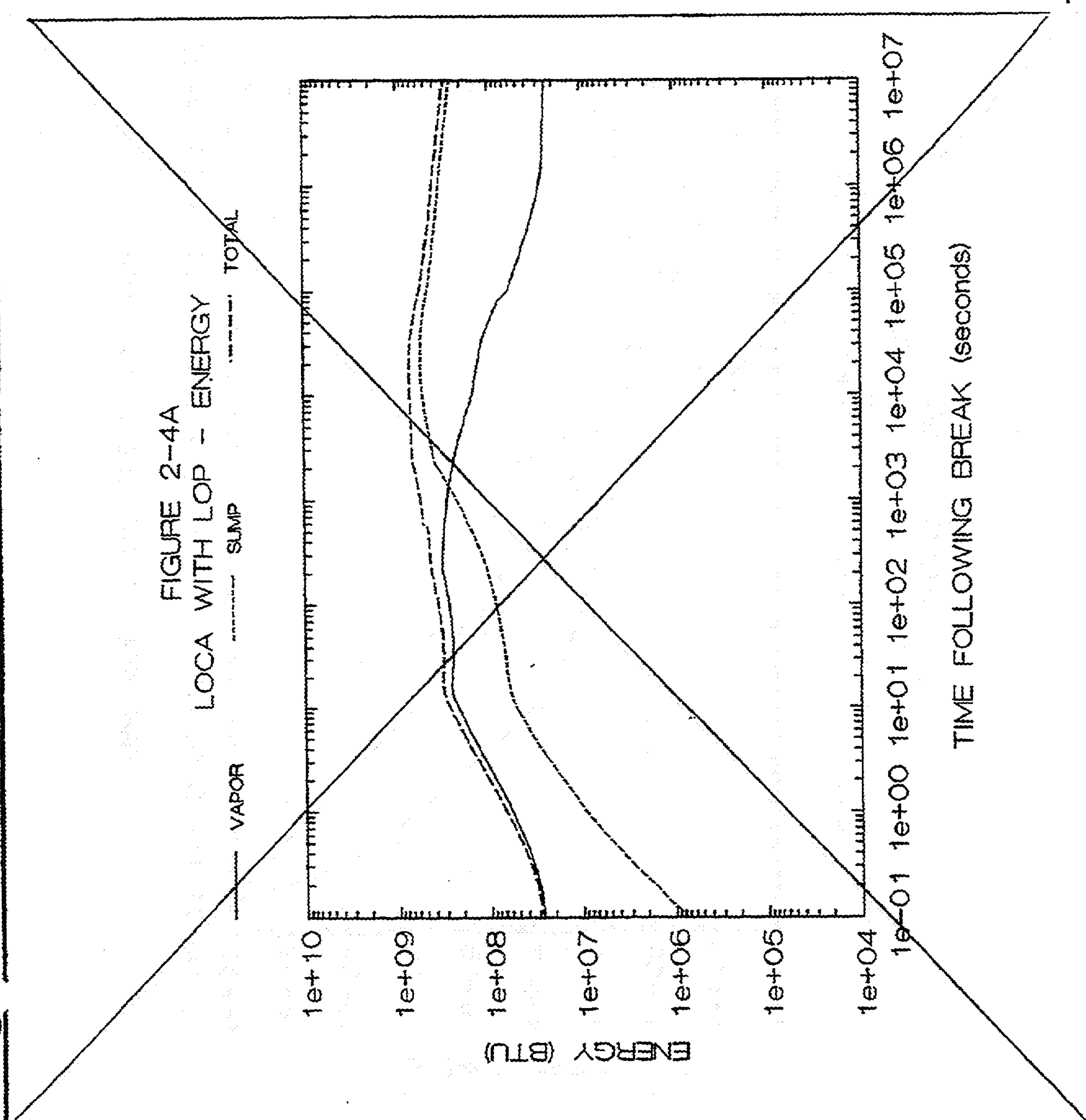
ICCN NO./ PRELIM. CCN NO. N-1	PAGE 7 OF 86
	CCN CONVERSION: CCN NO. CCN – 1

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026

Subject Containment P/T Analysis for Design Basis LOCA Sheet No. 13

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					
	A. Evinay	01/31/95	P. Barbour	01/31/95					

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



NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1	PAGE 8 OF 86
	CCN CONVERSION: CCN NO. CCN – 1

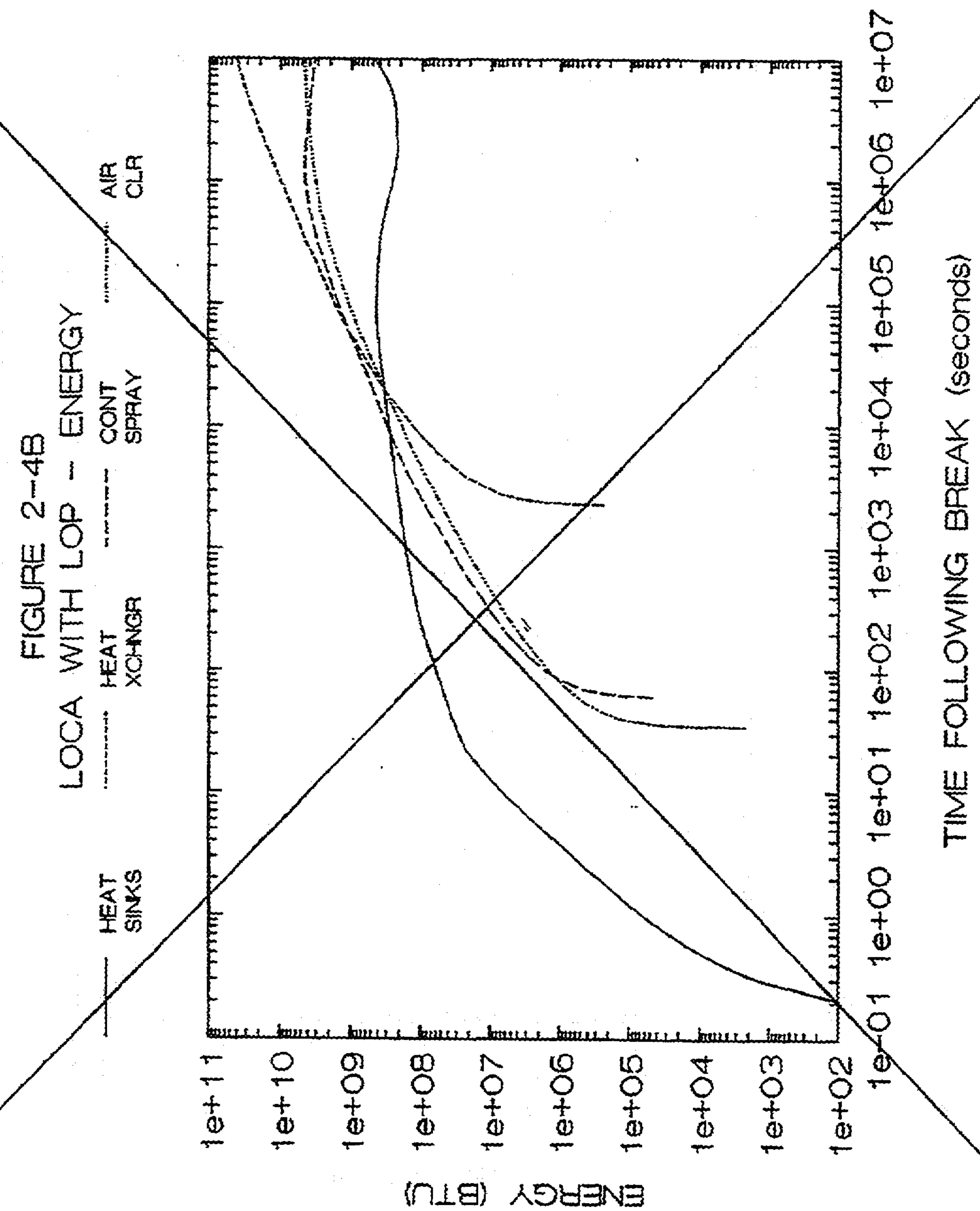
Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026

Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 14

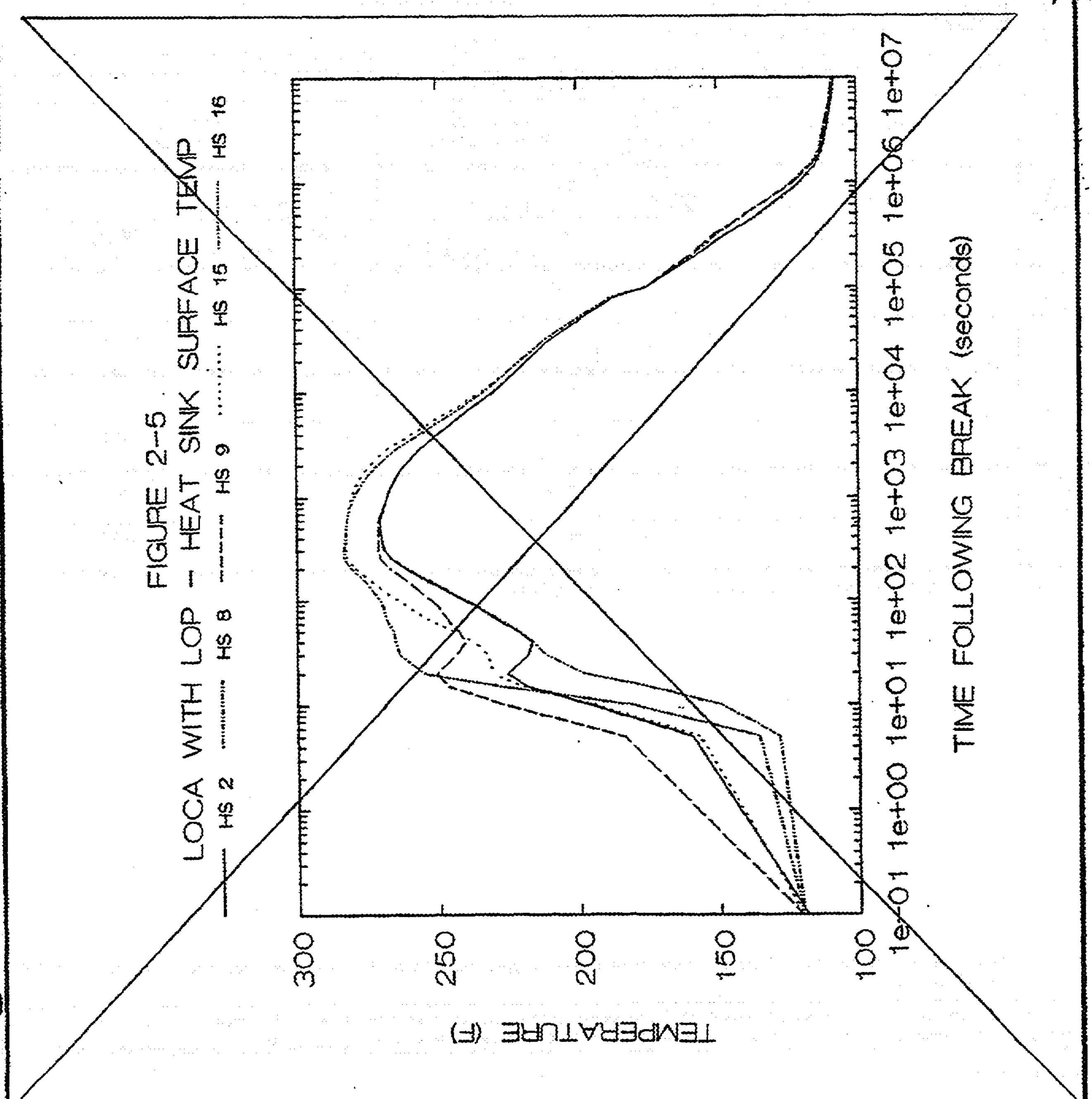
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						
	A. Evinay	01/31/95	P. Barbour	01/31/95						

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



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						
	A. Evinsay	01/31/95	P. Barbour	01/31/95						

THIS FIGURE IS REPLACED BY FIGURE 2-5 IN SUPPLEMENT A



CCN CONVERSION: /

CALCULATION TITLE PAGE

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

CCN CONVERSION: /
CCN NO. CCN- /

Calc. No. N-4080-026 DCP/MMP/FIDCN/FCN No. & Rev. N/A

Subject Containment P/T Analysis for Design Basis LOCA - SUPPLEMENT A Sheet A1

System Number/Primary Station System Designator 1201 / BBB 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 ☐ DATABASE IN ACCORDANCE WITH NES&L 41-5-1	PROGRAM/DATABASE NAME(S) ☐ ALSO, LISTED BELOW NE100 (COPATTA)	VERSION/RELEASE NO.(S) G1-15

RECORDS OF ISSUES

REV. / DISC.	DESCRIPTION	TOTAL SHTS. / LAST SHT.	PREPARED (Print name/initial)	APPROVED (Signature)	
△ 0	ORIGINAL ISSUE	77 / A-77	ORIG. ALLEN EVINAY AE	GS [signature]	Other
			IRE PAUL BARBOUR PB	DM [signature]	DATE 2/6/95
△			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 ____________.

SCE 26-121-1 REV. 9/91

CALCULATION CROSS-INDEX

ICCN NO./ PRELIM. CCN NO. N-1 | PAGE 11 OF 86

CCN CONVERSION: CCN NO. CCN-- 1

Calculation No. N-4080-026 - SUPPLEMENT A   Sheet No. A2

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. Calc/Document No.	Rev. No.	OUTPUTS: Results and conclusion of the subject calculation are used in these interfacing calculations and/or documents. Calc/Document No.	Rev. No.	Does the output interface calc/document require revision? YES / NO	Identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number.
[initials] 0 2/6/95	Calculations:		UFSAR, Section 3.11.3.1.1	10	Yes	SAR23-341
	N-4080-026	0	UFSAR, Section 6.2.1	10	Yes	SAR23-357
	M-0014-009, Supplement A	0	DBD-SO23-TR-EQ	1	Yes	SAR23-341*
	M-0072-036	0	DBD-SO23-TR-AA	0	Yes	NEDOTRAK Log AJB-94-004
			DBD-S023-400	0	Yes	NEDOTRAK Log VJB-95-001
			EQDPs M37600		Yes	NEDOTRAK Log BC-93-079
			M37601			
			M37606			
			M37607			
			M37608			
	Unit 2 Operating License & Technical Specifications	Amdt 101	M37609			
			M37610			
			M37612			
	Unit 3 Operating License & Technical Specifications	Amdt 90	M37615			
			M37618			
			M37619			
			M37620			
			M37621			
			M37624			
			M37629			
			M37631			
			M37635			
			M37636			
			M37640			
			M37641			
			M37644			
			M37646			
			M37703			
			M37704			
			M37705			
			M37706			
			M38279			

CALCULATION CROSS-INDEX

ICCN NO./ PRELIM. CCN NO. N-1 | PAGE 12 OF 86

CCN CONVERSION: CCN NO. CCN-- 1

Calculation No. N-4080-026 - 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 (initials) 2/6/95 ↓			EQDPs, cont'd M38290 M38377 M38378 M38379 M38381 M38382 M38383 M38384 M38385 M38773		Yes ↓	NEDOTRAK Log BC-93-079 ↓
			M38785 M38790 M38798 M39079 M40819 M85083 M85091 M85102 M85108			
						*Performed by NEDO EQ Group as automatic follow-on to R/A of UFSAR Change

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1	PAGE 13 OF 86
CCN CONVERSION CCN NO. CCN -	

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-4

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

TABLE OF CONTENTS

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

1.0 PURPOSE

1.1 TASK DESCRIPTION

The purpose of this Supplement A is to provide a new calculation of the Containment P/T response to the Design Basis LOCA (DB LOCA) event consistent with the Licensing Basis of SONGS Units 2 and 3 (reference 6.2), where the pre-LOCA initial containment pressure is the nominal atmospheric value (14.7 psia) used in prior UFSAR containment functional design. The results of this Supplement A will become the AOR for the Design Basis analysis (DBA) LOCA for the containment functional design and Equipment Qualification. The Supplement A contains additional results to support plant operations aspects of containment P/T analysis. Supplement A will also serve as the AOR for calculation of peak post-LOCA 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 remains valid for the purposes of defining the input modelling for the Design Basis LOCA containment P/T analysis for all parameters except those minor changes identified below.

This Supplement A incorporates several minor changes in the containment heat removal spray system (CSS) and emergency air cooler unit (ECU) 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 containment recirculation mode spray flow rate is reduced to 1950 gpm, bounding the lowest calculated recirculation spray flow with 7.5% degraded containment spray pumps (reference 6.3).

1.1.3 The emergency air cooling unit (ECU) start time is delayed to coincide with the start time of full containment spray flow at 60 seconds. This change adds 25 seconds to the currently calculated post-LOCA start time for the ECUs with loss of power (reference 6.13) at a very small penalty in containment P/T response while providing margin for future changes in ECU start time.

The Design Basis LOCA event continues to be the 9.8175 ft^2 Double-Ended Suction Leg Slot (DESLS) Break LOCA with maximum safety injection flow and loss of off-site power (LOOP).

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Bechtel Standard Computer Code NE100, Release G1-15 (COPATTA) (reference 6.4), on the Nuclear Fuels Engineering IBM-RISC workstation system is used in this calculation to evaluate the containment pressure and temperature transients for the design basis LOCA analysis.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

1.2 CRITERIA, CODES and STANDARDS

The criteria, codes and standards applicable to the Containment P/T Analysis for Design Basis LOCA (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 ^{o}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

2.1.1 Initial Containment Pressure @ 0 PSIG

Figures 2-1 through 2-6 show the analysis results out to 1E+7 seconds (116 days), which is far enough out in time to demonstrate the return of containment conditions to near ambient values. Section 10 contains tabulated data taken from the AOR computer output which was used to prepare the graphs included in this section.

Figure 2-1 presents the containment gauge pressure versus time for the Design Basis LOCA. The plot in Figure 2.1 is generated using the data presented in Section 10.1.

Figure 2-2 presents the containment sump and vapor region temperatures versus time for the Design Basis LOCA. 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 at the surface of the structural heat sinks versus time used by the COPATTA Code during the Design Basis LOCA. The plot in Figure 2.3 is generated using the data presented in Section 10.1.

Figure 2-4A presents the energy content of containment steam and air in the vapor region, the combined steam and air energy, the water energy content in the sump region, and combined total for the vapor and sump regions. The plots in Figure 2-4A are generated using the data presented in Section 10.2.

Figure 2-4B presents the integrated energy content of the containment building structural heat sinks, integrated energy transferred out of the containment through the ECUs and spray heat exchangers, and the integrated energy transferred from the vapor region to the containment sump water by the CSS. The plots in Figure 2-4B are generated using the data presented in Section 10.2.

Figure 2-5 presents the inside surface temperature of heat sink 1 (reactor building dome, painted steel liner plate) to represent the maximum post-LOCA temperature of the containment structure. The plot in Figure 2.5 is generated using the data presented in Section 10.1.

Figure 2-6 presents the CCW heat load from one train of ECUs (2ECUs) and the Spray Hx, together with the combined total. The plots in Figure 2.6 are generated using the data presented in Section 10.2.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Table 2-1 presents the containment P/T Design Basis LOCA accident chronology for case of the initial containment pressure of 14.7 psia (0 psig).

The calculated peak pressure of 55.1 psig is less than the 60 psig design pressure and also less than the previously identified peak pressure (56.9 psig) in the prior AOR (N-4080-026, reference 6.1). The decrease in the peak pressure is mainly attributed to the change in the initial containment pressure from 1.5 psig to 0 psig.

It should be noted that this new AOR peak pressure for the Design Basis LOCA is unchanged from the original AOR value of 55.1 psig documented in calculation N-4080-002 (reference 6.14) although the current analysis includes degraded performance parameters for both containment sprays and ECU heat removal systems and reduced gap conductance between the containment liner plate and concrete shell. The explanation for this apparent anomaly is that the current analysis also includes updated structural heat sink surface areas which were originally utilized in early containment steam line break P/T analyses such as calculations N-4080-005 and N-4080-007 (references 6.15 and 6.16, respectively), as well as the current MSLB containment P/T AOR in N-4080-027 (reference 6.17). The updated heat sinks were not incorporated into LOCA analysis prior to calculation N-4080-026 since the LOCA peak containment pressure was non-limiting and the updated heat sinks only served to lower the calculated peak pressure. The use of different heat sink models for LOCA and MSLB analyses is discussed in the UFSAR (section 6.2.1.1.3.1.B), and the heat sink input used for the MSLB analyses as well as the new LOCA analyses in this calculation are provided in UFSAR Table 6.2-13.

The calculated peak vapor temperature of 295.4 °F is less than the 300 °F design temperature. The peak vapor temperature of 295.4 °F is slightly greater than the previously identified peak temperature (294.5 °F) in the prior AOR (N-4080-026, reference 6.1). The increase in the peak temperature is primarily attributed to the reduced air mass in the containment with 0 psig initial containment pressure compared with the prior analysis at 1.5 psig. The lower air inventory reduces the total containment heat capacity, resulting in slight increase in short-term peak temperature [see BN-TOP-3, Revision 4, Section 4.1.2 and Table 15 (reference 6.8)]. The delay in ECU startup time from 35 seconds to 60 seconds also adds to the slight increase in the peak vapor temperature as compared to the prior analysis.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

2.1.2 **Initial Containment Pressure @ 1.5 PSIG**

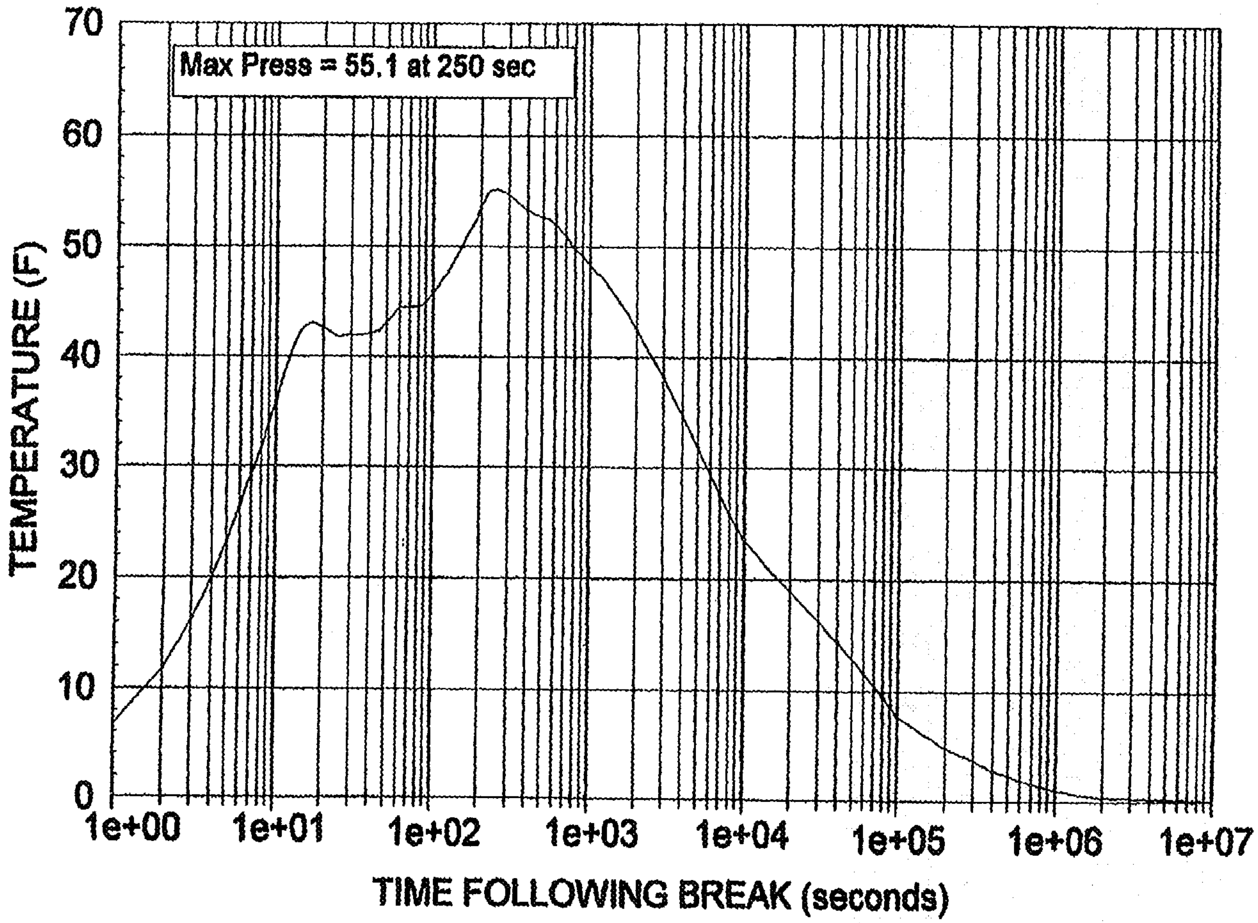
Table 2-2 presents the containment P/T Design Basis LOCA accident chronology for the case of the initial containment pressure of 16.2 psia (1.5 psig).

The calculated peak pressure of 57.0 psig is less than the 60 psig design pressure but slightly greater than the previously identified peak pressure (56.9 psig) in the prior AOR (N-4080-026, reference 6.1). The increase in the peak pressure is attributed to the changes in the delay in the ECU start time and reduced CSS injection rates (see Section 1.1).

The calculated peak vapor temperature of 294.9 °F is less than the 300 °F design temperature. The peak vapor temperature of 294.9 °F is slightly greater than the previously identified peak temperature (294.5 °F) in the prior AOR (N-4080-026, reference 6.1). The increase in the peak temperature is primarily attributed to the delay in ECU startup time from 35 seconds to 60 seconds.

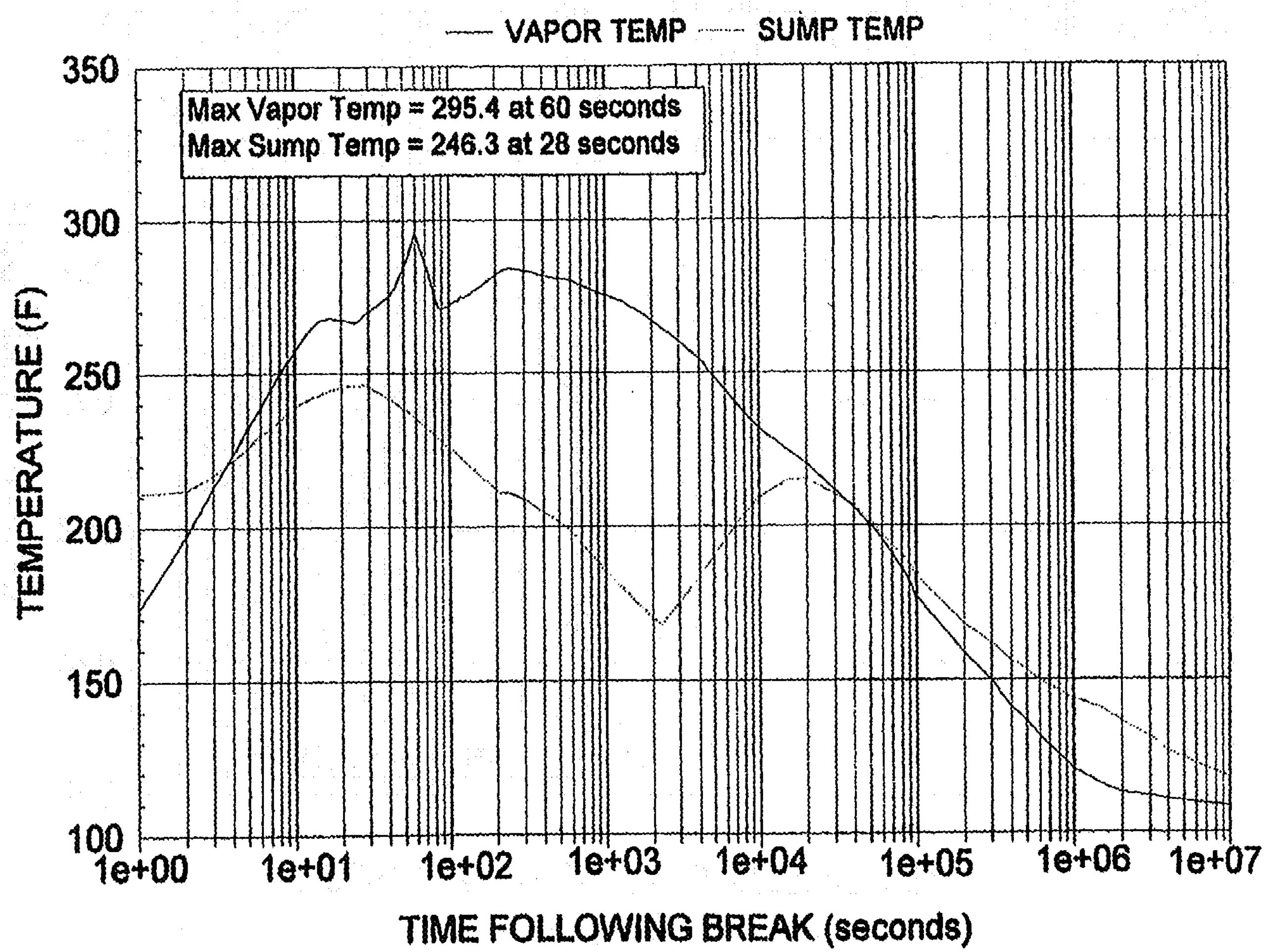
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-1
LOCA WITH LOP - CONTAINMENT PRESSURE



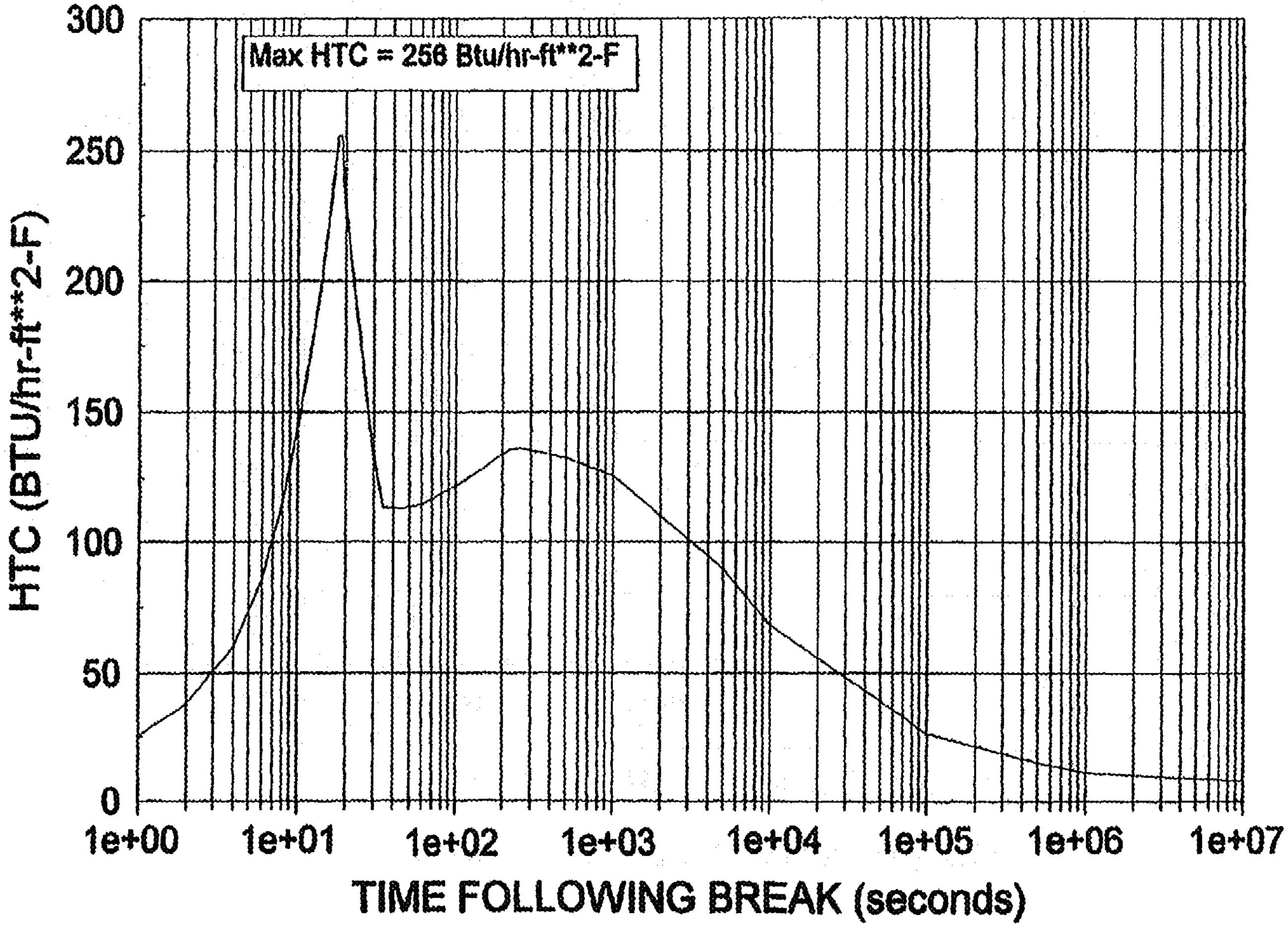
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
A	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-2
LOCA WITH LOP - TEMPERATURE



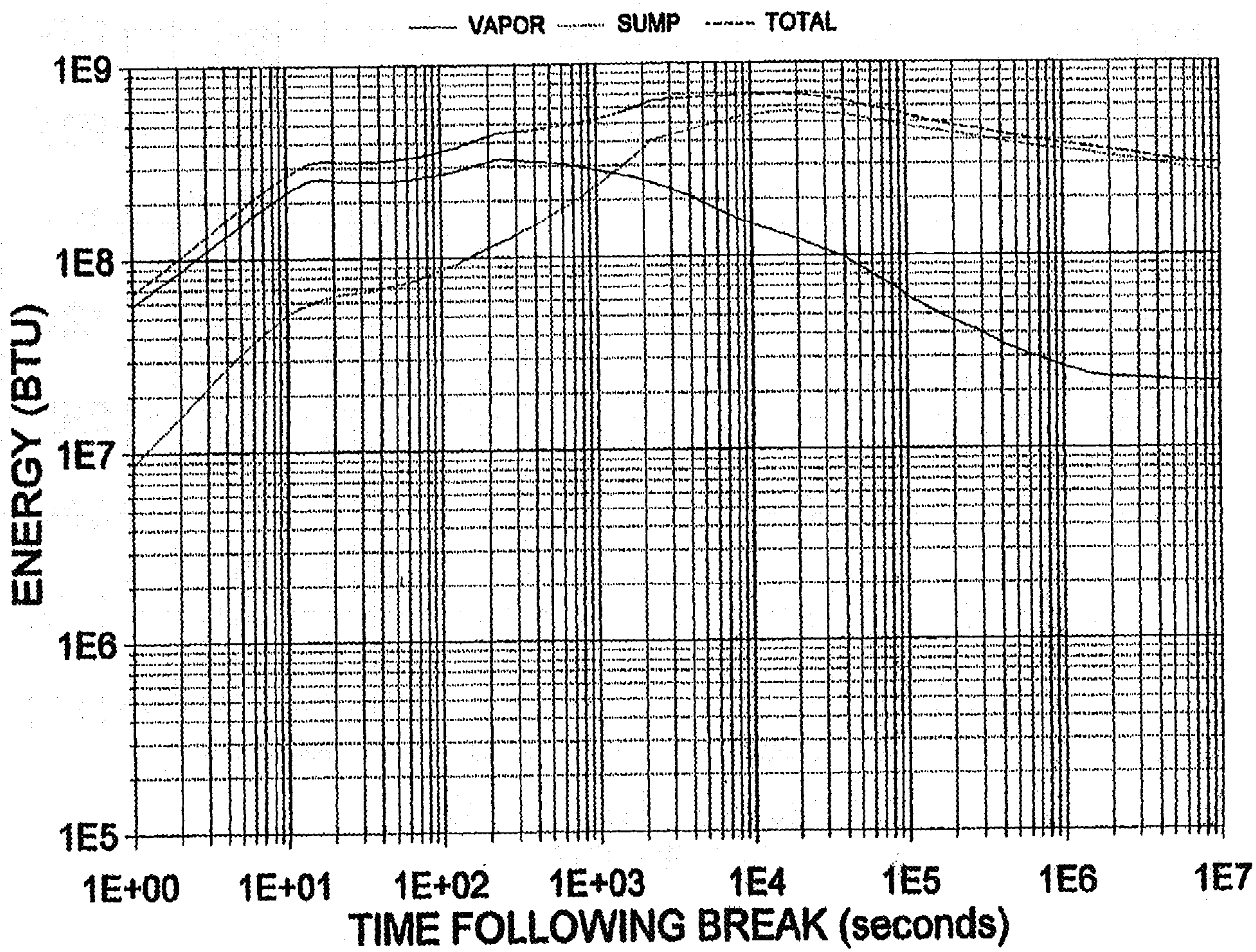
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-3
LOCA WITH LOP - CONDENSING HTC



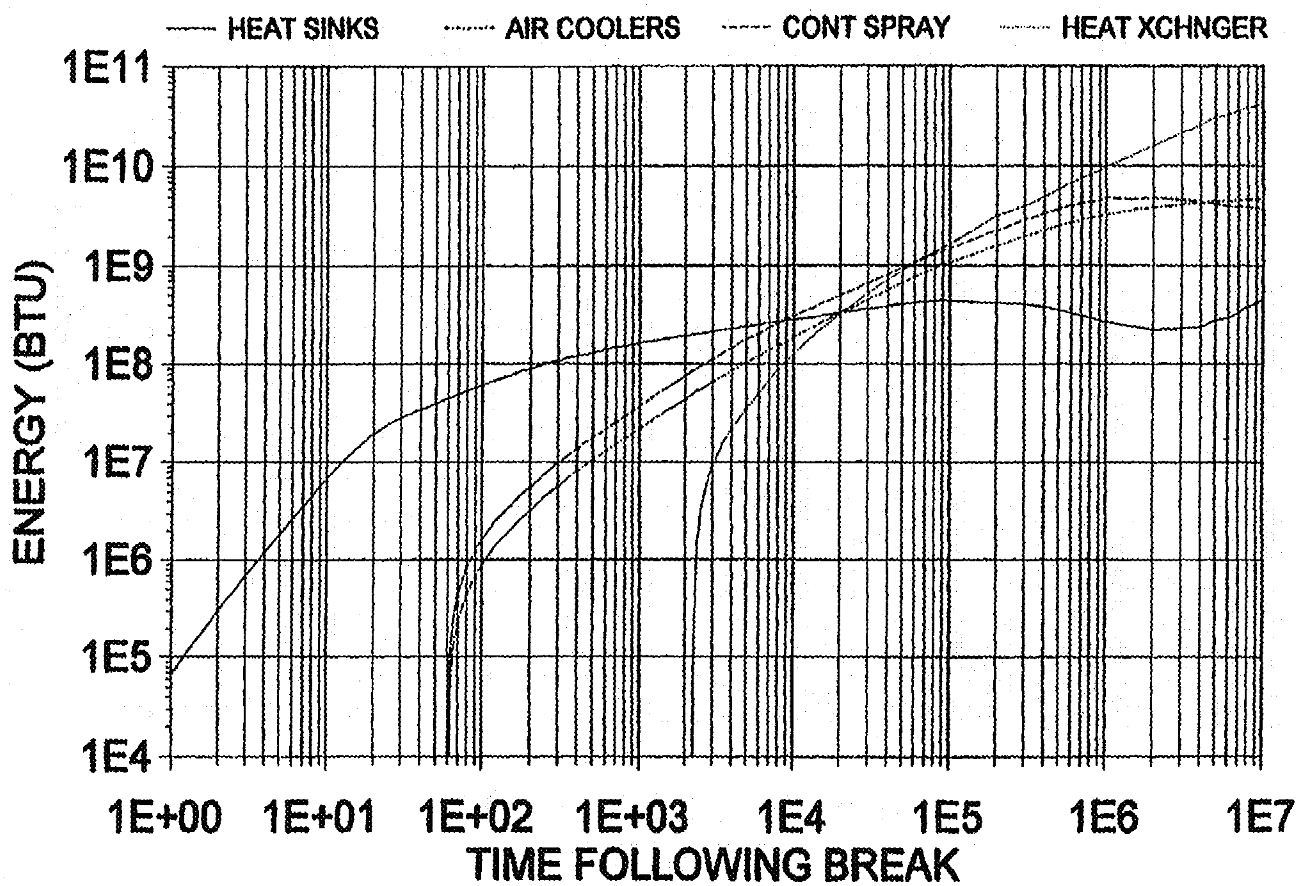
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-4A
LOCA WITH LOP - ENERGY



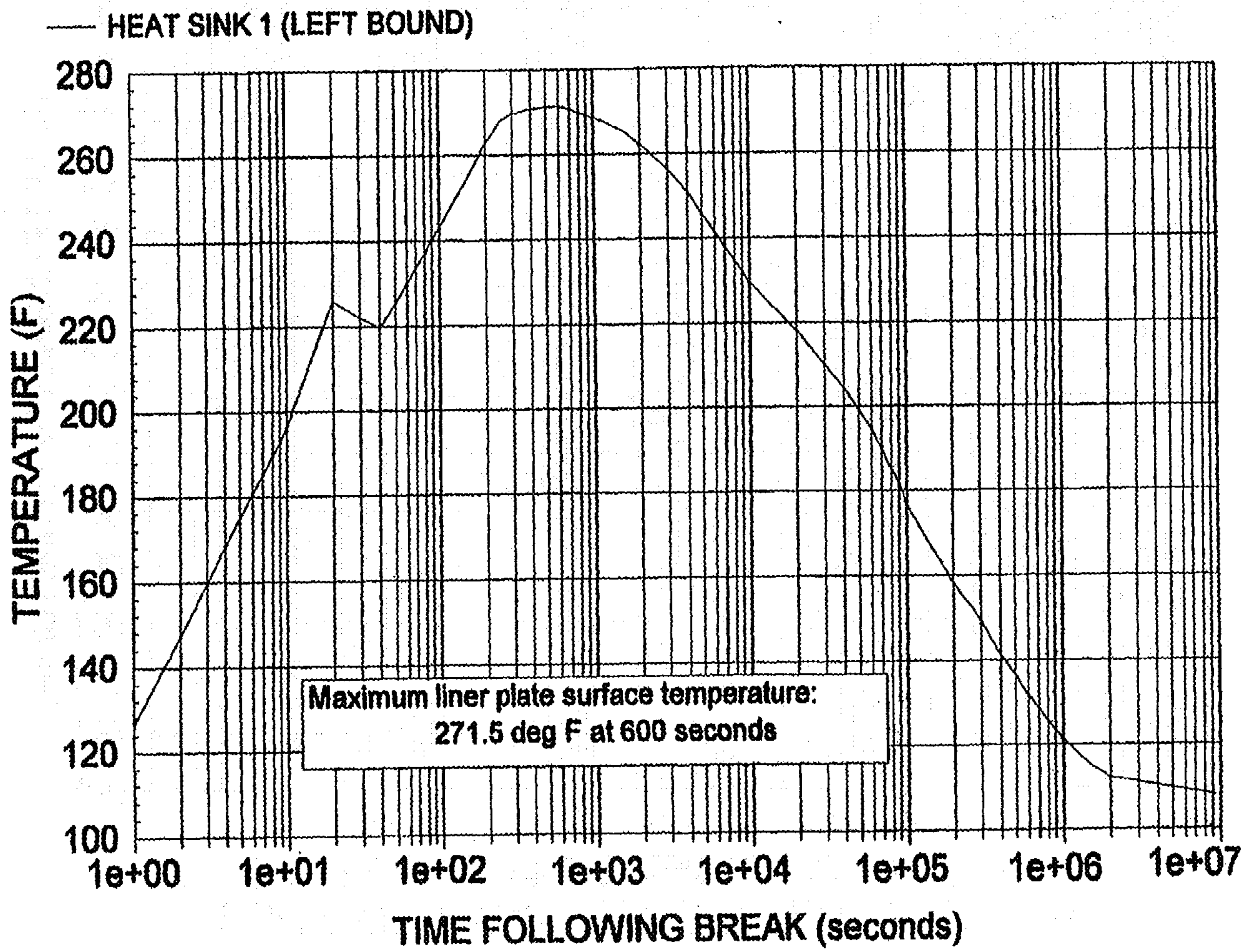
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
A	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-4B
LOCA WITH LOP - ENERGY



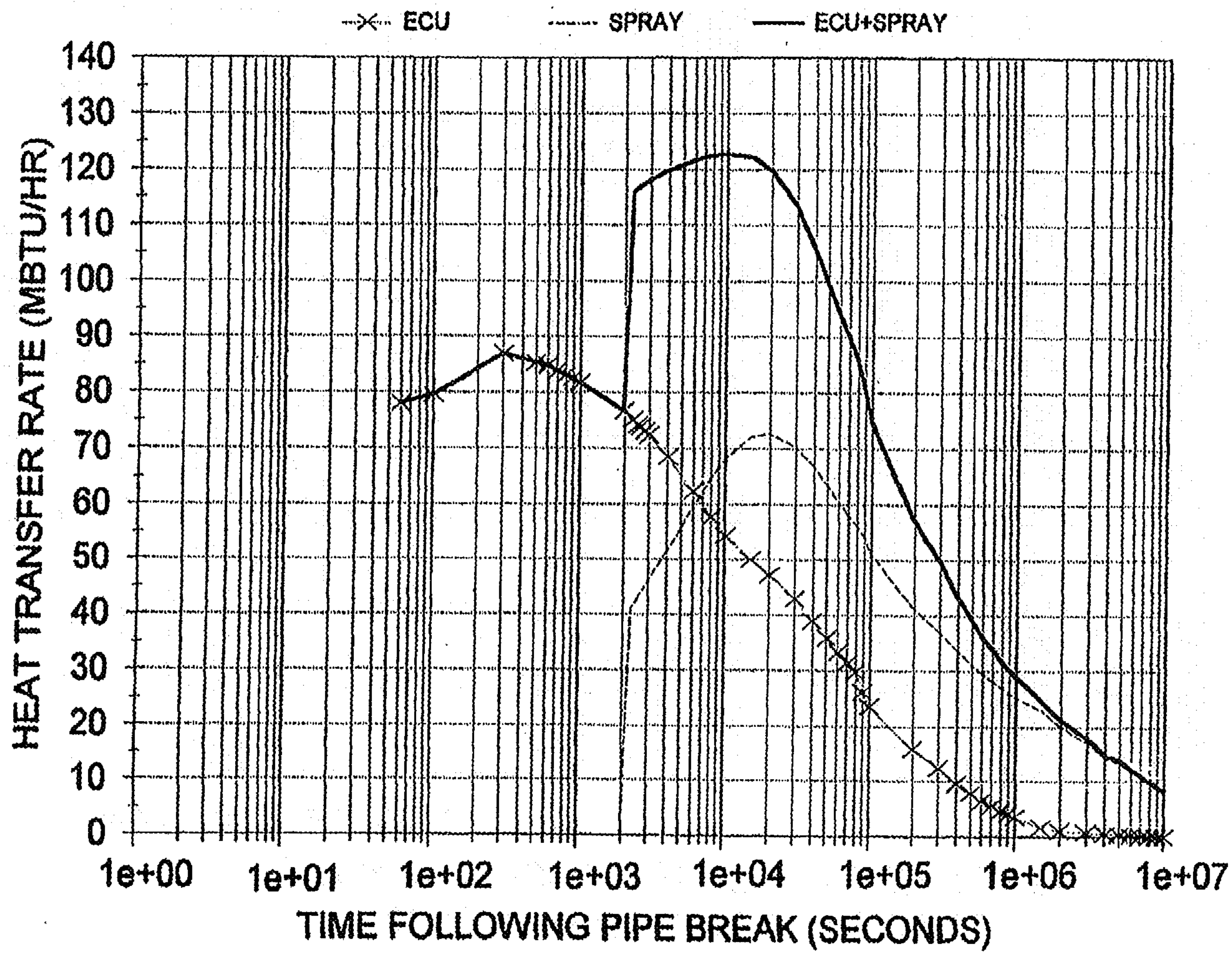
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-5: LINER PLATE SURFACE TEMP
LOCA 102% POWER-9.8175 FT2 BREAK AREA



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

FIGURE 2-6
ECU AND SPRAY HX HT RATES (MBTU/HR)
DBA LOCA-Double Ended Suction Line Slot



Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A
CCN CONVERSION CCN NO. CCN - 1

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Table 2-1

CONTAINMENT P/T DESIGN BASIS LOCA

EVENT CHRONOLOGY

Initial Containment Pressure = 14.7 psia

TIME (seconds)	EVENT
0.0	LOCA Occurs
17.0	**Peak Containment pressure during Blowdown Phase (43.0 psig)**
22.0	End of Blowdown
22.0	Start of Emergency Core Cooling (ECC) Injection Phase
22.0	Start of Core Reflood
60.0	Start of Emergency Air Coolers
60.0	Containment Injection Sprays Start
60.0	**Peak Containment Temperature 295.4 °F**
211.1	Start of Post-Reflood
250.0	**Peak Containment Pressure of 55.1 psig reached**
573.3	End of Post-Reflood

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Table 2-1

(Continued)

CONTAINMENT P/T DESIGN BASIS LOCA

EVENT CHRONOLOGY

Initial Containment Pressure = 14.7 psia

TIME (seconds)	EVENT
573.3	End of ABB-CE-provided Mass and Energy Data
573.3	Start of COPATTA Mass and Energy Release Calculations
600.0	**Containment Liner Plate at Maximum Temperature of 271.5 °F**
2284	End of ECC Injection Phase
2284	Start of ECC Recirculation Phase
2284	End of CS Injection Phase
2284	Start of CS Recirculation Phase
7200	HPSI Realigned to 50:50 split between HL and CL Injection
1E+7	END of COPATTA Run

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Table 2-2

CONTAINMENT P/T DESIGN BASIS LOCA

EVENT CHRONOLOGY

Initial Containment Pressure = 16.2 psia

TIME (seconds)	EVENT
0.0	LOCA Occurs
17.0	**Peak Containment pressure during Blowdown Phase (44.6 psig)**
22.0	End of Blowdown
22.0	Start of Emergency Core Cooling (ECC) Injection Phase
22.0	Start of Core Reflood
60.0	Start of Emergency Air Coolers
60.0	Containment Injection Sprays Start
60.0	**Peak Containment Temperature 294.9 °F**
211.1	Start of Post-Reflood
252.0	**Peak Containment Pressure of 57.0 psig reached**
573.3	End of Post-Reflood

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

Table 2-2

(Continued)

CONTAINMENT P/T DESIGN BASIS LOCA

EVENT CHRONOLOGY

Initial Containment Pressure = 16.2 psia

573.3	End of ABB-CE-provided Mass and Energy Data
573.3	Start of COPATTA Mass and Energy Release Calculations
600.0	**Containment Liner Plate at Maximum Temperature of 270.7 °F**
2284	End of ECC Injection Phase
2284	Start of ECC Recirculation Phase
2284	End of CS Injection Phase
2284	Start of CS Recirculation Phase
7200	HPSI Realigned to 50:50 split between HL and CL Injection
1E+7	END of COPATTA Run

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

2.2 RECOMMENDATIONS

This Supplement A provides a new analysis of record for the containment pressure and temperature response to the Design Basis LOCA event for containment functional design as reported in Section 6.2 of the UFSAR. The new analysis is also applicable to equipment qualification analysis. Supplement A also provides analysis for the determination of peak post-LOCA 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-LOCA 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.

The prior containment P/T response analysis contained in N-4080-026, Revision 0, remains applicable only for the purposes of defining the input modelling for the DB-LOCA containment P/T analysis for all parameters except those changes identified in this Supplement A to the calculation.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

3.0 ASSUMPTIONS

The assumptions used in this calculation are identical to those used in the prior Containment P/T Analysis for Design Basis LOCA (reference 6.1), except where noted. Reference 6.1 remains valid for the purposes of defining the input modelling for the DB-LOCA containment P/T analysis for all parameters except those changes identified in this Supplement A 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 Unit 2 and 3 Technical Specifications LCO 3.6.1.5 (references 6.5 and 6.6).

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 35 seconds in the Design Input 4.3.a. In the present analysis the air cooler start time has been increased to 60 seconds to coincide with the containment spray actuation time. This includes a 10 seconds delay time for the emergency diesel generator actuation after LOOP. The emergency air cooling units have relatively little impact on short-term containment pressure and temperature, and by adding 25 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 6.13), the 60 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.

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

4.0 DESIGN INPUT

The design input used in this calculation are identical to those used in the prior Containment P/T Analysis for Design Basis LOCA (reference 6.1), except where noted. Reference 6.1 remains valid for the purposes of defining the input modelling for the DB-LOCA containment P/T analysis for all parameters except those changes identified in this Supplement A to the calculation. The design inputs 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

4.2.a ITEM 2:PROBLEM RUN TIME

The problem run time will be set to 1E+7 seconds (~116 days), the same run time used for the prior analysis in the base calculation (reference 6.1). This run time of 1E+7 seconds is sufficiently long to show the containment pressure and temperature have returned to near ambient values.

4.2.b ITEM 3: INITIAL CONTAINMENT PRESSURE

Consistent with the original design basis containment P/T response analysis for LOCA 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.

The Supplement A also provides an analysis for the determination of peak post-LOCA 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 35 seconds to 60 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

Minor changes are made to card series 301 input to correct typographical errors at 19.8 and 432.076 seconds. This card series provides the mass flow rate and fluid enthalpy entering the containment from LOCA. The data is for the Design basis LOCA at 102% power with 9.8175 ft^2 double-ended suction leg slot (DESLS) break. The changes made to correct input data are :

19.8, **7.146e+06**, 4.8810e+02 ==>> 19.800, **6.066e+06**, 4.8810e+02

432.076, 4.8233e+06, **1.1593e+02** ==>> 432.076, 4.8233e+06, **1.1817e+02**

4.5 CARD SERIES 601

Minor changes are made to card series 601 input to correct typographical error which inadvertently rammed down the reflood period spillage down to the initial post-reflood value rather than holding it constant as specified by ABB-CE in their original data transmittal letter (reference 6.7).

The changes are:

From:

```
$LIST POOL=601,
           0.00,     0.00,      0.00,
          28.00,     0.00,      0.00,
          28.00,   4.e+06, 5.362e+08,    PRESENT N-4080-026
        211.101, 8.73e+05,   7.7e+07,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

To:-

```
$LIST POOL=601,
                 0.00,       0.00,        0.00,
                28.00,       0.00,        0.00,
                28.00,  4.823e+06,   5.362e+08,
  ADD LINE     211.10,  4.823e+06,   5.362e+08,    NEW N-4080-026
              211.101,   8.73e+05,     7.7e+07,
```

4.6 CARD SERIES 801

No changes are made to card series 801 input except:

4.6.a.2(a) CONTAINMENT SPRAY INJECTION MODE SPRAY FLOW RATE

The minimum containment spray pump flow Rate with 7.5% pump degradation has been changed to 1606 gpm (reference 6.3). In this Supplement A 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 previous analysis (reference 6.1), 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 is switched to CSS recirculation flow at 2284 seconds. This calculated value is slightly longer than the previous value of 2280 seconds (reference 6.1, section 4.10.b.1 and 4.10.b.2) due to the slightly smaller injection spray flow (1600 gpm v.s. 1612 gpm) used in this re-analysis. In addition to CSS recirculation flow, containment heat removal is also provided by the continued operation of the single train emergency air cooler units (2ECUs).

4.6.a.2(b) CONTAINMENT SPRAY RECIRCULATION MODE SPRAY FLOW RATE

The containment recirculation spray flow is rounded down to 1950 gpm from the minimum calculated value of 1991 gpm used in the prior analysis (reference 6.1), providing a small conservatism for the long-term containment cooldown analysis. Based on the same sump water temperature previously used in reference 6.1 the corresponding mass flow rate is 9.30e+5 lbm/hr.

4.7 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	01/31/95	PAUL BARBOUR	02/03/95					

5.0 METHODOLOGY

The Containment P/T LOCA evaluated in this calculation is the design basis 9.8175 ft^2 DESLS at 102% power with loss of off-site power and with 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 LOCA.

The methodology employed in this calculation is identical to the present AOR (reference 6.1) for the Containment P/T Design Basis LOCA, with the exception that two different pre-LOCA 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-LOCA 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.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

6.0 REFERENCES

6.1 SONGS Units 2&3 Calculation N-4080-026, Revision 0, "Containment P/T Analysis for Design Basis LOCA", 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.

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

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

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

6.7 Letter, CE to BPC, "FSAR Mass/Energy Release Data for Containment Design", S-CE-2604, dated March 1, 1976 (CDM No. C760301G-45-2-4SVT).

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

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.

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

6.14 SONGS Units 2 and 3 Calculation N-4080-002, Revision 1, "Containment Pressure-Temperature Transient Analysis", October 19, 1976

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

6.15 SONGS Units 2 and 3 Calculation N-4080-005, Revision 0, "MSLB Analysis for Environmental Qualification", March 15, 1978

6.16 SONGS Units 2 and 3 Calculation N-4080-007, Revision 2, "Containment Pressure and Temperature From MSLB at Various Power Levels (NRC Question 022.7)", April 21, 1983

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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

7.0 NOMENCLATURE

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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

8.0 CALCULATION

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

COPATTA input data for the Containment P/T Design Basis LOCA Analysis for Equipment Qualification uses the Containment P/T Design Basis LOCA 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

* DBLOCA+LOOP (DESLS), CPi=0.0 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s

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=1,1E7,14.7,2.305E6,120,0.6,20,582.945,1,1,0.08,14.7,0,0.50 $END

ITEM 2: TNFL = 1E7 seconds(per 4.2.a)

ITEM 3: PAIR = 14.7 psia

The initial containment pressure before the LOCA mass and energy release is set to 14.7 psia for Design Basis 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.

8.1.4 CARD SERIES 5 Air Cooler Information

$LIST POOL=5,2,60,1E7,0,0 $END

ITEM 3: This item reflect the change of Containment Air Cooler start time from 35 seconds to 60 seconds as discussed in Design Input Item 4.3.a. No other changes have been made to this card data.

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

8.1.5 CARD SERIES 801 (Table 9)

This Card Series reflect the change of Containment Spray System (CSS) injection flow rate from 1612 gpm to 1600 gpm. The input in this table is also modified to account for the change in time to CSS recirculation time from 2280 seconds to 2284 seconds due to the change of the CSS flow rate from 1612 gpm to 1600 gpm (see section 4.10 reference 6.1, sheet #56 for the calculation of t-recirc). The CSS recirculation flow rate has also been changed from 1991 gpm to 1950 gpm per 4.6.a.2(b) (9.30e+5 lbm/hr) and this is reflected in the input shown below.

```
$LIST POOL=801,
               0,          0,          0,     0,  100,  100,
              60,          0,          0,     0,  100,  100,
              60, 7.956e+05,           0,     0,  100,  100,
         573.273, 7.956e+05,           0,     0,  100,  100,
         573.273, 7.956e+05,  3.12e+06,  0.90,  100,  100,
             800, 7.956e+05,  3.12e+06,  0.90,  100,  100,
             900, 7.956e+05,  3.12e+06,  0.91,  100,  100,
            1500, 7.956e+05,  3.12e+06,  0.92,  100,  100,
            2284, 7.956e+05,  3.12e+06,  0.93,  100,  100,
            2284, 9.303e+05,  6.30e+05,  0.67,    0,    0,
            3000, 9.303e+05,  6.30e+05,  0.68,    0,    0,
            4000, 9.303e+05,  6.30e+05,  0.68,    0,    0,
            5000, 9.303e+05,  6.30e+05,  0.70,    0,    0,
            7200, 9.303e+05,  6.30e+05,  0.73,    0,    0,
            7200, 9.303e+05,  6.30e+05,  0.50,    0,    0,
         1.00e+7, 9.303e+05,  6.30e+05,  0.50,    0,    0 $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.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

8.2 COPATTA CODE INPUT DATA - Initial Containment Pressure **CPi = 16.2 psia**

Supplement A also provides additional analysis to determine the margin for peak post-LOCA 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 LOCA Analysis and Equipment Qualification, presented in Section 8.1 of this document.

8.2.1 TITLE CARD

* TSLOCA+LOOP (DESLS), CPi=1.5 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s

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 1General Problem Information

&LIST POOL=1,1E7,16.2,2.305E6,120,0.6,20,582.945,1,1,0.08,14.7,0,0.50 $END

ITEM 3: PAIR = 16.2 psia

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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

9.0 COPATTA INPUT FILES

9.1 DBLOCA CPi = 14.7 psia

```
* DBLOCA+LOOP (DESLS), CPi=0.0 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s
 $LIST POOL=0,2,1,0,1 $END
 $LIST POOL=1,1E7,14.7,2.305e6,120,0.6,20,582.945,1,18,0.00,14.7,0.5 $END
 $LIST POOL=2,0,0,1.68e5,2934,0,120,573.273 $END
 $LIST POOL=3,0,0,0,0,0,1.00e7,0,0,0,0 $END
 $LIST POOL=4,1,6860,216,105,3.0e6,0,0,0,0,0,0,0 $END
 $LIST POOL=5,2,60,1.0e7,0,0 $END
 $LIST POOL=6,0,0,0 $END
 $LEAK NOPEN=0 $END
 $LIST POOL=101,
              0.0000,      0.0000,
          5.7327E+02,      0.0000,
          5.7327E+02,  3.2931E+08,
          6.0000E+02,  3.2624E+08,
          8.0000E+02,  3.0812E+08,
          1.0000E+03,  2.9449E+08,
          2.0000E+03,  2.2734E+08,
          4.0000E+03,  1.7963E+08,
          6.0000E+03,  1.5728E+08,
          8.0000E+03,  1.4506E+08,
          1.0000E+04,  1.3706E+08,
          2.0000E+04,  1.1366E+08,
          4.0000E+04,  8.9771E+07,
          6.0000E+04,  7.8463E+07,
          8.0000E+04,  7.2141E+07,
          1.0000E+05,  6.7894E+07,
          2.0000E+05,  5.4991E+07,
          4.0000E+05,  4.1412E+07,
          6.0000E+05,  3.4734E+07,
          8.0000E+05,  3.0911E+07,
          1.0000E+06,  2.8363E+07,
          2.0000E+06,  2.1296E+07,
          4.0000E+06,  1.4713E+07,
          6.0000E+06,  1.1629E+07,
          1.0000E+07,  8.5482E+06 $END
 $LIST POOL=201,
                  0,  2.5836e7,
             211.10,  2.5836e7,
             211.10,         0,
            573.273,         0,
            573.273,  1.2635e7,
           8.64e+04,  1.2635e7,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
                8.64e+04,          0,
                1.00e+07,          0 $END
   $LIST POOL=301,
                       0,           0,            0,
                   0.025,  2.7068e+08,   5.4632e+02,
                   0.075,  2.6757e+08,   5.4681e+02,
                   0.175,  2.8058e+08,   5.4848e+02,
                    0.20,  3.3993e+08,   5.4933e+02,
                   0.225,  3.3506e+08,   5.4967e+02,
                    0.25,  3.3534e+08,   5.5012e+02,
                    0.40,  3.1384e+08,   5.5312e+02,
                    0.75,  2.9337e+08,   5.6162e+02,
                    0.85,  2.7364e+08,   5.6237e+02,
                     1.0,  2.4650e+08,   5.6329e+02,
                     1.2,  2.2548e+08,   5.6429e+02,
                     2.0,  2.0756e+08,   5.6709e+02,
                     3.0,  1.8229e+08,   5.7573e+02,
                     4.0,  1.5767e+08,   5.9697e+02,
                     5.0,  1.3255e+08,   6.3045e+02,
                     6.0,  1.1328e+08,   6.5884e+02,
                     8.0,  9.4860e+07,   6.7161e+02,
                    10.0,  7.8800e+07,   6.8765e+02,
                    12.0,  5.4454e+07,   7.6610e+02,
                    13.5,   3.566e+07,    8.640e+02,
                    14.5,   2.888e+07,    7.502e+02,
                    15.0,   2.627e+07,    7.199e+02,
                    16.0,   1.768e+07,    6.699e+02,
                    17.1,   1.119e+07,    6.556e+02,
                    17.2,   1.140e+07,    6.386e+02,
                    17.3,   9.065e+06,    6.213e+02,
                    18.5,   6.152e+06,    6.439e+02,
                    19.3,   8.806e+06,    4.605e+02,
                    19.8,   6.066e+06,    4.881e+02,
                    20.6,   4.172e+06,    5.348e+02,
                    20.8,   1.016e+07,    3.317e+02,
                    21.4,   3.629e+06,    3.700e+02,
                    21.6,    1.77e+06,     3.66e+02,
                    21.8,     3.0e+05,      3.4e+02,
                    22.0,        0.00,         0.00,
                    22.0,        0.00,         0.00,
                   22.25,  5.8302e+05,   1.3000e+03,
                   23.25,  9.2236e+05,   1.3000e+03,
                   24.25,  1.5463e+06,   1.3000e+03,
                   25.25,  2.0444e+06,   1.3000e+03,
                   26.25,  2.4255e+06,   1.3000e+03,
                   27.75,  2.8736e+06,   1.3000e+03,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
     28.00,  1.8443e+06,  1.3000e+03,
     36.00,  1.8201e+06,  1.3000e+03,
     44.50,  1.7920e+06,  1.3000e+03,
     44.75,  2.7987e+06,  1.3000e+03,
     75.00,  2.6467e+06,  1.3000e+03,
    100.00,  2.5190e+06,  1.3000e+03,
    125.00,  2.3921e+06,  1.3000e+03,
    150.00,  2.2677e+06,  1.3000e+03,
    175.00,  2.1401e+06,  1.3000e+03,
    200.00,  2.0116e+06,  1.3000e+03,
    211.10,  1.9553e+06,  1.3000e+03,
   211.101,  2.2478e+06,  1.1865e+03,
   211.336,  2.2378e+06,  1.1865e+03,
   211.573,  2.2279e+06,  1.1865e+03,
   211.812,  2.2179e+06,  1.1865e+03,
   212.052,  2.2080e+06,  1.1865e+03,
   213.026,  2.1615e+06,  1.1877e+03,
   215.073,  2.0469e+06,  1.1878e+03,
   216.989,  1.9466e+06,  1.1879e+03,
   219.039,  1.8464e+06,  1.1880e+03,
   221.233,  1.7463e+06,  1.1881e+03,
   222.894,  1.6748e+06,  1.1883e+03,
   225.021,  1.5891e+06,  1.1884e+03,
   226.920,  1.5179e+06,  1.1885e+03,
   228.953,  1.4468e+06,  1.1887e+03,
   231.139,  1.3760e+06,  1.1889e+03,
   233.014,  1.3194e+06,  1.1891e+03,
   235.017,  1.2631e+06,  1.1892e+03,
   237.167,  1.2070e+06,  1.1894e+03,
   238.890,  1.1647e+06,  1.1900e+03,
   240.719,  1.1232e+06,  1.1898e+03,
   242.668,  1.0816e+06,  1.1900e+03,
   245.484,  1.0265e+06,  1.1902e+03,
   246.897,  9.9907e+05,  1.1904e+03,
   249.420,  9.5821e+05,  1.1906e+03,
   251.151,  9.3110e+05,  1.1908e+03,
   254.936,  8.7746e+05,  1.1911e+03,
   259.251,  8.2462e+05,  1.1914e+03,
   262.929,  7.8563e+05,  1.1917e+03,
   267.086,  7.4729e+05,  1.1919e+03,
   271.855,  7.0974e+05,  1.1921e+03,
   281.634,  6.4948e+05,  1.1925e+03,
   292.060,  6.0412e+05,  1.1925e+03,
   302.415,  5.7236e+05,  1.1923e+03,
   311.215,  5.5256e+05,  1.1919e+03,
   321.094,  5.3597e+05,  1.1820e+03,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
            331.360,  5.2312e+05,  1.1820e+03,
            340.999,  5.1401e+05,  1.1819e+03,
            351.095,  5.0663e+05,  1.1819e+03,
            361.352,  5.0080e+05,  1.1819e+03,
            371.311,  4.9637e+05,  1.1818e+03,
            391.750,  4.8974e+05,  1.1818e+03,
            411.491,  4.8546e+05,  1.1819e+03,
            432.076,  4.8233e+05,  1.1817e+03,
            452.069,  4.8013e+05,  1.1817e+03,
            471.774,  4.7851e+05,  1.1816e+03,
            524.047,  4.7578e+05,  1.1816e+03,
            573.273,  4.7426e+05,  1.1816e+03,
            573.273,        0.00,        0.00,
           1.00e+07,        0.00,        0.00 $END
    $LIST POOL=401,
                  0,  0,  0,
              211.1,  0,  0,
            573.273,  0,  0,
            573.273,  1,  1,
           8.64e+04,  1,  1,
           8.64e+04,  1,  0,
           1.00e+07,  1,  0 $END
    $LIST POOL=501,
                0.0,  0,  0,
            1.0e+07,  0,  0 $END
    $LIST POOL=601,
               0.00,      0.00,      0.00,
              28.00,      0.00,      0.00,
              28.00, 4.823e+06, 5.362e+08,
             211.10, 4.823e+06, 5.362e+08,
            211.101,  8.73e+05,   7.7e+07,
            211.336,  8.83e+05,   7.8e+07,
            211.573,  8.93e+05,   7.9e+07,
            211.812,  9.03e+05,   7.9e+07,
            212.052,  9.13e+05,   8.0e+07,
            213.026,  9.60e+05,   8.4e+07,
            215.073,  1.07e+06,   9.5e+07,
            216.989,  1.17e+06,   1.0e+08,
            219.039,  1.27e+06,   1.1e+08,
            221.233,  1.37e+06,   1.2e+08,
            222.894,  1.45e+06,   1.3e+08,
            225.021,  1.53e+06,   1.3e+08,
            226.920,  1.60e+06,   1.4e+08,
            228.953,  1.67e+06,   1.5e+08,
            231.139,  1.75e+06,   1.5e+08,
            233.014,  1.80e+06,   1.6e+08,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
            235.017,    1.86e+06,    1.6e+08,
            237.167,    1.91e+06,    1.7e+08,
            238.890,    1.96e+06,    1.7e+08,
            240.719,    2.00e+06,    1.8e+08,
            242.668,    2.04e+06,    1.8e+08,
            245.484,    2.09e+06,    1.8e+08,
            246.897,    2.12e+06,    1.9e+08,
            249.420,    2.16e+06,    1.9e+08,
            251.151,    2.19e+06,    1.9e+08,
            254.936,    2.24e+06,    2.0e+08,
            259.251,    2.30e+06,    2.0e+08,
            262.929,    2.34e+06,    2.1e+08,
            267.086,    2.37e+06,    2.1e+08,
            271.855,    2.41e+06,    2.1e+08,
            281.634,    2.47e+06,    2.2e+08,
            292.060,    2.52e+06,    2.2e+08,
            302.415,    2.55e+06,    2.2e+08,
            311.215,    2.57e+06,    2.3e+08,
            321.094,    2.59e+06,    2.3e+08,
            331.360,    2.60e+06,    2.3e+08,
            340.999,    2.61e+06,    2.3e+08,
            351.095,    2.61e+06,    2.3e+08,
            361.352,    2.62e+06,    2.3e+08,
            371.311,    2.62e+06,    2.3e+08,
            391.750,    2.63e+06,    2.3e+08,
            411.491,    2.64e+06,    2.3e+08,
            432.076,    2.64e+06,    2.3e+08,
            452.069,    2.64e+06,    2.3e+08,
            471.774,    2.64e+06,    2.3e+08,
            524.047,    2.65e+06,    2.3e+08,
            573.273,    2.65e+06,    2.3e+08,
            573.273,        0.00,       0.00,
            1.00e+07,       0.00,       0.00 $END
$LIST POOL=701,
                  0,  0,  1,  0,
              211.1,  0,  1,  0,
              211.1,  0,  0,  0,
            573.273,  0,  0,  0,
           8.64e+04,  0,  0,  0,
           1.00e+07,  0,  0,  0 $END
$LIST POOL=801,
                 0,          0,          0,      0,  100,  100,
                60,          0,          0,      0,  100,  100,
                60,  7.956e+05,          0,      0,  100,  100,
           573.273,  7.956e+05,          0,      0,  100,  100,
           573.273,  7.956e+05,   3.12e+06,   0.90,  100,  100,
```

```
                800,  7.956e+05,  3.12e+06,   0.90,  100,  100,
                900,  7.956e+05,  3.12e+06,   0.91,  100,  100,
               1500,  7.956e+05,  3.12e+06,   0.92,  100,  100,
               2284,  7.956e+05,  3.12e+06,   0.93,  100,  100,
               2284,  9.303e+05,  6.30e+05,   0.67,    0,    0,
               3000,  9.303e+05,  6.30e+05,   0.68,    0,    0,
               4000,  9.303e+05,  6.30e+05,   0.68,    0,    0,
               5000,  9.303e+05,  6.30e+05,   0.70,    0,    0,
               7200,  9.303e+05,  6.30e+05,   0.73,    0,    0,
               7200,  9.303e+05,  6.30e+05,   0.50,    0,    0,
            1.00e+7,  9.303e+05,  6.30e+05,   0.50,    0,    0 $END
 $LIST POOL=901,
                0.0,  0,  0,
            1.0e+07,  0,  0 $END
 $LIST POOL=1001,
                0,  100,  2.0,
               24,  100,  2.0 $END
 $LIST POOL=1101,
            105,       0.000,
            120,   1.670e+06,
            130,   3.020e+06,
            140,   4.570e+06,
            150,   6.320e+06,
            160,   8.270e+06,
            170,   1.040e+07,
            180,   1.273e+07,
            190,   1.523e+07,
            200,   1.788e+07,
            210,   2.068e+07,
            220,   2.361e+07,
            230,   2.664e+07,
            240,   2.974e+07,
            250,   3.291e+07,
            260,   3.611e+07,
            270,   3.931e+07,
            280,   4.252e+07,
            287,   4.474e+07,
            290,   4.569e+07,
            300,   4.882e+07 $END
 $LIST POOL=1201,
            0.0,  0.729,
            0.1,  0.737,
            0.2,  0.747,
            0.3,  0.757,
            0.4,  0.771,
            0.5,  0.788,
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
          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,
               1,  0.05,    0.1,  10,
              10,  0.05,    1.0,   9,
              20,  0.05,    1.0,  10,
             100,   0.1,    1.0,  20,
             300,   1.0,    5.0,  10,
             400,   1.0,   10.0,  10,
             600,   2.0,   10.0,  10,
          3e+03,   5.0,   50.0,   4,
          4e+03,  10.0,    100,   5,
          1e+04,  50.0,    500,   4,
          4e+04,  50.0,   2500,   4,
          1e+05,  50.0,   5000,   2,
          3e+05,  50.0,  25000,   4,
          1e+06,  50.0,  1e+05,   1,
          1e+07,  50.0,  5e+05,   1,
          2e+07,  50.0,  5e+05,   1 $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,
                   21, 4.06363 $END
 $LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2 $END
 $LIST POOL=101300, 0, 0 $END
 $LIST POOL=101400, 2, 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, 2, 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
```

NES&L DEPARTMENT

CALCULATION SHEET

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-41

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
 $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, 2, 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"
 $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, 2, 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, 2, 2, 2, 2 $END
```

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-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-42

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
* 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, 2, 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, 2, 2, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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, 2, 2, 0, 2 $END
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

```
* 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, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

9.2 TSLOCA CPi = **16.2** psia

```
* TSLOCA+LOOP (DESLS), CPi=1.5 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s
 $LIST POOL=0,2,1,0,1 $END
 $LIST POOL=1,1E7,16.2,2.305e6,120,0.6,20,582.945,1,18,0.00,14.7,0.5 $END
```

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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

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 with the initial containment pressure @ 0 PSIG.

10.1 Tables for Figures 2-1, 2-2 and 2-5

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	CONTAINMENT VAPOR TEMP (F)	CONTAINMENT SUMP TEMP (F)	HEAT SINK 1 (LEFT BOUND)* (F)
0	0.00	120.00	120.00	
1	6.68	173.11	211.06	126.2
2	11.69	197.16	212.02	
3	16.00	212.43	216.68	
4	19.78	223.39	221.70	
5	23.24	232.08	225.69	
6	26.22	238.77	229.96	
7	29.02	244.51	232.05	
8	31.47	249.70	234.56	
9	33.81	253.41	236.59	
10	35.82	256.86	238.60	195.9
11	37.76	260.02	240.16	
12	39.41	262.74	241.27	
13	40.78	264.72	242.14	
14	41.94	266.61	242.77	
15	42.58	267.43	243.44	
16	42.90	267.87	244.00	

NES&L DEPARTMENT

CALCULATION SHEET

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

CCN CONVERSION CCN NO. CCN -

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-46

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

TIME (SEC)	CONTAINMENT PRESSURE (PSIG)	CONTAINMENT VAPOR TEMP (F)	CONTAINMENT SUMP TEMP (F)	HEAT SINK 1 (LEFT BOUND)* (F)
17	43.00	267.98	244.47	
18	42.92	267.88	244.81	
19	42.79	267.69	245.10	
20	42.62	267.46	245.44	226.0
22	42.22	266.86	245.93	
24	41.89	266.43	246.07	
25	41.81	266.63	246.13	
26	41.80	267.12	246.19	
28	41.87	268.70	246.30	
30	41.90	269.75	245.52	
32	41.91	270.75	244.75	
33	41.93	271.28	244.37	
34	41.95	271.84	244.00	
36	42.00	272.97	243.26	
38	42.05	274.11	242.53	
40	42.12	274.30	241.82	219.7
42	42.19	276.47	241.13	
44	42.26	277.65	240.45	
45	42.23	278.45	240.11	
46	42.47	279.60	239.78	
48	42.74	281.89	239.12	
50	43.01	284.17	238.48	
52	43.28	286.42	237.84	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	CONTAINMENT	CONTAINMENT	CONTAINMENT	HEAT SINK 1
TIME	PRESSURE	VAPOR TEMP	SUMP TEMP	(LEFT BOUND)*
(SEC)	(PSIG)	(F)	(F)	(F)
54	43.56	288.70	237.23	
56	43.85	290.93	236.62	
58	44.12	293.15	236.03	
60	44.40	295.35	235.44	229.8
62	44.41	293.37	234.88	
64	44.41	291.34	234.32	
66	44.41	289.33	233.77	
68	44.42	287.35	233.23	
70	44.43	285.38	232.70	
75	44.46	280.63	231.42	
80	44.52	276.08	230.18	236.9
85	44.62	271.76	228.99	
90	44.87	270.75	227.89	
95	45.34	271.43	226.66	
100	45.66	271.85	225.87	242.9
105	46.12	272.91	224.91	
110	46.51	273.28	223.99	
115	46.94	273.45	223.13	
120	47.32	274.42	222.27	
125	47.52	274.22	221.46	
130	48.04	274.77	220.68	
135	48.44	275.33	219.92	
140	48.83	275.85	219.40	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	CONTAINMENT	CONTAINMENT	CONTAINMENT	HEAT SINK 1
TIME	PRESSURE	VAPOR TEMP	SUMP TEMP	(LEFT BOUND)*
(SEC)	(PSIG)	(F)	(F)	(F)
145	49.29	276.93	218.48	
150	49.67	277.34	217.79	254.5
155	49.99	277.47	217.15	
160	50.38	277.89	216.50	
165	50.77	278.36	215.89	
170	51.13	279.06	215.28	
175	51.48	279.37	214.72	
180	51.85	279.88	214.16	
185	52.23	280.27	213.61	
190	52.58	280.68	213.09	
195	52.96	281.27	212.58	
200	53.37	281.84	212.06	
205	53.71	282.17	211.58	
210	54.04	282.48	211.12	
215	54.35	282.81	211.11	
220	54.61	283.12	211.16	
225	54.80	283.36	211.16	
230	54.95	283.53	211.12	
235	55.03	283.63	211.06	
240	55.08	283.74	210.95	
245	55.13	283.74	210.85	
250	55.13	283.74	210.72	268.0
255	55.13	283.73	210.58	

NES&L DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO. N-1 | PAGE 58 OF 86
CCN CONVERSION CCN NO. CCN -

Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-49

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

TIME	CONTAINMENT PRESSURE	CONTAINMENT VAPOR TEMP	CONTAINMENT SUMP TEMP	HEAT SINK 1 (LEFT BOUND)*
(SEC)	(PSIG)	(F)	(F)	(F)
260	55.11	283.71	210.42	
265	55.07	283.66	210.25	
270	55.02	283.61	210.08	
275	54.97	283.54	209.90	
280	54.90	283.47	209.71	
285	54.84	283.39	209.53	
290	54.76	283.31	209.34	
295	54.70	283.22	209.14	
300	54.63	283.14	208.94	269.8
310	54.49	282.96	208.54	
320	54.34	282.78	208.15	
330	54.20	282.61	207.76	
340	54.05	282.44	207.37	
350	53.92	282.28	206.98	
400	53.21	281.41	204.74	270.9
450	52.88	281.00	203.32	
500	52.58	280.61	201.68	271.3
550	52.36	280.34	200.15	
600	51.96	279.83	198.31	271.5
700	50.87	278.44	194.34	
800	49.92	277.21	190.98	270.1
900	49.08	276.11	188.05	
1000	48.33	275.10	185.46	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

TIME	CONTAINMENT PRESSURE	CONTAINMENT VAPOR TEMP	CONTAINMENT SUMP TEMP	HEAT SINK 1 (LEFT BOUND)*
(SEC)	(PSIG)	(F)	(F)	(F)
1100	47.63	274.17	183.17	
1200	47.26	273.64	181.12	267.7
1300	46.62	272.76	179.29	
1400	46.01	271.91	177.63	266.4
1500	45.38	271.03	176.13	
1600	44.81	270.21	174.74	265.2
1700	44.25	269.40	173.47	
1800	43.69	268.58	172.28	263.9
1900	43.13	267.75	171.19	
2000	42.58	266.92	170.16	262.6
2100	42.03	266.09	169.20	
2200	41.50	265.29	168.30	261.1
2300	41.00	264.51	167.75	
2400	40.56	263.84	168.85	259.8
2500	40.17	263.26	169.94	
2600	39.80	262.68	170.99	258.8
2700	39.39	262.03	172.02	
2800	38.98	261.40	173.04	257.6
2900	38.58	260.77	174.02	
3000	38.20	260.15	175.00	256.5
3500	36.34	257.14	179.51	253.7
4000	34.72	254.38	183.54	251.1
8000	25.87	237.24	203.80	234.9

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	CONTAINMENT	CONTAINMENT	CONTAINMENT	HEAT SINK 1
TIME	PRESSURE	VAPOR TEMP	SUMP TEMP	(LEFT BOUND)*
(SEC)	(PSIG)	(F)	(F)	(F)
9000	24.54	234.25	206.86	
10000	23.58	232.03	209.19	229.7
15000	20.72	224.93	214.74	
20000	19.00	220.27	215.51	218.2
40000	14.39	205.95	206.90	204.6
60000	11.68	195.72	197.30	194.7
90000	8.60	181.76	187.81	181.8
1E+5	7.64	176.64	183.17	176.6
2E+5	4.84	158.75	167.98	158.5
3E+5	3.74	149.88	161.72	149.5
4E+5	2.81	141.35	156.37	141.7
5E+5	2.33	136.30	152.98	136.4
6E+5	1.91	131.59	150.11	132.0
7E+5	1.64	128.47	148.14	128.7
8E+5	1.41	125.49	146.37	125.8
9E+5	1.23	123.16	144.94	123.4
1E+6	1.08	121.10	143.72	121.3
1.5E+6	0.59	115.64	140.39	115.2
2E+6	0.43	113.32	136.04	112.3
4E+6	0.29	111.00	126.70	110.0
6E+6	0.20	109.72	122.27	108.9
1E+7	0.14	108.50	117.82	108.0

* Inside surface temperature of containment dome.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

10.1 (CONTINUED)

Table for FIGURE 2-3
Condensing Heat Transfer Coefficient v.s. Time

TIME	CONDENSING HEAT TRANSFER COEFFICIENT
sec	BTU/hr-ft^2-^{0}F
0	0
0.05	9.3
0.1	9.9
0.2	12.7
0.5	18.6
0.4	16.7
0.6	20.1
0.8	22.9
1	25.5
2	37.5
4	59.9
6	85.2
8	113.6
10	142.0
12	170.4
14	198.8
16	227.2
18	255.6
19	255.6
20	229.8
22	206.6
24	185.7
26	166.9
28	150.0
30	134.8
35	113.6
40	113.4
45	113.2
50	113.7

TIME	CONDENSING HEAT TRANSFER COEFFICIENT
sec	$BTU/hr-ft^2-^0F$
55	114.3
60	114.8
70	116.8
80	119.3
90	120.7
100	122.1
125	125.7
130	126.3
140	127.7
150	128.8
175	131.7
200	134.2
225	136.1
250	136.5
275	136.2
300	135.7
400	134.0
500	132.9
1000	126.1
2000	113.8
3000	102.7
4000	95.0
5000	89.7
7000	80.5
10000	68.3
20000	55.9
50000	39.2
70000	33.9
100000	26.4
500000	15.2
1000000	11.1
10000000	8.1

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

10.2

Table for FIGURE 2-4A

Integrated Energy Content of Containment Steam, Air and Combined Vapor Mixture; Sump Region; and Combined total of Vapor and Sump Regions

		INTEGRATED	ENERGY		
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
0.1	1.37e+07	1.47e+07	2.84e+07	1.61e+06	3.00e+07
1	4.23e+07	1.59e+07	5.82e+07	8.73e+06	6.70e+07
2	6.96e+07	1.65e+07	8.61e+07	1.52e+07	1.01e+08
3	9.34e+07	1.69e+07	1.10e+08	2.17e+07	1.32e+08
4	1.14e+08	1.72e+07	1.31e+08	2.75e+07	1.59e+08
5	1.33e+08	1.73e+07	1.50e+08	3.26e+07	1.83e+08
6	1.50e+08	1.76e+07	1.67e+08	3.70e+07	2.04e+08
7	1.65e+08	1.77e+07	1.83e+08	4.08e+07	2.24e+08
8	1.79e+08	1.78e+07	1.97e+08	4.44e+07	2.41e+08
9	1.91e+08	1.79e+07	2.09e+08	4.77e+07	2.57e+08
10	2.03e+08	1.80e+07	2.21e+08	5.08e+07	2.72e+08

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
11	2.13e+08	1.80e+07	2.31e+08	5.34e+07	2.85e+08
12	2.22e+08	1.82e+07	2.40e+08	5.55e+07	2.96e+08
13	2.31e+08	1.82e+07	2.49e+08	5.71e+07	3.06e+08
14	2.36e+08	1.81e+07	2.54e+08	5.82e+07	3.13e+08
15	2.40e+08	1.82e+07	2.58e+08	5.94e+07	3.17e+08
16	2.41e+08	1.83e+07	2.60e+08	6.05e+07	3.20e+08
17	2.42e+08	1.83e+07	2.60e+08	6.15e+07	3.22e+08
18	2.42e+08	1.83e+07	2.60e+08	6.22e+07	3.22e+08
19	2.41e+08	1.83e+07	2.59e+08	6.28e+07	3.22e+08
20	2.40e+08	1.83e+07	2.58e+08	6.35e+07	3.22e+08
22	2.38e+08	1.83e+07	2.56e+08	6.46e+07	3.21e+08
24	2.36e+08	1.83e+07	2.54e+08	6.51e+07	3.19e+08
25	2.35e+08	1.83e+07	2.54e+08	6.54e+07	3.19e+08
26	2.35e+08	1.83e+07	2.53e+08	6.56e+07	3.19e+08
28	2.35e+08	1.83e+07	2.53e+08	6.60e+07	3.19e+08
30	2.34e+08	1.83e+07	2.53e+08	6.66e+07	3.19e+08

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Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-56

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
32	2.34e+08	1.84e+07	2.52e+08	6.73e+07	3.20e+08
33	2.34e+08	1.84e+07	2.52e+08	6.76e+07	3.20e+08
34	2.34e+08	1.84e+07	2.52e+08	6.79e+07	3.20e+08
36	2.34e+08	1.84e+07	2.52e+08	6.85e+07	3.21e+08
38	2.34e+08	1.85e+07	2.52e+08	6.91e+07	3.21e+08
40	2.33e+08	1.85e+07	2.52e+08	6.96e+07	3.22e+08
42	2.33e+08	1.85e+07	2.52e+08	7.02e+07	3.22e+08
44	2.33e+08	1.85e+07	2.52e+08	7.08e+07	3.23e+08
45	2.33e+08	1.86e+07	2.52e+08	7.11e+07	3.23e+08
46	2.34e+08	1.86e+07	2.52e+08	7.14e+07	3.24e+08
48	2.34e+08	1.87e+07	2.53e+08	7.19e+07	3.25e+08
50	2.35e+08	1.87e+07	2.54e+08	7.25e+07	3.26e+08
52	2.36e+08	1.88e+07	2.54e+08	7.30e+07	3.27e+08
54	2.36e+08	1.88e+07	2.55e+08	7.36e+07	3.29e+08
56	2.37e+08	1.89e+07	2.56e+08	7.41e+07	3.30e+08
58	2.38e+08	1.89e+07	2.57e+08	7.47e+07	3.31e+08
60	2.39e+08	1.90e+07	2.58e+08	7.52e+07	3.33e+08

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
62	2.39e+08	1.89e+07	2.58e+08	7.57e+07	3.34e+08
64	2.40e+08	1.89e+07	2.59e+08	7.63e+07	3.35e+08
66	2.41e+08	1.88e+07	2.60e+08	7.68e+07	3.37e+08
68	2.42e+08	1.88e+07	2.61e+08	7.73e+07	3.38e+08
70	2.43e+08	1.87e+07	2.62e+08	7.79e+07	3.39e+08
75	2.45e+08	1.86e+07	2.64e+08	7.92e+07	3.43e+08
80	2.47e+08	1.85e+07	2.66e+08	8.05e+07	3.46e+08
85	2.50e+08	1.84e+07	2.68e+08	8.17e+07	3.50e+08
90	2.52e+08	1.84e+07	2.70e+08	8.31e+07	3.53e+08
95	2.54e+08	1.84e+07	2.72e+08	8.45e+07	3.57e+08
100	2.56e+08	1.84e+07	2.74e+08	8.59e+07	3.60e+08
105	2.59e+08	1.82e+07	2.77e+08	8.72e+07	3.64e+08
110	2.61e+08	1.83e+07	2.79e+08	8.86e+07	3.68e+08
115	2.63e+08	1.84e+07	2.81e+08	9.00e+07	3.71e+08
120	2.65e+08	1.83e+07	2.83e+08	9.13e+07	3.75e+08
125	2.67e+08	1.84e+07	2.85e+08	9.27e+07	3.78e+08
130	2.69e+08	1.84e+07	2.88e+08	9.41e+07	3.82e+08

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Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-58

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
135	2.71e+08	1.84e+07	2.90e+08	9.54e+07	3.85e+08
140	2.73e+08	1.84e+07	2.92e+08	9.67e+07	3.89e+08
145	2.76e+08	1.83e+07	2.94e+08	9.80e+07	3.92e+08
150	2.78e+08	1.84e+07	2.96e+08	9.94e+07	3.95e+08
155	2.80e+08	1.85e+07	2.98e+08	1.01e+08	3.99e+08
160	2.82e+08	1.85e+07	3.00e+08	1.02e+08	4.02e+08
165	2.84e+08	1.85e+07	3.02e+08	1.03e+08	4.06e+08
170	2.86e+08	1.84e+07	3.04e+08	1.05e+08	4.09e+08
175	2.88e+08	1.85e+07	3.06e+08	1.06e+08	4.12e+08
180	2.90e+08	1.86e+07	3.08e+08	1.07e+08	4.16e+08
185	2.92e+08	1.85e+07	3.10e+08	1.09e+08	4.19e+08
190	2.94e+08	1.86e+07	3.12e+08	1.10e+08	4.22e+08
195	2.96e+08	1.86e+07	3.14e+08	1.11e+08	4.25e+08
200	2.98e+08	1.85e+07	3.16e+08	1.12e+08	4.29e+08
205	3.00e+08	1.85e+07	3.18e+08	1.14e+08	4.32e+08
210	3.01e+08	1.86e+07	3.20e+08	1.15e+08	4.35e+08
215	3.03e+08	1.87e+07	3.22e+08	1.16e+08	4.38e+08

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-59

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
220	3.04e+08	1.87e+07	3.23e+08	1.17e+08	4.40e+08
225	3.05e+08	1.87e+07	3.24e+08	1.18e+08	4.42e+08
230	3.06e+08	1.86e+07	3.25e+08	1.18e+08	4.43e+08
235	3.07e+08	1.87e+07	3.25e+08	1.19e+08	4.44e+08
240	3.07e+08	1.85e+07	3.26e+08	1.20e+08	4.46e+08
245	3.07e+08	1.86e+07	3.26e+08	1.21e+08	4.47e+08
250	3.07e+08	1.86e+07	3.26e+08	1.22e+08	4.47e+08
255	3.07e+08	1.86e+07	3.26e+08	1.23e+08	4.48e+08
260	3.07e+08	1.86e+07	3.25e+08	1.24e+08	4.49e+08
265	3.07e+08	1.85e+07	3.25e+08	1.25e+08	4.50e+08
270	3.06e+08	1.85e+07	3.25e+08	1.25e+08	4.50e+08
275	3.06e+08	1.85e+07	3.25e+08	1.26e+08	4.51e+08
280	3.06e+08	1.85e+07	3.24e+08	1.27e+08	4.51e+08
285	3.05e+08	1.85e+07	3.24e+08	1.28e+08	4.52e+08
290	3.05e+08	1.84e+07	3.23e+08	1.29e+08	4.52e+08
295	3.05e+08	1.85e+07	3.23e+08	1.30e+08	4.53e+08
300	3.04e+08	1.85e+07	3.23e+08	1.31e+08	4.53e+08

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
310	3.03e+08	1.85e+07	3.22e+08	1.32e+08	4.54e+08
320	3.03e+08	1.85e+07	3.21e+08	1.34e+08	4.55e+08
330	3.02e+08	1.85e+07	3.20e+08	1.36e+08	4.56e+08
340	3.01e+08	1.85e+07	3.19e+08	1.38e+08	4.57e+08
350	3.00e+08	1.85e+07	3.19e+08	1.39e+08	4.58e+08
400	2.97e+08	1.86e+07	3.15e+08	1.48e+08	4.63e+08
450	2.94e+08	1.86e+07	3.13e+08	1.56e+08	4.69e+08
500	2.93e+08	1.86e+07	3.11e+08	1.64e+08	4.75e+08
550	2.91e+08	1.86e+07	3.10e+08	1.72e+08	4.82e+08
600	2.89e+08	1.86e+07	3.08e+08	1.79e+08	4.87e+08
700	2.83e+08	1.85e+07	3.01e+08	1.94e+08	4.95e+08
800	2.77e+08	1.85e+07	2.96e+08	2.08e+08	5.04e+08
900	2.73e+08	1.85e+07	2.91e+08	2.21e+08	5.13e+08
1.0e+03	2.68e+08	1.85e+07	2.87e+08	2.35e+08	5.22e+08
1.1e+03	2.64e+08	1.84e+07	2.83e+08	2.49e+08	5.31e+08
1.2e+03	2.61e+08	1.82e+07	2.79e+08	2.62e+08	5.41e+08
1.3e+03	2.57e+08	1.82e+07	2.75e+08	2.75e+08	5.51e+08

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
1.4e+03	2.54e+08	1.82e+07	2.72e+08	2.88e+08	5.60e+08
1.5e+03	2.50e+08	1.83e+07	2.68e+08	3.02e+08	5.70e+08
1.6e+03	2.47e+08	1.83e+07	2.65e+08	3.15e+08	5.80e+08
1.7e+03	2.43e+08	1.83e+07	2.62e+08	3.28e+08	5.89e+08
1.8e+03	2.40e+08	1.82e+07	2.58e+08	3.40e+08	5.99e+08
1.9e+03	2.37e+08	1.82e+07	2.55e+08	3.53e+08	6.09e+08
2.0e+03	2.34e+08	1.82e+07	2.52e+08	3.66e+08	6.18e+08
2.1e+03	2.31e+08	1.82e+07	2.49e+08	3.79e+08	6.28e+08
2.2e+03	2.28e+08	1.82e+07	2.46e+08	3.91e+08	6.37e+08
2.3e+03	2.25e+08	1.81e+07	2.43e+08	4.03e+08	6.46e+08
2.4e+03	2.24e+08	1.81e+07	2.42e+08	4.06e+08	6.48e+08
2.5e+03	2.20e+08	1.84e+07	2.38e+08	4.10e+08	6.48e+08
2.6e+03	2.18e+08	1.81e+07	2.36e+08	4.14e+08	6.49e+08
2.7e+03	2.16e+08	1.81e+07	2.34e+08	4.17e+08	6.51e+08
2.8e+03	2.13e+08	1.81e+07	2.32e+08	4.20e+08	6.52e+08
2.9e+03	2.11e+08	1.81e+07	2.29e+08	4.24e+08	6.53e+08
3.0e+03	2.09e+08	1.80e+07	2.27e+08	4.27e+08	6.54e+08

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Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-62

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
3.5e+03	2.00e+08	1.79e+07	2.17e+08	4.42e+08	6.59e+08
4.0e+03	1.90e+08	1.78e+07	2.08e+08	4.55e+08	6.63e+08
8.0e+03	1.43e+08	1.47e+07	1.58e+08	5.23e+08	6.80e+08
9.0e+03	1.36e+08	1.74e+07	1.53e+08	5.33e+08	6.86e+08
1.0e+04	1.30e+08	1.73e+07	1.48e+08	5.41e+08	6.89e+08
1.5e+04	1.15e+08	1.72e+07	1.32e+08	5.61e+08	6.93e+08
2.0e+04	1.05e+08	1.70e+07	1.22e+08	5.64e+08	6.87e+08
4.0e+04	8.06e+07	1.67e+07	9.73e+07	5.41e+08	6.38e+08
6.0e+04	6.35e+07	1.64e+07	7.99e+07	5.08e+08	5.88e+08
9.0e+04	4.97e+07	1.61e+07	6.58e+07	4.87e+08	5.52e+08
1.0e+05	4.47e+07	1.60e+07	6.07e+07	4.73e+08	5.33e+08
2.0e+05	3.01e+07	1.55e+07	4.57e+07	4.27e+08	4.73e+08
3.0e+05	2.45e+07	1.53e+07	3.99e+07	4.08e+08	4.48e+08
4.0e+05	2.00e+07	1.51e+07	3.51e+07	3.91e+08	4.26e+08
5.0e+05	1.77e+07	1.50e+07	3.26e+07	3.81e+08	4.14e+08
6.0e+05	1.57e+07	1.49e+07	3.06e+07	3.72e+08	4.03e+08
7.0e+05	1.45e+07	1.48e+07	2.93e+07	3.66e+08	3.95e+08

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Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-63

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

		INTEGRATED	ENERGY	FIG 2-4A	
TIME	STEAM	AIR	VAPOR	SUMP	TOTAL
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)	(BTU)
8.0e+05	1.34e+07	1.47e+07	2.81e+07	3.61e+08	3.89e+08
9.0e+05	1.26e+07	1.47e+07	2.73e+07	3.56e+08	3.84e+08
1.0e+06	1.20e+07	1.46e+07	2.66e+07	3.52e+08	3.79e+08
1.5e+06	9.58e+06	1.45e+07	2.41e+07	3.42e+08	3.66e+08
2.0e+06	8.93e+06	1.44e+07	2.33e+07	3.29e+08	3.52e+08
2.5e+06	8.82e+06	1.44e+07	2.32e+07	3.21e+08	3.44e+08
3.0e+06	8.61e+06	1.44e+07	2.30e+07	3.14e+08	3.37e+08
4.0e+06	8.38e+06	1.43e+07	2.27e+07	2.99e+08	3.22e+08
5.0e+06	8.20e+06	1.43e+07	2.25e+07	2.92e+08	3.15e+08
6.0e+06	7.98e+06	1.43e+07	2.23e+07	2.85e+08	3.07e+08
7.0e+06	7.93e+06	1.43e+07	2.22e+07	2.82e+08	3.04e+08
8.0e+06	7.84e+06	1.43e+07	2.21e+07	2.78e+08	3.00e+08
9.0e+06	7.77e+06	1.43e+07	2.21e+07	2.75e+08	2.97e+08
1.0e+07	7.77e+06	1.43e+07	2.21e+07	2.71e+08	2.93e+08

10.2 (Continued)

Table for FIGURE 2-4B

Integrated Energy Content of the Containment Building Structural Heat Sinks; Integrated Energy Transferred out of the Containment through the ECUs and Spray Heat Exchangers; and Integrated Energy transferred from the Vapor Region to the Containment Sump Water by the CSS

		INTEGRATED	ENERGY	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
0.1	3.92e-01			
1	6.73e+06			
2	3.01e+05			
3	6.85e+05			
4	1.20e+06			
5	1.83e+06			
6	2.59e+06			
7	3.47e+06			
8	4.44e+06			
9	5.51e+06			
10	6.65e+06			

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
11	7.85e+06			
12	9.10e+06			
13	1.04e+07			
14	1.17e+07			
15	1.30e+07			
16	1.44e+07			
17	1.57e+07			
18	1.70e+07			
19	1.82e+07			
20	1.94e+07			
22	2.16e+07			
24	2.35e+07			
25	2.44e+07			
26	2.53e+07			
28	2.69e+07			
30	2.83e+07			
32	2.97e+07			

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Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-66

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
33	3.03e+07			
34	3.09e+07			
36	3.22e+07			
38	3.33e+07			
40	3.44e+07			
42	3.55e+07			
44	3.66e+07			
45	3.72e+07			
46	3.77e+07			
48	3.88e+07			
50	3.98e+07			
52	4.08e+07			
54	4.18e+07			
56	4.28e+07			
58	4.37e+07			
60	4.47e+07	2.16e+03		
62	4.56e+07	4.55e+04	8.58e+04	

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-67

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
64	4.65e+07	8.88e+04	1.71e+05	
66	4.75e+07	1.32e+05	2.55e+05	
68	4.83e+07	1.76e+05	3.38e+05	
70	4.92e+07	4.20e+05	4.20e+05	
75	5.13e+07	3.28e+05	6.22e+05	
80	5.33e+07	4.36e+05	8.19e+05	
85	5.53e+07	5.46e+05	1.01e+06	
90	5.71e+07	6.55e+05	1.20e+06	
95	5.90e+07	7.65e+05	1.43e+06	
100	6.07e+07	8.75e+05	1.58e+06	
105	6.25e+07	9.86e+05	1.77e+06	
110	6.42e+07	1.10e+06	1.96e+06	
115	6.58e+07	1.21e+06	2.15e+06	
120	6.74e+07	1.32e+06	2.34e+06	
125	6.90e+07	1.43e+06	2.53e+06	
130	7.05e+07	1.55e+06	2.72e+06	
135	7.20e+07	1.66e+06	2.92e+06	

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-68

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME (SEC)	HEAT SINKS (BTU)	ECUs (AC) (BTU)	CONTAINMENT SPRAYS (BTU)	SPRAY HX (BTU)
140	7.35e+07	1.77e+06	3.11e+06	
145	7.49e+07	1.89e+06	3.31e+06	
150	7.64e+07	2.00e+06	3.50e+06	
155	7.77e+07	2.12e+06	3.70e+06	
160	7.91e+07	2.23e+06	3.89e+06	
165	8.05e+07	2.35e+06	4.09e+06	
170	8.18e+07	2.47e+06	4.29e+06	
175	8.31e+07	2.58e+06	4.49e+06	
180	8.43e+07	2.70e+06	4.98e+06	
185	8.56e+07	2.82e+06	4.88e+06	
190	8.68e+07	2.93e+06	5.08e+06	
195	8.80e+07	3.06e+06	5.28e+06	
200	8.92e+07	3.18e+06	5.48e+06	
205	9.04e+07	3.30e+06	5.68e+06	
210	9.16e+07	3.42e+06	5.88e+06	
215	9.27e+07	3.54e+06	6.08e+06	
220	9.38e+07	3.66e+06	6.29e+06	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
225	9.49e+07	3.78e+06	6.49e+06	
230	9.60e+07	3.90e+06	6.69e+06	
235	9.70e+07	4.02e+06	6.90e+06	
240	9.80e+07	4.14e+06	7.10e+06	
245	9.90e+07	4.26e+06	7.30e+06	
259	1.00e+08	4.38e+06	7.50e+06	
255	1.01e+08	4.50e+06	7.70e+06	
260	1.02e+08	4.63e+06	7.91e+06	
265	1.03e+08	4.75e+06	8.11e+06	
270	1.04e+08	4.87e+06	8.31e+06	
275	1.04e+08	4.99e+06	8.51e+06	
280	1.05e+08	5.11e+06	8.72e+06	
285	1.06e+08	5.23e+06	8.92e+06	
290	1.07e+08	5.35e+06	9.72e+06	
295	1.08e+08	5.47e+06	9.32e+06	
300	1.08e+08	5.59e+06	9.53e+06	
310	1.10e+08	5.83e+06	9.93e+06	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
320	1.11e+08	6.08e+06	1.03e+07	
330	1.13e+08	6.32e+06	1.07e+07	
340	1.14e+08	6.56e+06	1.11e+07	
350	1.15e+08	6.80e+06	1.15e+07	
400	1.21e+08	8.00e+06	1.35e+07	
450	1.26e+08	9.19e+06	1.59e+07	
500	1.30e+08	1.04e+07	1.75e+07	
550	1.34e+08	1.16e+07	1.95e+07	
600	1.38e+08	1.27e+07	2.15e+07	
700	1.44e+08	1.51e+07	2.55e+07	
800	1.50e+08	1.74e+07	2.94e+07	
900	1.55e+08	1.97e+07	3.33e+07	
1.0e+03	1.60e+08	2.20e+07	3.72e+07	
1.1e+03	1.64e+08	2.42e+07	4.10e+07	
1.2e+03	1.68e+08	2.65e+07	4.49e+07	
1.3e+03	1.72e+08	2.87e+07	4.87e+07	
1.4e+03	1.75e+08	3.10e+07	5.25e+07	

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME (SEC)	HEAT SINKS (BTU)	ECUs (AC) (BTU)	CONTAINMENT SPRAYS (BTU)	SPRAY HX (BTU)
1.5e+03	1.79e+08	3.32e+07	5.63e+07	
1.6e+03	1.82e+08	3.53e+07	6.00e+07	
1.7e+03	1.85e+08	3.75e+07	6.38e+07	
1.8e+03	1.87e+08	3.97e+07	6.75e+07	
1.9e+03	1.90e+08	4.18e+07	7.12e+07	
2.0e+03	1.92e+08	4.40e+07	7.49e+07	
2.1e+03	1.95e+08	4.72e+07	7.86e+07	
2.2e+03	1.97e+08	4.82e+07	8.22e+07	
2.3e+03	1.99e+08	5.03e+07	8.59e+07	1.71e+05
2.4e+03	2.02e+08	5.34e+07	8.95e+07	1.32e+06
2.5e+03	2.04e+08	5.44e+07	9.31e+07	2.49e+06
2.6e+03	2.06e+08	5.65e+07	9.67e+07	3.68e+06
2.7e+03	2.08e+08	5.85e+07	1.02e+08	4.89e+06
2.8e+03	2.10e+08	6.06e+07	1.03e+08	6.12e+06
2.9e÷03	2.11e+08	6.26e+07	1.09e+08	7.37e+06
3.0e+03	2.13e+08	6.46e+07	1.10e+08	8.63e+06
3.5e+03	2.21e+08	7.45e+07	1.28e+08	1.52e+07

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME	HEAT SINKS	ECUs (AC)	CONTAINMENT SPRAYS	SPRAY HX
(SEC)	(BTU)	(BTU)	(BTU)	(BTU)
4.0e+03	2.29e+08	8.42e+07	1.44e+08	2.22e+07
8.0e+03	2.66e+08	1.54e+08	2.57e+08	8.76e+07
9.0e+03	2.73e+08	1.61e+08	2.80e+08	1.06e+08
1.0e+04	2.79e+08	1.85e+08	3.02e+08	1.25e+08
1.5e+04	3.05e+08	2.57e+08	4.02e+08	2.23e+08
2.0e+04	3.27e+08	3.24e+08	4.92e+08	3.24e+08
4.0e+04	3.86e+08	5.62e+08	8.08e+08	7.13e+08
6.0e+04	4.15e+08	7.63e+08	1.08e+09	1.07e+09
9.0e+04	4.38e+08	1.02e+09	1.43e+09	1.54e+09
1.0e+05	4.34e+08	1.09e+09	1.53e+09	1.69e+09
2.0e+05	4.14e+08	1.62e+09	2.32e+09	3.22e+09
3.0e+05	4.03e+08	2.02e+09	2.92e+09	4.02e+09
4.0e+05	3.79e+08	2.32e+09	3.40e+09	5.01e+09
5.0e+05	3.54e+08	2.56e+09	3.76e+09	5.91e+09
6.0e+05	3.31e+08	2.77e+09	4.05e+09	6.75e+09
7.0e+05	3.11e+08	2.93e+09	4.27e+09	7.55e+09
8.0e+05	2.93e+08	3.08e+09	4.45e+09	8.32e+09

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	INTEGRATED	ENERGY	FIG 2-4B	
TIME (SEC)	HEAT SINKS (BTU)	ECUs (AC) (BTU)	CONTAINMENT SPRAYS (BTU)	SPRAY HX (BTU)
9.0e+05	2.78e+08	3.20e+09	4.59e+09	9.06e+09
1.0e+06	2.66e+08	3.31e+09	4.88e+09	9.77e+09
1.5e+06	2.38e+08	3.70e+09	4.69e+09	1.31e+10
2.0e+06	2.25e+08	3.89e+09	4.88e+09	1.62e+10
2.5e+06	2.27e+08	4.04e+09	4.78e+09	1.89e+10
3.0e+06	2.30e+08	4.16e+09	4.65e+09	2.14e+10
4.0e+06	2.39e+08	4.36e+09	4.45e+09	2.57e+10
5.0e+06	2.75e+08	4.48e+09	4.22e+09	3.12e+10
6.0e+06	2.91e+08	4.53e+09	4.01e+09	3.28e+10
7.0e+06	3.31e+08	4.57e+09	3.97e+09	3.58e+10
8.0e+06	3.79e+08	4.67e+09	3.92e+09	3.86e+10
9.0e+06	4.04e+08	4.69e+09	3.85e+09	4.00e+10
1.0e+07	4.58e+08	4.69e+09	3.82e+09	4.25e+10

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

10.2 (Continued)

Table for FIGURE 2-6

CCW Heat Load from 1 Train of ECUs (2ECUs) and Spray-Hx and Combined Total

	HEAT	RATES	
TIME	ECUs(AC)	SPRAY	AC+SPRAY
(SEC)	(BTU/HR)	(BTU/HR)	(BTU/HR)
6.0e+01	7.79e+07		7.79e+07
1.0e+02	7.95e+07		7.95e+07
3.0e+02	8.70e+07		8.70e+07
5.0e+02	8.54e+07		8.54e+07
6.0e+02	8.49e+07		8.49e+07
7.0e+02	8.40e+07		8.40e+07
8.0e+02	8.31e+07		8.31e+07
9.0e+02	8.26e+07		8.26e+07
1.0e+03	8.17e+07		8.17e+07
2.0e+03	7.67e+07		7.67e+07
2.3e+03	7.51e+07	4.11e+07	1.162e+08
2.5e+03	7.42e+07	4.25e+07	1.167e+08
2.6e+03	7.39e+07	4.32e+07	1.171e+08
2.7e+03	7.31e+07	4.45e+07	1.176e+08

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-75

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	HEAT	RATES	
TIME	ECUs(AC)	SPRAY	AC+SPRAY
(SEC)	(BTU/HR)	(BTU/HR)	(BTU/HR)
3.0e+03	7.23e+07	4.58e+07	1.181e+08
4.0e+03	6.86e+07	5.14e+07	1.200e+08
6.0e+03	6.24e+07	5.93e+07	1.217e+08
8.0e+03	5.77e+07	6.48e+07	1.225e+08
1.0e+04	5.44e+07	6.84e+07	1.228e+08
1.5e+04	5.01e+07	7.21e+07	1.222e+08
2.0e+04	4.71e+07	7.26e+07	1.197e+08
3.0e+04	4.30e+07	7.03e+07	1.133e+08
4.0e+04	3.90e+07	6.69e+07	1.059e+08
5.0e+04	3.60e+07	6.34e+07	9.94e+07
6.0e+04	3.35e+07	6.05e+07	9.40e+07
7.0e+04	3.15e+07	5.81e+07	8.96e+07
8.0e+04	2.99e+07	5.62e+07	8.61e+07
9.0e+04	2.63e+07	5.43e+07	8.06e+07
1.0e+05	2.37e+07	5.12e+07	7.50e+07
2.0e+05	1.60e+07	4.13e+07	5.72e+07
3.0e+05	1.25e+07	3.71e+07	4.96e+07

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Project or DCP/MMP SONGS UNITS 2 and 3 Calc No. N-4080-026-Sup-A

Subject CONTAINMENT P/T ANALYSIS for DESIGN BASIS LOCA Sheet No. A-76

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

	HEAT	RATES	
TIME	ECUs (AC)	SPRAY	AC+SPRAY
(SEC)	(BTU/HR)	(BTU/HR)	(BTU/HR)
4.0e+05	9.62e+06	3.36e+07	4.32e+07
5.0e+05	7.94e+06	3.14e+07	3.93e+07
6.0e+05	6.49e+06	2.95e+07	3.60e+07
7.0e+05	5.54e+06	2.82e+07	3.38e+07
8.0e+05	4.75e+06	2.71e+07	3.18e+07
9.0e+05	4.17e+06	2.61e+07	3.03e+07
1.0e+06	3.61e+06	2.53e+07	2.90e+07
1.5e+06	1.75e+06	2.31e+07	2.49e+07
2.0e+06	1.13e+06	2.03e+07	2.14e+07
3.0e+06	8.18e+05	1.73e+07	1.81e+07
4.0e+06	5.72e+05	1.42e+07	1.48e+07
5.0e+06	4.60e+05	1.34e+07	1.39e+07
6.0e+06	3.09e+05	1.20e+07	1.23e+07
7.0e+06	1.85e+05	1.09e+07	1.11e+07
8.0e+06	6.69e+04	9.83e+06	9.89e+06
9.0e+06	1.70e+01	9.14e+06	9.14e+06
1.0e+07	1.53e+01	8.38e+06	8.38e+06

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	ALLEN EVINAY	01/31/95	PAUL BARBOUR	02/03/95					

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 files name and date are as follows:

FICHE TITLE : DBLOCA J2732 13-Jan-95

JOB TITLE : * DBLOCA+LOP (DESLS), CPi=0.0 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s

RUN DATE : 12-12-94 21:08:39 GMT

LAST SHEET : Page 512

FICHE TITLE : TSLOCA J2745 13-Jan-95

JOB TITLE : * TSLOCA+LOP (DESLS), CPi=1.5 psig, MAX SI, CSS=1600/1950 gpm, ECUs@60s

RUN DATE : 12-23-94 00:38:52 GMT

LAST SHEET : Page 512

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Calc. No. N-4080-026 DCP/MMP/FIDCN/FCN No. & Rev. N/A

Subject CONTAINMENT P/T ANALYSIS FOR DESIGN BASIS LOCA Sheet 1

System Number/Primary Station System Designator ~~BLDG~~ / XB1 , ~~BBB~~ 1201 SONGS Unit 2&3 Q-Class II*

Tech Spec Affecting? ☐ NO ☒ YES, Section No. B3.6.1.4 Equipment Tag No. N/A

CONTROLLED COMPUTER PROGRAM/ DATABASE	☒ PROGRAM ☐ DATABASE IN ACCORDANCE WITH NES&L 41-5-1	PROGRAM/DATABASE NAME(S) ☒ ALSO LISTED BELOW "DECAY" MAP-121 "COPATTA" MAP-175	VERSION/RELEASE NO(S). Version 01 Version G1/14

RECORD OF ISSUES

REV. / DISC	DESCRIPTION	TOTAL SHTS / LAST SHT.	PREPARED (Print name/initial)	APPROVED (Signature)	
0 BPC N	SEE NOTE 1 BELOW ISSUED FOR USE	217 217	ORIG R. Nakano [signature] IRE J. Elliott [signature]	GS [signature] DM [signature]	Other [signature] DATE 1-28-94
			ORIG IRE	GS DM	Other DATE
			ORIG IRE	GS DM	Other DATE
			ORIG IRE	GS DM	Other DATE

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

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

* Containment isolation valves, penetrations, and heat removal systems are QC-II per the Songs 2,3 Q-List (CDM 90034)

Note 1:
The purpose of Revision 0 is to resolve OIRs 91-072, 92-046 and 92-058 which state that inconsistencies found in Calculation N-4080-002 need to be corrected.

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

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Calculation No. N-4080-026

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 AJS 1-28-94	Calculation C-257-1.06 Calculation M-0014-009 Calculation M-0026-001 Calculation M-0026-002 Calculation M-0072-036 Calculation N-0880-015 Calculation N-4080-002 Calculation N-4080-003 Calculation N-4080-005 Calculation N-0240-006	1 0 5 1 0 0 1 5 0 0	Units 2&3 UFSAR DBD-SO23-TR-AA DBD-SO23-TR-EQ DBD-SO23-400 SONGS Unit 2 Technical Specifications B3.6.1.4 (page B3/4 6-2, Amend. 16) SONGS Unit 3 Technical Specifications B3.6.1.4 (page B3/4 6-2, Orig Issue)	9 0 A 0 A. 108 A. 97	YES	UFSAR Change Request No. SAR23-278 NEDOTRAK AJB-94-004 OIRs 91-072, 92-046, 92-058 NEDOTRAK ACTION #OIR 92-015 SUBACTION 02 NEDOTRAK AJB-94-002
	Unit 2 Operating License and Technical Specs LCO 3.6.1.4 (page 3/4 6-7, Orig issue) LCO 3.6.1.5 (page 3/4 6-8, Orig issue) Sect. 5.2.2 (page 5-1, Amend. (Orig issue) Unit 3 Operating License and Technical Specs LCO 3.6.1.4 (page 3/4 6-7, Orig Issue) LCO 3.6.1.5 (page 3/4 6-8, Orig Issue) Section 5.2.2 (page 5-1, Orig Issue) Units 2&3 UFSAR DBD-SO23-400 DBD-SO23-TR-EQ SD-SO23-360 SD-SO23-390 SD-SO23-400 SD-SO23-720 SD-SO23-740	Amend. 108 Amend. 97 9 0 A 2 1 2 1 3	Calculation N-4080-002 EDQP M37600 EDQP M37601 EDQP M37606 EDQP M37607 EDQP M37608 EDQP M37609 EDQP M37612 EDQP M37615 EDQP M37618 EDQP M37619 EDQP M37620 EDQP M37621 EDQP M37624 EDQP M37629 EDQP M37631 EDQP M37635 EDQP M37636	1		NEDOTRAK AJB-94-009 NEDOTRAK BC 93079

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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	
[initials] 1-28-94	P&ID 40111A	26	EDQP M37640		YES	NEDOTRAK BC 93079 [initials] 1-28-94
	P&ID 40114A	10	EDQP M37641			
	P&ID 40114B	14	EDQP M37644			
	P&ID 41072A	7	EDQP M37646			
			EDQP M37703			
	EQ Condition Monitoring Program Assessment	March 1988	EDQP M37704			
			EDQP M37705			
	SO123-XXIV-37.26.12	0 (PCN 0-1)	EDQP M37706			
			EDQP M38279			
	NCR 93030001		EDQP M38290			
	NCR 93030002		EDQP M38377			
	NCR 93030003		EDQP M38378			
	NCR 93030004		EDQP M38379			
			EDQP M38381			
			EDQP M38382			
			EDQP M38383			
			EDQP M38384			
			EDQP M38385			
			EDQP M38773			
			EDQP M38785			
			EDQP M38789			
			EDQP M38790			
			EDQP M38798			
			EDQP M39079			
			EDQP M40819			
			EDQP M85083			
			EDQP M85091			
			EDQP M85102			

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1 PURPOSE

1.1 TASK DESCRIPTION

The purpose of this calculation is to evaluate the containment pressure and temperature response to a design basis Loss-of-Coolant-Accident (LOCA) for SONGS Units 2 and 3. The results of this calculation supersede the results of Calculation N-4080-002, "Containment Press-Temp Transient Analysis", (Reference 6.1.g) with respect only to the Design Basis LOCA event (9.8175 ft^2 Double Ended Suction Leg Slot (DESLS) Break with maximum safety injection flow). Per the conclusions presented in Calculation N-4080-002, this is the worst case LOCA, 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 DESLSB will remain the limiting case.

In this calculation, both the short term and the long term effects of a pressure-temperature transient due to a design basis LOCA with a loss of offsite power (LOP) will be evaluated.

The design basis LOCA is being revised to resolve inadequacies in the original analysis identified in the following Open Item Reports:

91-072 Calculation N-4080-002 (Reference 6.1.g) uses a containment liner to concrete conductance of 100 BTU/h-ft^2-°F which is non conservative.

This calculation uses a conservative interface conductance of 50 BTU/h-ft^2-°F given in BN-TOP-3 (Reference 6.11) (See Design Input Item 4.13).

92-046 Calculation N-4080-002 used input that did not have proper references or justifications.

This calculation provides references for all design inputs and justifications for all assumptions.

92-058 The RWST volume modeled in Calculation N-4080-002 gave non-conservative results

This calculation models an RWST volume that will give conservative results (See Design Input Item 4.10.b.1)

This calculation also addresses the reduced Containment Spray flowrates as described in disposition step 2 of NCRs 93030001, 93030002, 93030003, and 93030004. (References 6.19). 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) will be used in this calculation to evaluate the pressure-temperature transient.

1.2 CRITERIA, CODES AND STANDARDS

The containment structure is to be designed such that it is capable of withstanding the adverse effects of a postulated LOCA. 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 LOCA 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. Per Standard Review Plan 6.2.1.1.A, to satisfy the requirements of this criterion requires an analysis to show that the containment pressure can be reduced to less than fifty percent of the containment peak pressure within 24 hours after the start of the LOCA.

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.

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

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2 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

2.1 RESULTS/CONCLUSIONS

The purpose of this calculation has been to evaluate the short and long term effects of the containment pressure-temperature transient resulting from a design basis LOCA with a loss of offsite power.

Figure 2-1 presents the containment gauge pressure versus time for the DBA LOCA. The plot in Figure 2-1 is generated using the data presented in Table 8.3-1.

Figure 2-2 presents the sump and vapor temperatures versus time for the DBA LOCA. The plots in Figure 2-2 are generated using the data presented in Table 8.3-1.

Figure 2-3 presents the condensing heat transfer coefficient used by the COPATTA Code versus time for the DBA LOCA. The plot in Figure 2-3 is generated using the data presented in Table 8.3-1.

Figures 2-4A and 2-4B present the energy content of a number of different components of the LOCA model versus time for the DBA LOCA. The plots in Figures 2-4A and 2-4B are generated using the data presented in Table 8.3-2. For further discussion on heat sink energies, refer to Section 8.3.2.

Figure 2-5 presents surface temperatures versus time for five heat sinks for the DBA LOCA. The plots in Figure 2-5 are generated using the data presented in Table 8.3-3. The heat sink data plotted is for the following heat sinks:

- HS 2 Containment Building Cylinder above grade
- HS 8 Lined refueling canal walls
- HS 9 Steam Generator compartment walls, unlined refueling canal walls & other internal walls
- HS 15 Miscellaneous carbon steel: thickness < 0.5"
- HS 16 Electrical equipment

Figures 2-1 and 2-2 show that the containment peak pressure (56.9 psig) is below the design pressure of 60 psig and the peak vapor temperature (294 °F) is below the design temperature of 300 °F. Therefore, General Design Criteria 16 and 50 (See Section 1.2) are met. The containment pressure at 24 hours (86400 seconds) is less than 12.5 psig (the pressure from the COPATTA output at 80000 seconds). This is considerably less than half of the peak pressure. Therefore, General Design Criterion 38 (See Section 1.2) is also met.

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Table 2-1 presents the accident chronology for the DBA LOCA.

Table 2-1
ACCIDENT CHRONOLOGY FOR THE DBA LOCA (DESLS)

TIME (seconds)	EVENT
0.0	Break occurs
17	Peak containment pressure during blowdown phase
22.0	End of Blowdown
22.0	Start of Emergency Core Cooling injection phase
22.0	Start of Core Reflood
35	Start of air cooler fans
60	MAXIMUM CONTAINMENT TEMPERATURE (294 °F)
60	Start of Containment Spray injection phase
211.1	End of Core Reflood
211.1	Start of Post-Reflood
241	MAXIMUM CONTAINMENT PRESSURE (56.9 psig)
573.273	End of Post-Reflood
573.273	End of CE-provided mass and energy release data
573.273	Start of COPATTA Code mass and energy release calculations
2280	End of Emergency Core Cooling injection phase
2280	Start of Emergency Core Cooling recirculation phase
2280	End of Containment Spray injection phase
2280	Start of Containment Spray recirculation phase
7200	HPSI realigned to a 50:50 split between hot and cold leg injection
10^7	End of COPATTA Code Calculations

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FIGURE 2-1
LOCA WITH LOP – CONTAINMENT PRESSURE

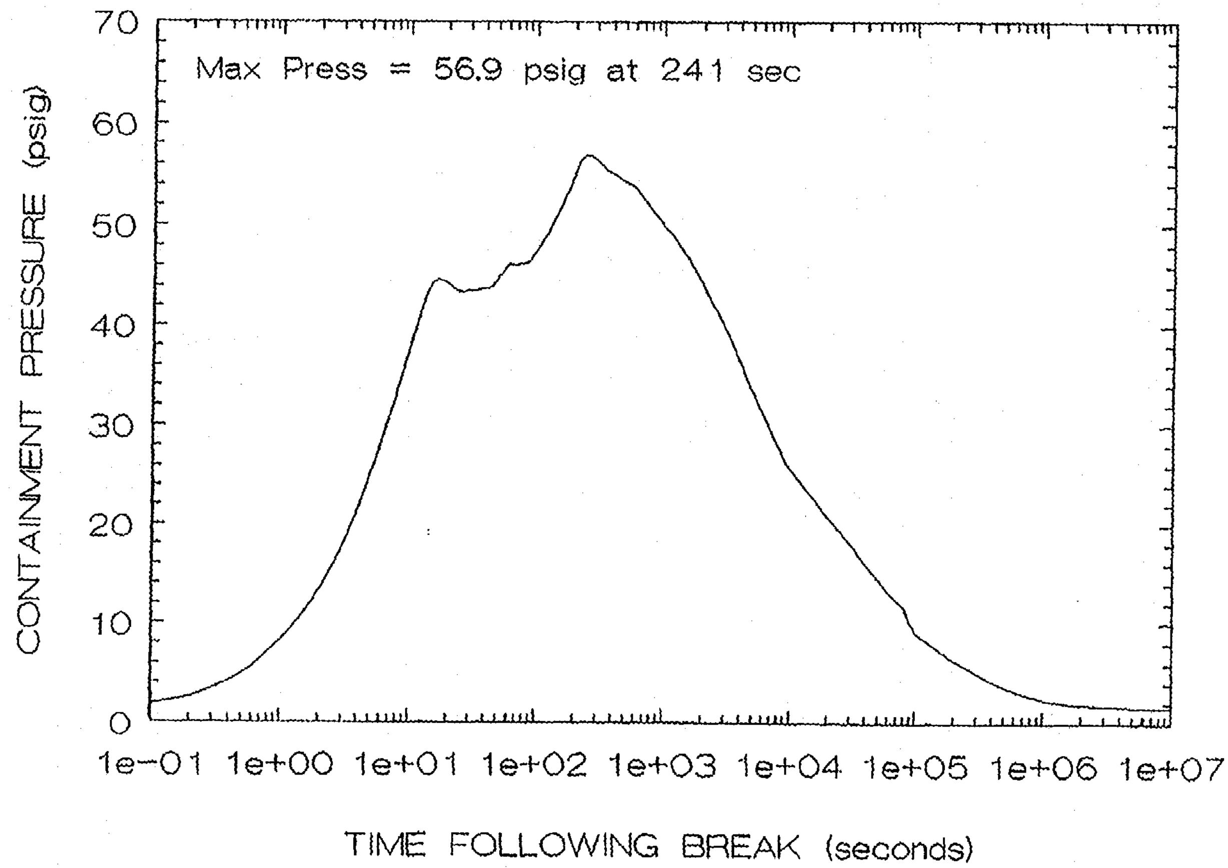

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FIGURE 2-2
LOCA WITH LOP - TEMPERATURE

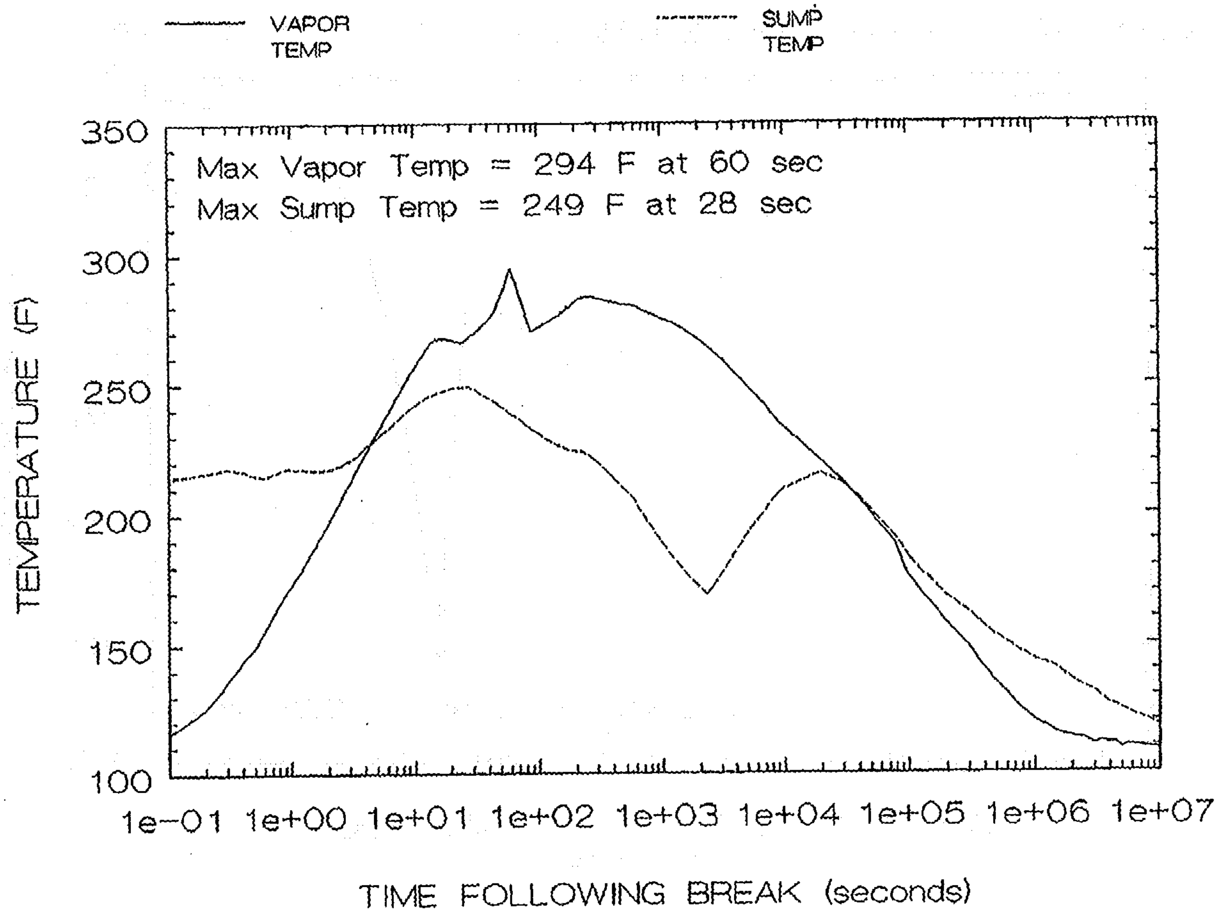

FIGURE 2-3
LOCA WITH LOP – CONDENSING HTC

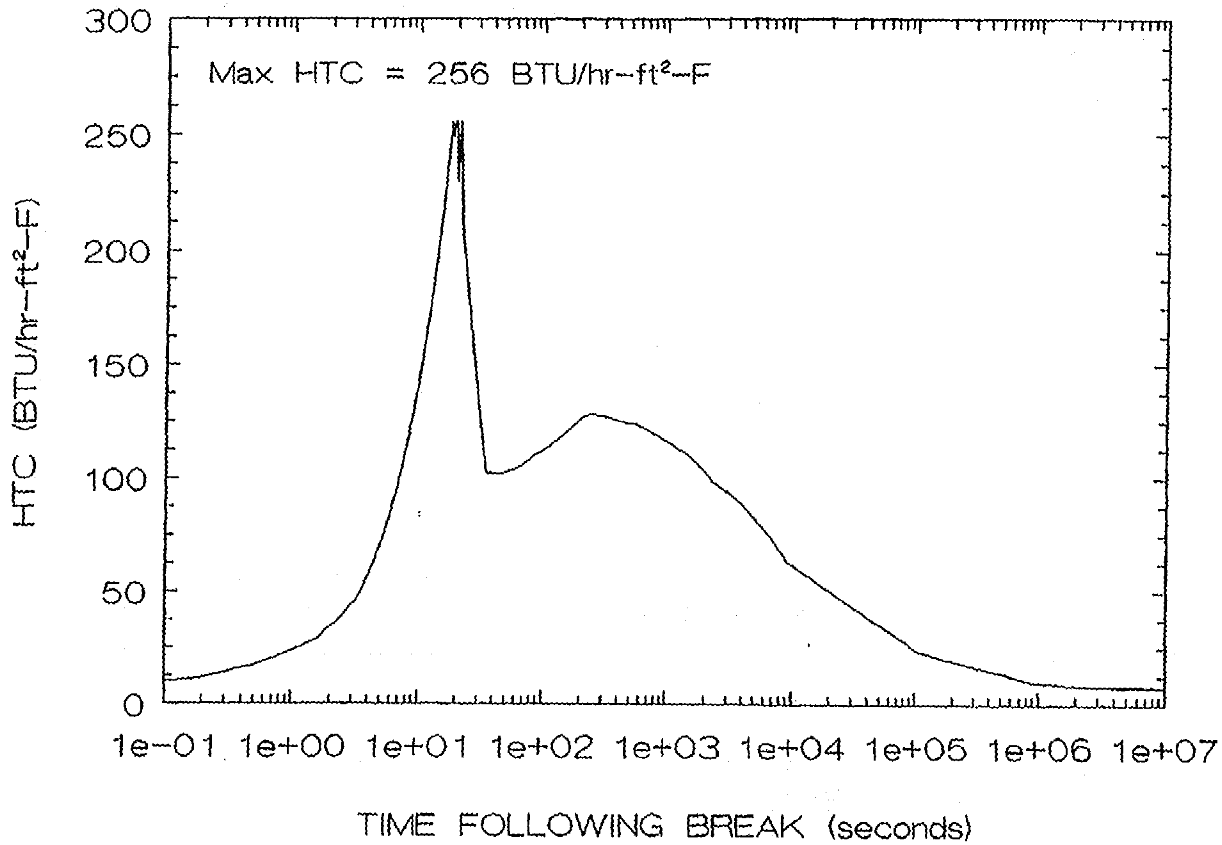

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FIGURE 2-4A
LOCA WITH LOP - ENERGY

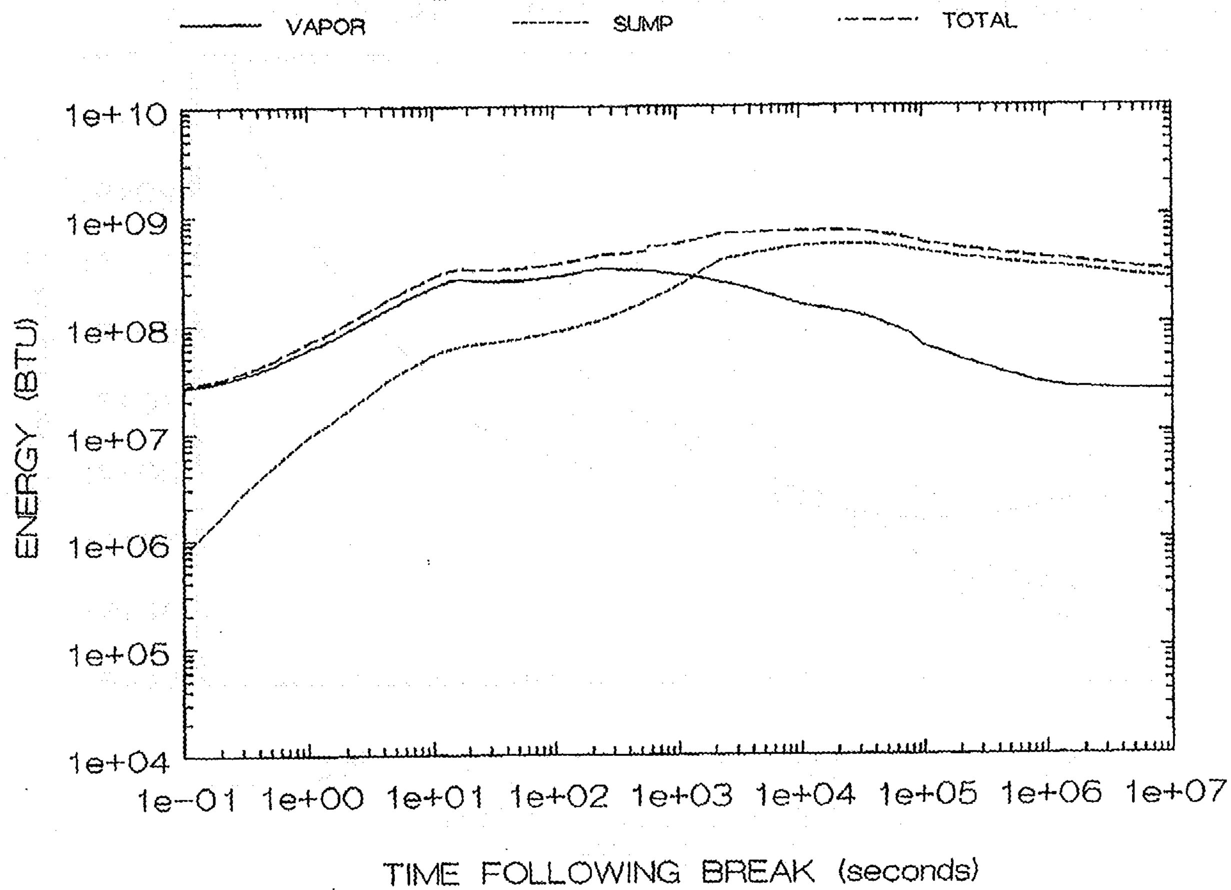

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FIGURE 2-4B
LOCA WITH LOP – ENERGY

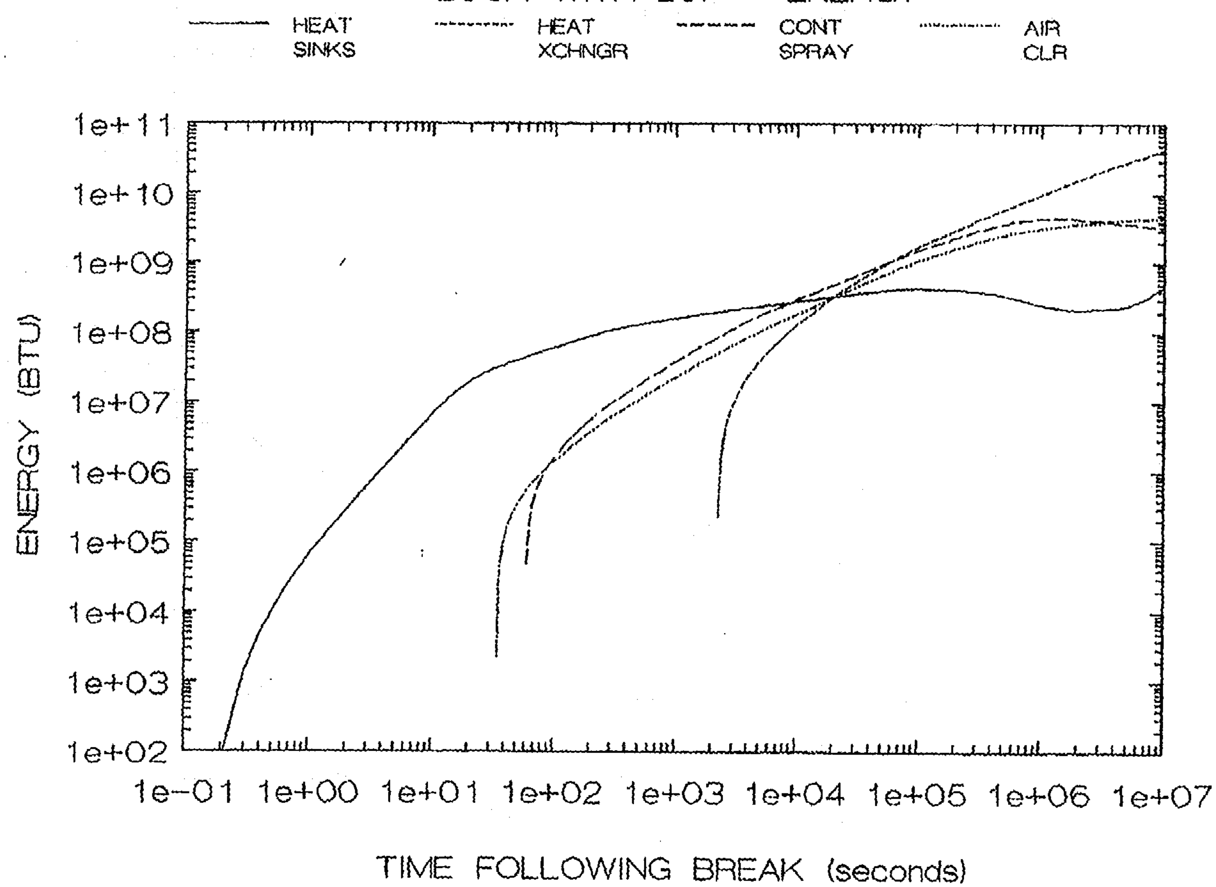

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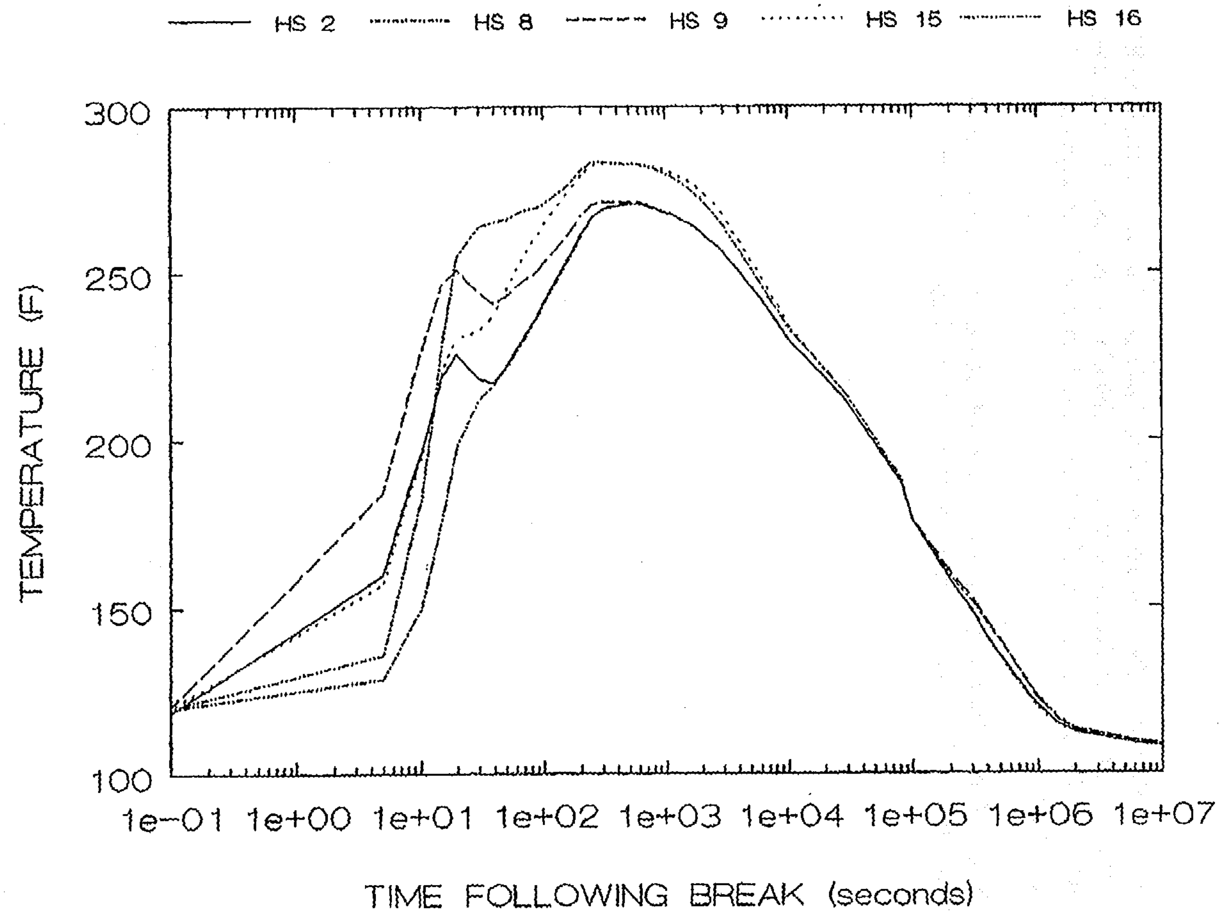
FIGURE 2-5
LOCA WITH LOP – HEAT SINK SURFACE TEMP



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2.2 RECOMMENDATIONS

Since this calculation is the new record of analysis for the Design Basis LOCA Pressure-Temperature Analysis, it should be noted in Calculation N-4080-002 that the results of the DESLSB case (Case 1 of page 6 of Reference 6.1.g) have been superseded by the results of this calculation.

In addition, all documents identified on the output side of the Calculation Cross Index Table should be reviewed to assess if this analysis has any impact on them.

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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.b).

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.b, 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.

Table 0-1 of draft Environmental Qualification Design Basis Document DBD-SO23-TR-EQ (Reference 6.6.b), indicates that the normal containment relative humidity is 60 percent. However, footnote "d" to Table 0-1 states that a document of record for this value has not been obtained.

b. ITEM 11: CONTAINMENT HEAT SINK REVAPORIZATION FRACTION

In this analysis, no credit will be taken for containment heat sink revaporization. Per the COPATTA Code Theory Manual (Reference 6.5.b, 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

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environment reduces the average energy concentration in the vapor space, 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. Since the LOCA provides only low levels of superheat prior to initiation of containment sprays at 60 seconds and the peak vapor temperature remains below the 300 °F design value, no credit for revaporization of the heat sink condensate will be taken.

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.b), 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.b), 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.

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3.2 CARD SERIES 2

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

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 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 4

a. ITEM 3: SDCHX SURFACE AREA

This calculation models a Shutdown Cooling Heat Exchanger (SDCHX) heat transfer surface area of 6860 square feet.

The Units 2 and 3 SDCHX Technical Manuals (References 6.9.a & b) describe a 7000 square foot SDCHX surface area. This area is consistent with the description present in SI/CS/SDC System Description SD-SO23-740 (Reference 6.7.e, section 2.2.20). However, to address possible plugging and corrosion, this calculation will assume (per engineering judgement) a two percent reduction in the surface area:

$$A_{SDCHX} = 0.98 \times 7000 \text{ ft}^2 = 6860 \text{ ft}^2$$

Minimizing the heat exchanger surface area minimizes the heat removed from the recirculating sump water via the heat exchanger, which minimizes the effectiveness of the Containment Spray System to reduce the containment air energy, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures during the sump water recirculation phase of the transient analysis.

3.4 CARD SERIES 5

a. ITEM 2: NUMBER OF EMERGENCY COOLING UNITS OPERATING

In this analysis, only one of the two emergency cooling unit trains (air cooler trains) will be assumed to be operational. As shown on P&ID 40172A (Reference 6.8.d), each train has two emergency cooling units. Therefore, two emergency cooling units are assumed to be operational in the LOCA analysis.

Per a July 30, 1992 E-Mail message (Reference 6.2.e), the generic assumption in a typical Pressure-Temperature analysis would be a single failure causing the loss of one train of containment cooling. The only common mode single failure at SONGS that can prevent an emergency air cooler train start-up is power related. To produce the loss of one air cooler train requires one failure of a Diesel Generator or a 4.16 KV bus, either of which will disable all pumps on that train (one Containment Spray pump and one Component Cooling Water pump). The 480 V power on the same train will also be disabled, preventing the startup of the two emergency cooling unit fans and disabling two LPSI MOV's, and four HPSI MOV's. The design basis LOCA mass and energy release data is based on maximum safety injection flows which require two HPSI trains, two LPSI trains, and all twelve penetration MOV's to be functional. Therefore, the power failure that would cause the loss of one train of containment cooling is in conflict with the design basis blowdown data.

However, to be consistent with the model used in the past and because it is a conservative assumption, only one emergency cooling unit train will be modeled in this analysis.

b. ITEM 4: EMERGENCY COOLING UNITS' SHUTOFF TIME

The containment emergency cooling units are assumed to operate for the duration of the accident (1.0e7 seconds ≈ 116 days).

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3.5 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.b, 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 increased 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).

4 DESIGN INPUT

This section presents the design input 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

The Shutdown Cooling Heat Exchanger (SDCHX) removes heat only from the spray flow path. P&IDs for Containment Spray System (40114A and 40114B) (References 6.8.b & c) show that the SDCHX cools water flowing through the containment spray system during both the injection and recirculation phases. The low pressure safety injection water flows directly to the reactor coolant loop, as it is prevented from entering the SDCHX by normally closed valves HV-8152 and HV-8153. The high pressure safety injection water also flows directly to the reactor coolant loop, as it is not designed with cross-connections to allow a flow path through the SDCHX.

The COPATTA Code must be informed which flow paths may be cooled by the SDCHX. If the Containment Spray flow path is not cooled by the SDCHX, then the warmer spray water will minimize the effectiveness of the Containment Spray System to reduce the containment air energy. If the Safety Injection water is not cooled by the SDCHX, then the warmer Safety Injection water will maximize the mass and energy release from the Reactor Vessel to the containment, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures.

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.b, 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.b, 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 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 containment temperature. The Equipment Qualification Condition Monitoring Program Assessment (Reference 6.10), contains the results of a study documenting actual Units 2 and 3 environmental conditions during a data collection period of October 7, 1985 to October 17, 1986. Figure 3-2 of the report shows that the maximum bulk average Unit 2 Containment temperature is 119 °F, and Figure 3-3 shows that the maximum bulk average Unit 3 Containment temperature is 104 °F.

Per the COPATTA Code Theory Manual (Reference 6.5.b, 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 scenario. 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 2

a. ITEM 5: REACTOR WATER VOLUME BELOW THE PIPE RUPTURE

The ruptured pipe connects to the reactor vessel at a nozzle, and the reactor vessel water below this nozzle connection will not be drained from the vessel via the pipe break. Therefore, the maximum volume of water that may be in the vessel at the end of blowdown is equivalent to the reactor water volume below the pipe rupture. Per Appendix C to CE Letter S-CE-3242 (Reference 6.2.c), the volume of water below the nozzles of the reactor vessel is 2934 ft^3.

Per Bechtel Topical Report BN-TOP-3 (Reference 6.11, section 3.2.4), for those time periods not addressed by the NSSS blowdown data, one may model the decay heat, sensible heat and metal-water reaction evaporation of the water remaining in the reactor vessel. If the exact water volume (mass) in the vessel is greater than the mass evaporated by the addition of decay heat, sensible heat, and metal-water reaction, then the excess reactor water volume modeled will be released to the containment sump where it would artificially depress the sump water temperature profile.

b. ITEM 8: TIME TO BEGIN THE MASS AND ENERGY BALANCE CALCULATIONS

The time at which mass and energy balance calculations for the water within the reactor vessel will begin is 573.273 seconds. CE Letter S-CE-2604 (Reference 6.2.a) provides the 9.82 ft^2 double ended suction leg slot (DESLS) break mass and energy release data. The mass and energy release data for the "Post-Reflood" Phase of the DESLS break are provided in Appendix A (Table 1-3) to the letter. The last data entry is for time 573.273 seconds.

Per Bechtel Topical Report BN-TOP-3 (Reference 6.11, section 3.2.4), for those time periods not addressed by the NSSS blowdown data, one may model the decay heat evaporation of the water remaining in the reactor vessel. At the specified time the temperature of all water within the vessel will be set to the saturation temperature corresponding to the total containment pressure in order to establish a starting point for succeeding calculations of vessel water energy. The core decay heat (Card Series 101), the sensible heat energy (Card Series 201), and the Safety Injection (Card Series 801) will begin to be added to the reactor vessel at this time. The specified time for this variable is equivalent to the end of the frothing phase as dictated by the CE mass and energy release data.

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4.4 CARD SERIES 4

a. ITEM 2: TYPE OF PRIMARY HEAT EXCHANGER

A single pass shell and U-tube (2 tube passes) heat exchanger is modeled in this analysis. The Single pass shell and U-Tube shutdown cooling heat exchanger (SDCHX) design is described in the Units 2 and 3 SDCHX Technical Manuals (References 6.9.a & b). The SDCHX type is consistent with the description present in SI/CS/SDC System Description SD-SO23-740 (Reference 6.7.e, section 2.2.20).

The type of heat exchanger dictates the efficiency of heat transfer between the recirculating sump water and the cooling Component Cooling Water System water. Per the COPATTA Code Theory Manual (Reference 6.5.b, section 3.2.2.2), the Code uses efficiency equations from Compact Heat Exchangers by Kays and London (Reference 6.14).

b. ITEM 4: OVERALL PRIMARY HEAT EXCHANGER HTC

The overall heat exchanger heat transfer coefficient of the Shutdown Cooling Heat Exchanger (SDCHX) is modeled as 216 BTU/hr-ft^2-°F. This overall heat transfer coefficient is provided in the Units 2 and 3 SDCHX Technical Manuals (References 6.9.a & b). These two documents provide data for "Mode 4" operation defining a situation with 225 °F tube side water, which corresponds to what should be the maximum sump water temperature (it is noted that "Mode 4" operation as used in this discussion is a vendor defined term that should not be confused with "Mode 4" of reactor operations as defined in the Operating License). The shell side flow rate for this mode is 3,000,000 lbs/hr of 120 °F water which corresponds to the coolant flow rate presented in Item 6 of this Card Series. In "Mode 4" operation a "service" transfer rate of 216 BTU/hr-ft^2-°F is provided to address performance reduction due to aging/fouling of the tubes. This "service" value is contrasted with the "clean" transfer rate of 283 BTU/hr-ft^2-°F provided in the Technical Manuals, and the 285 BTU/hr-ft^2-°F value present in SI/CS/SDC System Description SD-SO23-740 (Reference 6.7.e, section 2.2.20).

Minimizing the SDCHX overall heat transfer coefficient minimizes the heat removed from the recirculating sump water via the HX, which minimizes the effectiveness of the Containment Spray System to reduce the containment air energy, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures during the recirculation phase of the transient analysis.

c. ITEM 5: PRIMARY HEAT EXCHANGER COOLANT INLET TEMPERATURE

The primary heat exchanger coolant inlet temperature is 105 °F. The maximum inlet temperature of the SDCHX 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.

Maximizing the SDCHX coolant inlet temperature minimizes the heat removed from the recirculating sump water via the HX, which minimizes the effectiveness of the Containment Spray System to reduce the containment air energy, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures.

d. ITEM 6: PRIMARY HEAT EXCHANGER COOLANT FLOW RATE

Per Component Cooling Water System (CCWS) Design Bases Document DBD-SO23-400 (Reference 6.6.a, Table 3-1) and Calculation M-0026-002 (Reference 6.1.d, page 40), the required CCWS flow to the Shutdown Cooling Heat Exchanger is 6000 gpm per train. This value was identified as being required because of its use in the original design basis LOCA pressure-temperature analysis of Calculation N-4080-002 (Reference 6.1.g, page 585). The CCWS flow rate of 6000 gpm specified in the CCWS DBD is consistent with the normally throttled 6000 gpm flow through the SDCHX that is specified in CCW System Description SD-SO23-400 (Reference 6.7.c, section 2.2.11).

The CCWS mass flow rate through the SDCHX can be calculated by dividing the volumetric flow rate by the specific volume of the CCWS coolant entering the SDCHX. Per Design Input Item 4.4.c, the maximum inlet temperature of the SDCHX coolant is no greater than 105 °F. At this temperature the cooling water has a specific volume of 0.016147 ft³/lbm (Reference 6.16, page 87). Therefore, the SDCHX coolant mass flow rate is:

$$\dot{M} = [(6000 \text{ gal/min}) \times (60 \text{ min/hr})] \div [(7.4805 \text{ gal/ft}^3) \times (0.016147 \text{ ft}^3\text{/lbm})]$$
$$\dot{M} = 3.0 \times 10^6 \text{ lbm/hr}$$

This mass flow rate is equivalent to the 3×10^6 lbm/hr mass flow rate of the SDCHX coolant provided in the Units 2 and 3 SDCHX Technical Manuals (References 6.9.a & b). These two documents provide data for "Mode 4" operation defining a situation with 225 °F tube side water, which corresponds to what should be the maximum sump water temperature (it is noted that "Mode 4" operation as used in this discussion is a vendor defined term that should not be confused with "Mode 4" of reactor operations as defined in the Operating License).

Minimizing the SDCHX inlet coolant mass flow rate minimizes the heat removed from the recirculating sump water via the HX, which minimizes the effectiveness of the Containment Spray System to reduce the containment air energy, thereby yielding a larger containment air energy inventory that will maximize the containment pressures and temperatures.

4.5 CARD SERIES 5

a. ITEM 3: TIME OF AIR COOLER INITIATION

The containment emergency cooling units' start time is 35 seconds for the LOCA with a loss of offsite power.

Per the Engineered Safety Features Actuation System's System Description (Reference 6.7.d, section 2.1.2.1.3), a CCAS is generated upon receipt of two out of four low pressurizer pressure or high containment pressure signals.

Calculation N-4080-003 (Reference 6.1.h, Section 8.1) determined that the emergency cooling units would be functional within 34 seconds for a LOCA with a loss of offsite power. To provide margin to address any future changes in system performance, this analysis assumes that the time of air cooler initiation with a loss of offsite power is 35 seconds. This assumption represents the addition of one seconds of delay time to the air cooler initiation time determined by Calculation N-4080-003.

Delaying the start of the containment air cooler operation conservatively delays the removal of containment atmosphere energy via the emergency cooling units, 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. Since the CCW piping is not insulated, it is expected that heat will be lost between the heat exchanger and containment. Additionally, heat will be gained by the CCW system once the piping enters containment because of the high ambient temperature following a LOCA. It is reasonable to assume that the temperature entering the coolers is the same as the temperature leaving the heat exchanger.

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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.

4.6 CARD SERIES 101: REACTOR CORE DECAY POWER

CE Letter S-CE-2604, (Reference 6.2.a) provides the mass and energy release from time zero to the end of entrainment (i.e., the "Blowdown", "Post-Blowdown" and "Reflood" phases). Per Appendix I to this letter, the mass and energy release data considers core power transient and decay heat. Per Appendix A (Table 1-3) to this letter, the last of the NSSS supplied mass and energy release data is at time 573.273 seconds. The methodology to be used in evaluating core decay heat for times after 573.273 seconds is taken from NRC Branch Technical Position (BTP) ASB 9-2 (Reference 6.4.e). This analysis employs this methodology by using Bechtel Standard Application Program MAP-121, the "DECAY" Code (Reference 6.5.a). The BTP ASB 9-2 methodology includes 20 percent margin for decay times of less than 1000 seconds, and 10 percent margin for decay times greater than 1000 seconds.

Input to the DECAY Code consists of the reactor power level and the reactor operating time. Standard Review Plan 15.6.5 (Reference 6.4.d, section III.4.2) states that a conservative evaluation of the dose consequences of a LOCA should model a power level of the licensed core thermal power, plus an allowance of two percent to account for power measurement uncertainties. Paragraph 2.(1) of the Operating License (References 6.3.a & b) indicates that the reactor power level should not exceed a maximum value of 3390 MWt. Therefore, a power level of 3458 MWt will be modeled, corresponding to an energy rate of:

$$\dot{E} = (1.02 \times 3390 \text{ MWt}) \times (3.413 \times 10^6 \text{ BTU/MWt-hr})$$
$$\dot{E} = (3458 \text{ MWt}) \times (3.413 \times 10^6 \text{ BTU/MWt-hr})$$
$$\dot{E} = 1.180 \times 10^{10} \text{ BTU/hour}$$

In this calculation no energy from the hydrogen recombiners is modeled because it is negligible compared to the decay heat energy. The hydrogen recombiners are each rated at 75 KW (2.56e5 Btu/hr) and provide about 60 KW (2.05e5 Btu/hr) post accident. As can be seen from the decay energy generated below, the energy from the hydrogen recombiners is negligible.

NRC Branch Technical Position ASB 9-2 (Revision 2) addresses the equations and input parameters that are to be used in evaluating reactor core decay heat. Per the BTP, an operating history of 16,000 hours is considered representative of many end-of-first or equilibrium cycle conditions and is, therefore, acceptable for use in a core decay heat evaluation. For this analysis a two year (17,520 hours) operating cycle will be conservatively assumed.

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026
CCN CONVERSION:
CCN NO. CCN –

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The reactor power level of 3458 MWt (1.180e10 BTU/hr) and the reactor operating time of 17,520 hours are inputs to the calculation of reactor core decay heat energy release that will be modeled for times at which CE has not provided mass and energy release data. Maximizing the reactor power level and the operating time will maximize the core decay heat energy release for these later times, and consequently increase the long-term containment pressures and temperatures. Because the core decay heat energy release prior to the end of the CE provided mass and energy release is included in the CE data, the reactor power level and decay heat calculations for the Card Series 101 input have no effect on the peak pressure and temperature which occur prior to the end of the CE supplied mass and energy release data at 573.273 seconds.

The input of the DECAY Code case run is:

```
NRC
1.180E10
17520
2
DECAYHT.OUT
Y
24
0   573.273 6E2 8E2
1E3 2E3 4E3 6E3 8E3
1E4 2E4 4E4 6E4 8E4
1E5 2E5 4E5 6E5 8E5
1E6 2E6 4E6 6E6 1E7
```

The output of the DECAY Code case run is:

```
MAP-121 DECAY HEAT CALCULATION CODE, VERSION V01:

COPYRIGHT 1979,1988 Bechtel Power Corporation

*****   NRC DECAY HEAT MODEL (ASB-92, REV. 2, 1981)   *****


NRC VERSION CALCULATES RESIDUAL DECAY HEAT BY EQUATIONS PRESENTED
IN NRC BRANCH TECHNICAL POSITION ASB 9-2. REV.2 JULY 1981. CODE CALCULATES
DECAY HEAT RESULTING FROM FISSION PRODUCT DECAY, FP,AND THE DECAY
OF U-239 AND NP-239. THE TOTAL DECAY RATE, INCLUDING THE APPROPRIATE
UNCERTAINTY FACTORS IS LABELED  TOTAL. THE TOTAL HEAT RELEASED IS
LABELED INTEGRAL. RESULTS ARE ACCURATE ONLY UP TO 1.0E07 SEC.


    OPERATING POWER =     .11800E+11 BTU/HR
```

```
OUTPUT FILENAME = DECAYHT.OUT

REACTOR OPERATING TIME =     .17520E+05 HRS

USER-SELECTED TIME AFTER SHUTDOWN (SEC.):

 .0000E+00  .5733E+03  .6000E+03  .8000E+03  .1000E+04  .2000E+04
 .4000E+04  .6000E+04  .8000E+04  .1000E+05  .2000E+05  .4000E+05
 .6000E+05  .8000E+05  .1000E+06  .2000E+06  .4000E+06  .6000E+06
 .8000E+06  .1000E+07  .2000E+07  .4000E+07  .6000E+07  .1000E+08
```

TIME (SEC)	FP (BTU/HR)	U-239 (BTU/HR)	NP-239 (BTU/HR)	U239+NP239 (BTU/HR)	TOTAL (BTU/HR)
.00000E+00	.98388E+09	.18833E+08	.17924E+08	.36757E+08	.11800E+11
.57327E+03	.29718E+09	.14213E+08	.17920E+08	.32132E+08	.32931E+09
.60000E+03	.29429E+09	.14027E+08	.17919E+08	.31947E+08	.32624E+09
.80000E+03	.27749E+09	.12715E+08	.17916E+08	.30631E+08	.30812E+09
.10000E+04	.26505E+09	.11526E+08	.17911E+08	.29437E+08	.29449E+09
.20000E+04	.20241E+09	.70540E+07	.17880E+08	.24934E+08	.22734E+09
.40000E+04	.15920E+09	.26422E+07	.17788E+08	.20430E+08	.17963E+09
.60000E+04	.13861E+09	.98965E+06	.17678E+08	.18667E+08	.15728E+09
.80000E+04	.12713E+09	.37069E+06	.17561E+08	.17932E+08	.14506E+09
.10000E+05	.11948E+09	.13884E+06	.17444E+08	.17582E+08	.13706E+09
.20000E+05	.96797E+08	.10236E+04	.16860E+08	.16861E+08	.11366E+09
.40000E+05	.74023E+08	.55638E-01	.15748E+08	.15748E+08	.89771E+08
.60000E+05	.63753E+08	.30241E-05	.14710E+08	.14710E+08	.78463E+08
.80000E+05	.58401E+08	.16437E-09	.13740E+08	.13740E+08	.72141E+08
.10000E+06	.55060E+08	.89342E-14	.12834E+08	.12834E+08	.67894E+08
.20000E+06	.45865E+08	.42489E-35	.91260E+07	.91260E+07	.54991E+08
.40000E+06	.36798E+08	.00000E+00	.46141E+07	.46141E+07	.41412E+08
.60000E+06	.32401E+08	.00000E+00	.23329E+07	.23329E+07	.34734E+08
.80000E+06	.29732E+08	.00000E+00	.11795E+07	.11795E+07	.30911E+08
.10000E+07	.27766E+08	.00000E+00	.59638E+06	.59638E+06	.28363E+08
.20000E+07	.21276E+08	.00000E+00	.19705E+05	.19705E+05	.21296E+08
.40000E+07	.14713E+08	.00000E+00	.21513E+02	.21513E+02	.14713E+08
.60000E+07	.11629E+08	.00000E+00	.23486E-01	.23486E-01	.11629E+08
.10000E+08	.85482E+07	.00000E+00	.27992E-07	.27992E-07	.85482E+07

Following is the normalized decay heat graph which plots the normalized decay heat versus time after shutdown.

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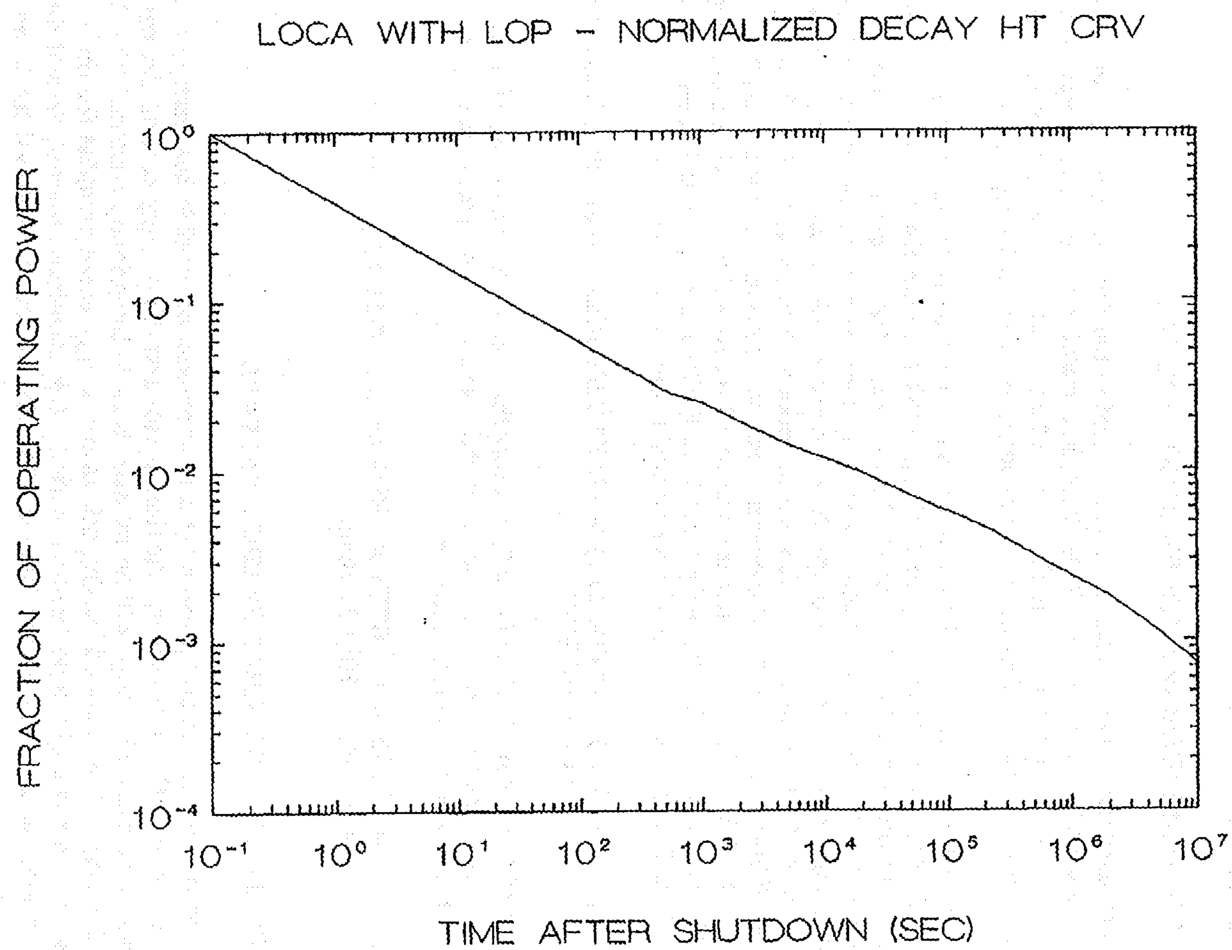

4.7 CARD SERIES 201

a. ZIRCONIUM METAL-WATER REACTION ENERGY

At high temperatures, the Zirconium metal present in the fuel cladding will react with the reactor water and release energy. This Zirconium metal-water reaction energy is released via the blowdown into the containment air space. Maximizing the Zirconium metal-water reaction energy release maximizes the containment pressure and temperature.

The energy release associated with the metal-water reaction is not incorporated into the CE blowdown data, and it is necessary to explicitly model the metal-water reaction energy for times prior to the end of the CE supplied blowdown profile. Page 2 of CE Letter S-CE-2604, (Reference 6.2.a), states that the maximum allowable Zirconium metal-water reaction energy release should be modeled as a constant release rate over the time interval between the start of the LOCA and the end of reflood. Section 6.2.1.3.8 of Appendix I of Letter S-CE-2604 states that the Zirconium metal-water reaction releases a total of 1.515×10^6 BTU. This energy release was based on an active core Zirconium metal mass of 54645 lbm, with a molecular weight of 91.22 lbm/lbm-mole, a reaction energy of 252900 BTU/lbm-mole, and a maximum allowable one percent reaction:

$$E_{m\text{-}w\ rxn} = (0.01) \times (54645\ \text{lbm}) \times (252900\ \text{BTU/lbm-mole}) / (91.22\ \text{lbm/lbm-mole}) = 1.515 \times 10^6\ \text{BTU}$$

Table 1-2 of CE Letter S-CE-2604 indicates that the end of reflood occurs at time 211.10 seconds. Therefore, the zirconium metal water reaction releases energy between 0 and 211.10 seconds at a constant rate of:

$$\dot{E}_{m\text{-}w\ rxn\ rate} = (1.515 \times 10^6\ \text{BTU}) \times (3600\ \text{sec/hr}) / (211.10\ \text{sec} - 0\ \text{sec}) = 2.5836 \times 10^7\ \text{BTU/hour}$$

b. STORED SENSIBLE HEAT ENERGY RELEASE

At the end of the post-reflood phase a significant amount of sensible heat energy remains stored in various RCS components. As time passes and the primary coolant decreases in temperature, this stored energy will be released back to the primary coolant. The CE supplied energy release data addressing this stored energy is not provided for times subsequent to the end of the post-reflood period. It is therefore necessary to add this sensible heat over some user specified time interval. The shorter the time interval the faster the energy is released into the containment air space, and the greater the containment pressure and temperature response.

Table 1-3 of CE Letter S-CE-2604 (Reference 6.2.a) indicates that the end of the Post-Reflood phase occurs at time 573.273 seconds. Appendix B to CE Letter S-CE-3242 (Reference 6.2.c), tabulates the quantity of stored sensible heat in various components at this time, for a reference temperature of 32 °F. Appendix C to CE Letter S-CE-3242 tabulates the temperatures of these various components at this same time. The heat capacity and mass of each component is tabulated in Appendix E to CE Letter S-CE-2604. With this information, Calculation N-4080-002 (Reference 6.1.g) determined the average component temperature, and the total quantity of stored sensible heat in various components at this time, for a reference temperature of 32 °F. This stored sensible heat was then manipulated to determine that a total of 301.22×10^6 BTU is stored as sensible heat in the various components at the end of the Post-Reflood phase, at a revised reference temperature of 105 °F.

Since cooldown of the containment requires many days, a conservative approximation is to add this sensible heat energy over a short duration of one day (86400 seconds). Therefore, sensible heat energy is released to the Reactor Vessel between 573.273 and 86400 seconds at a constant rate of:

$$\dot{E}_{sens.ht.} = (301.22 \times 10^6 \text{ BTU}) \times (3600 \text{ sec/hr}) / (86400 \text{ sec} - 573.273 \text{ sec})$$
$$= 1.2635 \times 10^7 \text{ BTU/hour}$$

4.8 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-4080-002 (Reference 6.1.g) indicate that the worst case LOCA is for the condition of a 9.8175 square foot area double ended suction leg slot (DESLS) break, with failure of a single cooling train. The mass and energy release data for this LOCA case are provided in Tables 1-1 through 1-3 of the CE Letter S-CE-2604 (Reference 6.2.a), and documented in the tables below.

Break mass flow rates in CE Letter S-CE-2604 are presented in units of pounds per second. The water addition rates entered into Card Series 301 are in units of pounds per hour. 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.

Break energy flow rates in CE Letter S-CE-2604 break energy flow rates are presented in units of Million BTU per second. The water enthalpies entered into Card Series 301 are in units of BTU per pound. 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 1×10^6 BTU per Million BTU.

"Blowdown" phase ($0 \leq t \leq 22.0$ sec)

The "Blowdown" phase exists from time zero to the time that the vessel has emptied. The mass and energy release data for the "Blowdown" Phase of the DESLS break are presented below as provided in Appendix A (Table 1-1) to CE Letter S-CE-2604. The mass and energy release rates are assumed to vary linearly between each data point in the following table.

NES&L DEPARTMENT

CALCULATION SHEET

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CCN CONVERSION: CCN NO. CCN –	

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026

Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 39

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Blowdown Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
0	0	0	0	0	0
0.025	75188	41.077	2.7068e+08	5.4632e+02	1.4788e+11
0.075	74324	40.641	2.6757e+08	5.4681e+02	1.4631e+11
0.175	77939	42.748	2.8058e+08	5.4848e+02	1.5389e+11
0.20	94424	51.870	3.3993e+08	5.4933e+02	1.8673e+11
0.225	93071	51.158	3.3506e+08	5.4967e+02	1.8417e+11
0.25	93149	51.243	3.3534e+08	5.5012e+02	1.8447e+11
0.40	87178	48.220	3.1384e+08	5.5312e+02	1.7359e+11
0.75	81491	45.767	2.9337e+08	5.6162e+02	1.6476e+11
0.85	76010	42.746	2.7364e+08	5.6237e+02	1.5389e+11
1.0	68473	38.570	2.4650e+08	5.6329e+02	1.3885e+11
1.2	62633	35.343	2.2548e+08	5.6429e+02	1.2723e+11
2.0	57656	32.696	2.0756e+08	5.6709e+02	1.1771e+11
3.0	50637	29.153	1.8229e+08	5.7573e+02	1.0495e+11
4.0	43798	26.146	1.5767e+08	5.9697e+02	9.4126e+10
5.0	36820	23.213	1.3255e+08	6.3045e+02	8.3567e+10
6.0	31466	20.731	1.1328e+08	6.5884e+02	7.4632e+10
8.0	26350	17.697	9.4860e+07	6.7161e+02	6.3709e+10
10.0	21889	15.052	7.8800e+07	6.8765e+02	5.4187e+10
12.0	15126	11.588	5.4454e+07	7.6610e+02	4.1717e+10
13.5	9905	8.5578	3.566e+07	8.640e+02	3.0808e+10
14.5	8021	6.0176	2.888e+07	7.502e+02	2.1663e+10
15.0	7296	5.2521	2.627e+07	7.199e+02	1.8908e+10

Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

R E V ⇓

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Blowdown Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
16.0	4910	3.2893	1.768e+07	6.699e+02	1.1841e+10
17.1	3107	2.0371	1.119e+07	6.556e+02	7.3336e+09
17.2	3168	2.0232	1.140e+07	6.386e+02	7.2835e+09
17.3	2518	1.5644	9.065e+06	6.213e+02	5.6318e+09
18.5	1709	1.1004	6.152e+06	6.439e+02	3.9614e+09
19.3	2446	1.1263	8.806e+06	4.605e+02	4.0547e+09
19.8	1985	0.96886	7.146e+06	4.881e+02	3.4879e+09
20.6	1159	0.61984	4.172e+06	5.348e+02	2.2314e+09
20.8	2823	0.93645	1.016e+07	3.317e+02	3.3712e+09
21.4	1008	0.37291	3.629e+06	3.700e+02	1.3425e+09
21.6	492	0.18020	1.77e+06	3.66e+02	6.4872e+08
21.8	84	0.028758	3.0e+05	3.4e+02	1.0353e+08
22.0	0	0	0	0	0

"Reflood" phase ($22.0 < t \leq 211.1$ sec)

The "Reflood" phase exists from the time the vessel has emptied to the time that entrainment ends. The mass and energy release data for the "Reflood" Phase of the DESLS break are presented below as provided in Appendix A (Table 1-2) to CE Letter S-CE-2604. The mass and energy release rates are assumed to vary linearly between each data point in the following table.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Reflood Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
22.0	0.00	0.00	0.00	0.00	0.00
22.25	161.95	0.210530	5.8302e+05	1.3000e+03	7.57908e+08
23.25	256.21	0.333078	9.2236e+05	1.3000e+03	1.19908e+09
24.25	429.52	0.558376	1.5463e+06	1.3000e+03	2.01015e+09
25.25	567.88	0.738240	2.0444e+06	1.3000e+03	2.65766e+09
26.25	673.75	0.875877	2.4255e+06	1.3000e+03	3.15316e+09
27.75	798.22	1.037687	2.8736e+06	1.3000e+03	3.73567e+09
28.00	512.31	0.666007	1.8443e+06	1.3000e+03	2.39763e+09
36.00	505.59	0.657271	1.8201e+06	1.3000e+03	2.36618e+09
44.50	497.77	0.647104	1.7920e+06	1.3000e+03	2.32957e+09
44.75	777.41	1.010629	2.7987e+06	1.3000e+03	3.63826e+09
75.00	735.20	0.955764	2.6467e+06	1.3000e+03	3.44075e+09
100.00	699.71	0.909620	2.5190e+06	1.3000e+03	3.27463e+09
125.00	664.47	0.863805	2.3921e+06	1.3000e+03	3.10970e+09
150.00	629.91	0.818881	2.2677e+06	1.3000e+03	2.94797e+09
175.00	594.47	0.772807	2.1401e+06	1.3000e+03	2.78211e+09
200.00	558.78	0.726408	2.0116e+06	1.3000e+03	2.61507e+09
211.10	543.15	0.706090	1.9553e+06	1.3000e+03	2.54192e+09

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

"Post-Reflood" phase (211.1 < t ≤ 573.273 sec)

The "Post-Reflood" (or "Frothing") phase exists from the time that entrainment has ended until the time that the steam generator secondary temperature has essentially reached equilibrium with the primary side temperature so that there is no longer a significant driving potential for secondary to primary heat transfer. The mass and energy release data for the "Post-Reflood" Phase of the DESLS break are provided in Appendix A (Table 1-3) to CE Letter S-CE-2604.

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Post-Reflood Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
211.101	624.38	0.740830	2.2478e+06	1.1865e+03	2.66699e+09
211.336	621.62	0.737560	2.2378e+06	1.1865e+03	2.65522e+09
211.573	618.86	0.734290	2.2279e+06	1.1865e+03	2.64344e+09
211.812	616.09	0.731010	2.2179e+06	1.1865e+03	2.63164e+09
212.052	613.33	0.727730	2.2080e+06	1.1865e+03	2.61983e+09
213.026	600.41	0.713130	2.1615e+06	1.1877e+03	2.56727e+09
215.073	568.58	0.675350	2.0469e+06	1.1878e+03	2.43126e+09
216.989	540.72	0.642320	1.9466e+06	1.1879e+03	2.31235e+09
219.039	512.88	0.609310	1.8464e+06	1.1880e+03	2.19352e+09
221.233	485.07	0.576330	1.7463e+06	1.1881e+03	2.07479e+09
222.894	465.22	0.552800	1.6748e+06	1.1883e+03	1.99008e+09
225.021	441.42	0.524590	1.5891e+06	1.1884e+03	1.88852e+09
226.920	421.64	0.501140	1.5179e+06	1.1885e+03	1.80410e+09
228.953	401.90	0.477740	1.4468e+06	1.1887e+03	1.71986e+09
231.139	382.21	0.454410	1.3760e+06	1.1889e+03	1.63588e+09
233.014	366.51	0.435800	1.3194e+06	1.1891e+03	1.56888e+09

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Subject Containment P/T Analysis for Design Basis LOCA Sheet No. 43

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Post-Reflood Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
235.017	350.86	0.417260	1.2631e+06	1.1892e+03	1.50214e+09
237.167	335.27	0.398780	1.2070e+06	1.1894e+03	1.43561e+09
238.890	323.52	0.384980	1.1647e+06	1.1900e+03	1.38593e+09
240.719	312.00	0.371210	1.1232e+06	1.1898e+03	1.33636e+09
242.668	300.44	0.357520	1.0816e+06	1.1900e+03	1.28707e+09
245.484	285.13	0.339370	1.0265e+06	1.1902e+03	1.22173e+09
246.897	277.52	0.330350	9.9907e+05	1.1904e+03	1.18926e+09
249.420	266.17	0.316900	9.5821e+05	1.1906e+03	1.14084e+09
251.151	258.64	0.307980	9.3110e+05	1.1908e+03	1.10873e+09
254.936	243.74	0.290320	8.7746e+05	1.1911e+03	1.04515e+09
259.251	229.06	0.272910	8.2462e+05	1.1914e+03	9.82476e+08
262.929	218.23	0.260060	7.8563e+05	1.1917e+03	9.36216e+08
267.086	207.58	0.247420	7.4729e+05	1.1919e+03	8.90712e+08
271.855	197.15	0.235030	7.0974e+05	1.1921e+03	8.46108e+08
281.634	180.41	0.215140	6.4948e+05	1.1925e+03	7.74504e+08
292.060	167.81	0.200110	6.0412e+05	1.1925e+03	7.20396e+08
302.415	158.99	0.189560	5.7236e+05	1.1923e+03	6.82416e+08
311.215	153.49	0.182950	5.5256e+05	1.1919e+03	6.58620e+08
321.094	148.88	0.175980	5.3597e+05	1.1820e+03	6.33528e+08
331.360	145.31	0.171760	5.2312e+05	1.1820e+03	6.18336e+08
340.999	142.78	0.168750	5.1401e+05	1.1819e+03	6.07500e+08
351.095	140.73	0.166330	5.0663e+05	1.1819e+03	5.98788e+08
361.352	139.11	0.164410	5.0080e+05	1.1819e+03	5.91876e+08

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Subject Containment P/T Analysis for Design Basis LOCA

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

LOSS OF COOLANT ACCIDENT MASS AND ENERGY RELEASE DATA (Post-Reflood Phase)
(9.8175 ft² break area, Double Ended Suction Leg Slot Break

TIME CS 301, Item 1	NSSS SUPPLIED DATA (CE Letter S-CE-2604)		DATA CONVERTED FOR CODE USE Card Series 301, Items 2 & 3		
(sec)	BREAK MASS FLOW RATE (lbm/sec)	BREAK ENERGY FLOW RATE (10^6 BTU/sec)	BREAK MASS FLOW RATE (lbm/hour)	BREAK ENTHALPY (BTU/lbm)	BREAK ENERGY FLOW RATE (BTU/hr)
371.311	137.88	0.162950	4.9637e+05	1.1818e+03	5.86620e+08
391.750	136.04	0.160770	4.8974e+05	1.1818e+03	5.78772e+08
411.491	134.85	0.159380	4.8546e+05	1.1819e+03	5.73768e+08
432.076	133.98	0.155320	4.8233e+05	1.1593e+03	5.59152e+08
452.069	133.37	0.157600	4.8013e+05	1.1817e+03	5.67360e+08
471.774	132.92	0.157060	4.7851e+05	1.1816e+03	5.65416e+08
524.047	132.16	0.156160	4.7578e+05	1.1816e+03	5.62176e+08
573.273	131.74	0.155660	4.7426e+05	1.1816e+03	5.603760e+08
573.273	0.00	0.00	0.00	0.00	0.00
1.00e+07	0.00	0.00	0.00	0.00	0.00

4.9 CARD SERIES 601

Card Series 601 is used to add water and/or energy directly to the containment sump, regardless of the enthalpy of the water being added. The water and/or energy being added to the sump represents reactor vessel spillage and direct floor spillage of the Safety Injection flow during the recirculation phase of the transient analysis.

In this analysis Card Series 601 is used to model spillage of the Safety Injection flow that is implicitly addressed in the 9.82 ft^2 double ended suction leg slot (DESLS) mass and energy release data provided in CE Letter S-CE-2604 (Reference 6.2.a). The mass and energy release data for the "Post-Reflood" Phase of the DESLS break are provided in Appendix A (Table 1-3) to the letter. The mass and energy release data are based on maximum Safety Injection flow rates, that is, assuming offsite power is available. The last data entry is for time 573.273 seconds. It is before this time that the Safety Injection Phase is implicitly modeled in Card Series 801 of the COPATTA Code. And, it is before this time that Card Series 601 is used to model spillage of the Safety Injection flow.

a. REACTOR VESSEL SPILLAGE

Reactor vessel spillage is that spillage to the containment sump which occurs when some fraction of the safety injection flow that enters the primary part of the NSSS overfills the reactor vessel, and overflows out through the break hole. Because this spillage has first mixed with the remaining fluid in the reactor vessel, it is characterized by the thermal properties (temperature) of the reactor vessel fluid inventory. Maximizing reactor vessel mass and energy spillage conservatively maximizes the temperature of the containment sump water inventory. Maximizing the sump temperature minimizes the effectiveness of the Containment Spray System to reduce the containment air energy.

"Blowdown" phase reactor vessel spillage ($0 \leq t \leq 22.0$ sec)

CE Letter S-CE-2604 (Appendix A, Table 1-1), states that for the case of the double ended suction leg slot (DESLS) break, the blowdown phase ends at 22 seconds. Appendix C to this same letter states that safety injection pump flow was not modeled during blowdown since the end of blowdown occurred before the postulated thirty second delay in obtaining Safety Injection pump flow. Therefore, there is no "Blowdown" Phase reactor vessel mass and energy spillage release for the DESLS break.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

"Reflood" phase reactor vessel spillage ($22.0 < t \leq 211.1$ sec)

CE Letter S-CE-2604 (Appendix B, Table 1), provides the "Reflood" Phase reactor vessel mass and energy spillage data for the DESLS break. The data indicates that 27.272×10^6 BTU of energy, and 245322 lbm of mass will spill into the sump at a uniform rate over the time period of 28.00 to 211.10 seconds. Therefore, mass and energy spillage is released during the Reflood Phase between 28.00 and 211.10 seconds at constant rates of:

$$\dot{M}_{\text{Reflood Phase spillage rate}} = (245322\ \text{lbm}) \times (3600\ \text{s/hr}) / (211.10 - 28.00\ \text{s}) = 4.823 \times 10^6\ \text{lbm/hour}$$

$$\dot{E}_{\text{Reflood Phase spillage rate}} = (27.272 \times 10^6\ \text{BTU}) \times (3600\ \text{s/hr}) / (211.10 - 28.00\ \text{s}) = 5.362 \times 10^8\ \text{BTU/hour}$$

"Post-Reflood" phase reactor vessel spillage ($211.1 < t \leq 573.273$ sec)

CE Letter S-CE-2604 (Appendix B), states that the "Post-Reflood" reactor vessel mass and energy spillage data for the DESLS break is defined by the difference between a constant total (blowdown plus spillage) mass release rate of 867 lbm/sec and the "Post-Reflood" blowdown mass release rates defined in Appendix A (Table 1-3) to the same letter. The "Post-Reflood phase reactor vessel mass and energy spillage begins at time 211.101 seconds, and continues until the end of blowdown at 573.273 seconds. The enthalpy of the spillage is assumed to be the 88 BTU/lbm value listed in Appendix B to the letter. The following table presents the results of the calculations that determine the "Post-Reflood" Phase Reactor Vessel Mass & Energy Spillage:

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

"POST-REFLOOD" PHASE REACTOR VESSEL MASS & ENERGY SPILLAGE

TIME	NSSS SUPPLIED DATA (CE Letter S-CE-2604)			DATA CONVERTED FOR COPATTA CODE USE IN CARD SERIES 601		SPILLAGE FRACTION
(sec)	SPILLAGE + BREAK MASS FLOW RATE (lbm/sec)	BREAK MASS FLOW RATE (lbm/sec)	SPILLAGE ENTHALPY (BTU/lbm)	SPILLAGE MASS FLOW RATE (lbm/hr)	SPILLAGE ENERGY FLOW RATE (BTU/hr)	(unitless)
211.101	867	624.38	88	8.73e+05	7.7e+07	0.28
211.336	867	621.62	88	8.83e+05	7.8e+07	0.28
211.573	867	618.86	88	8.93e+05	7.9e+07	0.29
211.812	867	616.09	88	9.03e+05	7.9e+07	0.29
212.052	867	613.33	88	9.13e+05	8.0e+07	0.29
213.026	867	600.41	88	9.60e+05	8.4e+07	0.31
215.073	867	568.58	88	1.07e+06	9.5e+07	0.34
216.989	867	540.72	88	1.17e+06	1.0e+08	0.38
219.039	867	512.88	88	1.27e+06	1.1e+08	0.41
221.233	867	485.07	88	1.37e+06	1.2e+08	0.44
222.894	867	465.22	88	1.45e+06	1.3e+08	0.46
225.021	867	441.42	88	1.53e+06	1.3e+08	0.49
226.920	867	421.64	88	1.60e+06	1.4e+08	0.51
228.953	867	401.90	88	1.67e+06	1.5e+08	0.54
231.139	867	382.21	88	1.75e+06	1.5e+08	0.56
233.014	867	366.51	88	1.80e+06	1.6e+08	0.58
235.017	867	350.86	88	1.86e+06	1.6e+08	0.60
237.167	867	335.27	88	1.91e+06	1.7e+08	0.61
238.890	867	323.52	88	1.96e+06	1.7e+08	0.63
240.719	867	312.00	88	2.00e+06	1.8e+08	0.64
242.668	867	300.44	88	2.04e+06	1.8e+08	0.65
245.484	867	285.13	88	2.09e+06	1.8e+08	0.67
246.897	867	277.52	88	2.12e+06	1.9e+08	0.68
249.420	867	266.17	88	2.16e+06	1.9e+08	0.69
251.151	867	258.64	88	2.19e+06	1.9e+08	0.70

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 48

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"POST-REFLOOD" PHASE REACTOR VESSEL MASS & ENERGY SPILLAGE

TIME	NSSS SUPPLIED DATA (CE Letter S-CE-2604)			DATA CONVERTED FOR COPATTA CODE USE IN CARD SERIES 601		SPILLAGE FRACTION
	SPILLAGE + BREAK MASS FLOW RATE	BREAK MASS FLOW RATE	SPILLAGE ENTHALPY	SPILLAGE MASS FLOW RATE	SPILLAGE ENERGY FLOW RATE	
(sec)	(lbm/sec)	(lbm/sec)	(BTU/lbm)	(lbm/hr)	(BTU/hr)	(unitless)
254.936	867	243.74	88	2.24e+06	2.0e+08	0.72
259.251	867	229.06	88	2.30e+06	2.0e+08	0.74
262.929	867	218.23	88	2.34e+06	2.1e+08	0.75
267.086	867	207.58	88	2.37e+06	2.1e+08	0.76
271.855	867	197.15	88	2.41e+06	2.1e+08	0.77
281.634	867	180.41	88	2.47e+06	2.2e+08	0.79
292.060	867	167.81	88	2.52e+06	2.2e+08	0.81
302.415	867	158.99	88	2.55e+06	2.2e+08	0.82
311.215	867	153.49	88	2.57e+06	2.3e+08	0.82
321.094	867	148.88	88	2.59e+06	2.3e+08	0.83
331.360	867	145.31	88	2.60e+06	2.3e+08	0.83
340.999	867	142.78	88	2.61e+06	2.3e+08	0.84
351.095	867	140.73	88	2.61e+06	2.3e+08	0.84
361.352	867	139.11	88	2.62e+06	2.3e+08	0.84
371.311	867	137.88	88	2.62e+06	2.3e+08	0.84
391.750	867	136.04	88	2.63e+06	2.3e+08	0.84
411.491	867	134.85	88	2.64e+06	2.3e+08	0.84
432.076	867	133.98	88	2.64e+06	2.3e+08	0.85
452.069	867	133.37	88	2.64e+06	2.3e+08	0.85
471.774	867	132.92	88	2.64e+06	2.3e+08	0.85
524.047	867	132.16	88	2.65e+06	2.3e+08	0.85
573.273	867	131.74	88	2.65e+06	2.3e+08	0.85

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b. DIRECT FLOOR SPILLAGE

CE Letter S-CE-2604 (Reference 6.2.a, Appendix C), states that direct floor spillage is that spillage to the containment floor which occurs when some fraction of the safety injection flow does not actually enter the primary part of the NSSS, but instead is injected directly into the containment. Maximizing direct floor mass and energy spillage conservatively reduces cooling of the reactor vessel water inventory, thereby maximizing the steaming of the vessel water inventory, and consequently maximizing the containment pressure and temperature response.

<u>"Blowdown" phase direct floor spillage ($0 \leq t \leq 22.0$ sec)</u>

CE Letter S-CE-2604 (Appendix A, Table 1-1), states that for the case of the double ended suction leg slot (DESLS) break, the blowdown phase ends at 22 seconds. Appendix C to this same letter states that safety injection pump flow was not modeled during blowdown since the end of blowdown occurred before the postulated thirty second delay in obtaining Safety Injection pump flow. Therefore, there is no "Blowdown" Phase direct floor mass and spillage release for the DESLS break.

<u>"Reflood" phase direct floor spillage ($22.0 < t \leq 211.1$ sec)</u>

Reactor Coolant System P&ID 40111A (Reference 6.8.a), shows that each of the four safety injection nozzles are located, respectively, in the four RCS Pump discharge legs. CE Letter S-CE-2604 (Appendix C), states that with this arrangement there is no "Reflood" Phase direct floor mass and energy spillage data for the DESLS break. The concept behind this assumption is that the RCS Pumps act as check valves, not allowing backflow to the DESLS break location.

<u>"Post-Reflood" phase direct floor spillage ($211.1 < t \leq 573.273$ sec)</u>

Reactor Coolant System P&ID 40111A shows that each of the four safety injection nozzles are located, respectively, in the four RCS Pump discharge legs. CE Letter S-CE-2604 (Appendix C), states that with this arrangement there is no "Post-Reflood" Phase direct floor mass and energy spillage data for the DESLS break. The concept behind this assumption is that the RCS Pumps act as check valves, not allowing backflow to the DESLS break location.

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4.10 CARD SERIES 801

a. INJECTION MODE CHARACTERISTICS

Initially the Containment Spray System (CSS) draws water from the Refueling Water Storage Tank (RWST) upon receipt of a Containment Spray Actuation Signal (CSAS). Per the Engineered Safety Features Actuation System (ESFAS) System Description (Reference 6.7.d, section 2.1.2.1.4), a CSAS is generated upon receipt of two out of four high-high Containment pressures and a Safety Injection Actuation Signal (SIAS). Per Section 2.1.2.1.1 of the ESFAS System Description, a SIAS is generated upon receipt of two out of four low pressurizer pressures or a high containment pressure.

a.1 Injection Mode Start Times

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

With a loss of offsite power, the containment spray would be functional within 59 seconds per Calculation N-4080-003 (Reference 6.1.h, Section 8.2). To provide margin to address any future changes in system performance, this analysis assumes that the time of containment spray initiation with a loss of offsite power is 60 seconds. The initiation time of 60 seconds is consistent with the initiation time modeled in previous LOCA analyses, including Calculation N-4080-002 (Reference 6.1.g).

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.

Once initiated, the containment spray system operates for the duration of the accident. The design basis LOCA is non-isolable and normal shutdown cooling cannot be established. Therefore, continued operation of the spray system following the injection mode, during long-term containment cooling, to recirculate the containment sump water through the SDHX is essential for reactor decay heat removal and sump water cooling.

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 RWST upon

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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.

SIS pumped flow during the early stages of the LOCA is implicitly addressed in the mass and energy release data provided in CE Letter S-CE-2604 (Reference 6.2.a). As such, the initial SIS flow characteristics need not be modeled explicitly as input data to the COPATTA Code until the end of the CE provided mass and energy release. The final mass and energy release data entry for the 9.82 ft^2 double ended suction leg slot break mass and energy release data entry is for time 573.273 seconds. It is only after this time that Card Series 801 of the COPATTA Code will be used to explicitly model the SIS Injection Mode flow characteristics.

Although the SIS Injection Mode is not explicitly modeled in the COPATTA Code until the end of the mass and energy release at 573.273 seconds, knowledge of the true safety injection start time is needed to assist in the determination of when the Recirculation Actuation Signal is initiated. Appendix C to CE Letter S-CE-2604 states that a 30 second delay is postulated prior to the occurrence of safety injection pump flow. This time is later than the safety injection flow start time of 12 seconds indicated by the flow data presented in CE Letter S-CE-3129 (Reference 6.2.b, Appendix D, page D-1). Engineering judgement dictates that the safety injection flow start time of 12 seconds is actually the start of flow from the nitrogen pressurized SITs. Therefore, a SIS Injection Mode start time of 30 seconds will be used in evaluating RWST inventory depletion.

a.1.(c) Charging System Injection Mode Start Time

The charging system supplies water to the Safety Injection System from the RWST upon receipt of a 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. In responding to the SIAS, the LPSI and HPSI pumps first deliver flow to the SIS at time 30 seconds (see section a.1.(b) above). It is assumed that in responding to the SIAS, the charging pumps also deliver flow to the SIS at time 30 seconds.

a.2 Injection Mode Flow Rates

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

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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 Calculation M-0014-009 (Reference 6.1.b, page 15). 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 section a.3 below), the containment spray flow rate of 1612 gallons/minute has a specific volume of 0.016130 ft^3/pound (Reference 6.16, page 88), and will be modeled in Card Series 801 with a mass flow rate of:

$$\dot{M} = [(1612 \text{ gallons/min}) \div (0.016130 \text{ ft}^3/\text{lbm})] \times (0.13368 \text{ ft}^3/\text{gallon}) \times (60 \text{ min/hour})$$
$$\dot{M} = 8.02e5 \text{ pounds/hour}$$

a.2.(b) Safety Injection System Injection Mode Flow Rate

CE Letter S-CE-2604 (Reference 6.2.a) provides the 9.82 ft^2 double ended suction leg slot break mass and energy release data. To ensure consistency with the safety injection assumptions employed in the LOCA mass and energy release model of Appendix H to CE Letter S-CE-2604, this calculation will model a maximum Safety Injection scenario by basing the calculations on both HPSI headers and two of the three HPSI pumps being operational, as well as the sole LPSI header and both LPSI pumps.

Per Appendix H to CE Letter S-CE-2604, each of the two HPSI pumps is capable of delivering 660 gallons/minute, and each of the two LPSI pumps is capable of delivering 2750 gallons/minute. If additive, one would calculate that the total SIS injection mode flow rate prior to recirculation would be 6820 gallons/minute, representing a HPSI pumps flow rate of 1320 gallons/minute (2 pumps at 660 gpm/HPSI pump) and a LPSI pumps flow rate of 5500 gallons/minute (2 pumps at 2750 gpm/LPSI pump).

However, the flows are not additive. When two pumps supply flow to the same piping header, the pressure effects associated with the common header cause the delivered flow to be less than the delivered flow associated with having the two pumps supply flow to separate headers. As noted previously, the two HPSI pumps deliver flow to two separate HPSI

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headers, while the two LPSI pumps feed a common LPSI header. Therefore, engineering judgement dictates that the HPSI pumps would still provide a total flow rate of 1320 gallons/minute, but that the LPSI pumps would provide a total flow rate of less than 5500 gallons/minute.

The lower total SIS injection mode flow rate is confirmed by Appendix B to CE Letter S-CE-2604 which states that the safety injection input mass flow rate is 867 pounds/second. At an injection mode water temperature of 100 °F (see section a.3 below), this safety injection flow has a specific volume of 0.016130 ft³/pound (Reference 6.16, page 88), and is equivalent to a flow rate of 6277 gallons/minute:

$$Q_{SI,inj} = (867\ \text{lbm/sec}) \times (0.016130\ \text{ft}^3/\text{lbm}) \times (7.4805\ \text{gal/ft}^3) \times (60\ \text{sec/min})$$
$$Q_{SI,inj} = 6277\ \text{gal/min}$$

It is this safety injection pumped flow rate that is modeled in Card Series 801 as:

$$\dot{M} = (867\ \text{pounds/seconds}) \times (3600\ \text{seconds/hour})$$
$$\dot{M} = 3.12e6\ \text{pounds/hour}$$

This equates to a flow rate of 4957 gallons/minute for the LPSI pumps, which is less than 5500 gallons/minute (2 pumps @ 2750 gpm/LPSI pump):

$$Q_{LSPSI} = 6277\ \text{gal/min} - 1320\ \text{gal/min}$$
$$Q_{LSPSI} = 4957\ \text{gal/min}$$

a.2.(c) Charging System Injection Mode Flow Rate

Per CVCS System Description SD-S023-390 (Reference 6.7.b, Part 1, Section 2.2.26), the three charging pumps each have a nominal pump flow rate of 44 gpm. Per Technical Specification LCO 3.1.2.1 (References 6.3.a & b), as a minimum, one boron injection flow path shall be operable, and this flow path should utilize one charging pump. Per CVCS System Description SD-S023-390 all three pumps start at an SIAS. In this calculation, a total of three charging pumps will be modeled, and the total charging flow rate will be:

$$Q_{CVCS,\,inj} = (44\ \text{gallons/minute}) \times (3\ \text{pumps}) = 132\ \text{gallons/minute}$$

Maximizing the number of pumps running will quicken the draining of the RWST. The time of occurrence of peak containment pressure and temperature is dependent on the start of the CSS injection mode. Therefore, the time of CSS recirculation mode initiation will have no impact on the containment peak pressure or temperature. However, accelerating the CSS and SIS recirculation mode initiation will hasten the switch from spray droplets composed of relatively cold RWST water to droplets composed of relatively hot containment sump water. 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 during the recirculation phase of the LOCA analysis.

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.

The introduction of safety injection water into the reactor coolant system provides additional mass and energy that will be eventually introduced into the containment air space. An increase in the safety injection water temperature results in a decrease in the amount of energy required to convert the safety injection liquid water to steam. Therefore, maximizing the safety injection water temperature allows for more energy to be released into the Containment air space, thereby maximizing containment pressures and temperatures.

a.4. Injection Mode Safety Injection System Spillage

The injection mode SIS spillage is discussed in Design Input Item 4.10.b.4.

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.d) 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. Per CE Letter S-CE-6814, these minimum transfer volumes are sufficient to allow at least 20 minutes of combined HPSI/LPSI flow to the RCS prior to recirculation mode (in which only the HPSI pumps provide flow to the RCS). In this calculation, the RWST volume is minimized to hasten the start of the recirculation mode. The RWST volume used is consistent with the injection phase RWST volume requirement given in Section VII of Calculation N-0240-006 (Reference 6.1.j)

With a loss of offsite power (LOP), the CSS establishes a spray flow of 1612 gallons/minute beginning at time 60 seconds (see discussion of time of CSS injection mode initiation).

With a maximum SI scenario, the two HPSI pumps and the two LPSI pumps discharge a total of 6277 gallons/minute beginning at time 30 seconds (see discussion of time of SIS injection mode initiation).

The three charging pumps discharge 132 gallons/minute beginning at time 30 seconds (see discussion of time of charging pumps injection mode initiation).

Based on these flow rates and times, the solutions of the following equations indicate that the RWST will deplete its useable water volume of 300,000 gallons in 2280 seconds with a loss of offsite power:

$$V_{RWST} = 300000 \text{ gallons}$$

$$= [(6277 \text{ gpm}) \times (t_{recirc} - 30 \text{ sec}) / (60 \text{ sec/min})] + [(1612 \text{ gpm}) \times (t_{recirc} - 60 \text{ sec}) / (60 \text{ sec/min})] + [(132 \text{ gpm}) \times (t_{recirc} - 30 \text{ sec}) / (60 \text{ sec/min})]$$

$$t_{recirc,\ w/LOP} = 2280 \text{ seconds}$$

The time of occurrence of peak containment pressure and temperature is dependent on the start of the CSS injection mode. Therefore, the time of CSS recirculation mode initiation will have no impact on the containment peak pressure or temperature. However, accelerating the CSS and SIS recirculation mode initiation will hasten the switch from spray droplets composed of relatively cold RWST water to droplets composed of relatively hot containment sump water. 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.

b.2 Recirculation Mode Flow Rates

b.2.(a) Containment Spray System Recirculation Mode Flow Rate

A CSS recirculation mode volumetric flow rate of 1991 gallons/minute begins coincident with the conclusion of flow realignment following the RAS, and continuing for the duration of the accident. This flow rate is determined by Calculation M-0014-009 (Reference 6.1.b, page 15) for the condition of CSS Pump degradation of 7.5 percent, and 225 °F sump water.

The time of occurrence of peak containment pressure and temperature is dependent on the start of the CSS injection mode. Therefore, the CSS recirculation mode flow rate will have no impact on the containment peak pressure or temperature. However, decreasing the CSS recirculation mode flow rate will reduce the amount of spray water available to remove energy from the containment vapor space, thereby reducing the rate of long term containment cooldown and depressurization.

At a recirculation mode water temperature of 225 °F (see following discussion), the containment spray flow rate of 1991 gallons/minute has a specific volume of 0.016812 ft^3/pound (Reference 6.16, page 86), and will be modeled in Card Series 801 with a mass flow rate of:

$\dot{M}$ = [(1991 gallons/min) ÷ (0.016812 ft^3/lbm)] × (0.13368 ft^3/gallon) × (60 min/hour)
$\dot{M}$ = 9.50e5 pounds/hour

b.2.(b) Safety Injection System Recirculation Mode Flow Rate

Per ESFAS System Description SD-SO23-720 (Reference 6.7.d, SDCN 1-1), upon generation of a RAS, the LPSI pumps are stopped, and the suction of the HPSI and CS pumps transfer from just the RWST to the combined path of the RWST and Containment Sump and then operator action isolates the RWST from the HPSI and CS pump suction lines.

A maximum Safety Injection scenario is modeled to ensure consistency with the SI assumptions employed in the LOCA mass and energy release model. CE Letter S-CE-2604 (Reference 6.2.a) provides the 9.82 ft^2 double ended suction leg slot (DESLS) break mass and energy release data.

During recirculation the flow rate will be from the two HPSI pumps only. Therefore the total SIS injection mode flow rate after the start of recirculation is:

$Q_{SI,recirc}$ = 2 pumps @ 660 gpm/HPSI pump = 1320 gal/min

At a recirculation mode water temperature of 225 °F, the safety injection flow rate of 1320 gallons/minute has a specific volume of 0.016812 ft^3/pound (Reference 6.16, page 86), and will be modeled in Card Series 801 with a mass flow rate of:

$\dot{M}$ = [(1320 gallons/min) ÷ (0.016812 ft^3/lbm)] × (0.13368 ft^3/gallon) × (60 min/hour)
$\dot{M}$ = 6.30e5 pounds/hour

The introduction of safety injection water into the reactor coolant system provides additional mass and energy that will be eventually introduced into the containment air space.

The introductory text to CE Letter S-CE-2604 states that the LOCA (blowdown) analysis has been performed conservatively assuming maximum safety injection flow rates. This conclusion is echoed in Appendix I to CE Letter S-CE-2604 (Section 6.2.1.3.7) which states that maximum safety injection flows are conservative for calculating containment peak pressures, and that maximum SIS flows were used in the generation of all LOCA mass and energy release data.

b.3 Recirculation Mode Water Temperature/Source

Per ESFAS System Description SD-SO23-720 (Reference 6.7.d, SDCN 1-1), upon generation of a RAS, the LPSI pumps are stopped, and the suction of the HPSI and CS pumps transfer from just the RWST to the combined path of the RWST and Containment Sump and then operator action isolates the RWST from the HPSI and CS pump suction lines. Previous analysis contained in Calculation N-4080-002 (Reference 6.1.g, page 7) indicates that the containment sump water temperature is above 200 °F during the first two hours of the LOCA event. And, as previously discussed, the maximum allowable RWST temperature is 100 °F. In this calculation, it is assumed that only the Containment Sump supplies the water to the HPSI and CS pumps during the recirculation mode. When the source of water is the containment sump, the temperature of the CS and the SI is the time dependent temperature of the sump and the COPATTA code will use the internally calculated sump temperature. This conservatively maximizes the temperature of the recirculation mode water.

Maximizing the recirculation mode water temperature increases the CSS recirculation 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.

The introduction of safety injection water into the reactor coolant system provides additional mass and energy that will be eventually introduced into the containment air space. An increase in the safety injection water temperature results in a decrease in the amount of energy required to convert the safety injection liquid water to steam. Therefore, maximizing the safety injection water temperature allows for more energy to be released into the Containment air space, thereby maximizing containment pressures and temperatures.

b.4. Recirculation Mode Safety Injection System Spillage

Not all of the Safety Injection water actually enters the reactor vessel. Prior to recirculation, if the postulated accident is modeled assuming that all SI flow enters the vessel, the input cold (100 °F) water will absorb the heat input with no boiloff, and actually cool down the reactor vessel water below saturation. (This was determined in Calculation N-0880-015 (reference 6.1.f). The ultimate pressures and temperatures will increase by accounting for spillage.

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The fraction of SI flow that is spilled directly to the containment sump is included in the NSSS-supplied data provided by CE letter S-CE-2604 (Reference 6.2.a) up to time $t = 573.273$ seconds following the beginning of the postulated accident.

From $t = 573.3$ seconds to the beginning of recirculation, and beyond to $t = 7200$ seconds (2 hours), the spillage fraction is taken from Calculation N-0880-015, with an adjustment made to account for differences in the safety injection flow rates assumed. The new spillage fraction, S_N, is calculated using the following method:

mass spilled from reactor vessel = mass entering reactor vessel - mass to be filled.

The mass to be filled is a constant, but the spillage fraction and the mass entering the reactor vessel change with time. The amount of mass entering the reactor vessel at various times that are to be modeled in this calculation are as given in the preceding sections. These mass flows are used with the spillage fractions and mass entering given in Calculation N-0880-015 to determine the spillage fractions used in this calculation.

$$M_{S,old} = M_{SI,old} - M_{FILL}$$
$$M_{S,new} = M_{SI,new} - M_{FILL}$$

$$S_O = \frac{M_{S,old}}{M_{SI,old}}$$

$$S_N = \frac{M_{S,new}}{M_{SI,new}}$$

$$M_{S,old} - M_{SI,old} = M_{S,new} - M_{SI,new}$$

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dividing all by $M_{SI,old}$ and mulplying $M_{s,new}$ by $\frac{M_{SI,new}}{M_{SI,new}}$, we get

$$\frac{M_{S,old}}{M_{SI,old}} - \frac{M_{SI,old}}{M_{SI,old}} = \frac{M_{S,new}}{M_{SI,old}}\frac{M_{SI,new}}{M_{SI,new}} - \frac{M_{SI,new}}{M_{SI,old}}$$

$$S_O - 1 = S_N \frac{M_{SI,new}}{M_{SI,old}} - \frac{M_{SI,new}}{M_{SI,old}}$$

$$S_O - 1 = \frac{M_{SI,new}}{M_{SI,old}}(S_N - 1)$$

$$\frac{M_{SI,old}}{M_{SI,new}}(S_O - 1) = S_N - 1$$

$$S_N = 1 + \frac{M_{SI,old}}{M_{SI,new}}(S_O - 1)$$

where,

$M_{SI,new}$ = New SI flow rate entering the reactor vessel from Design Input Items 4.10.a.2.(b) and 4.10.b.2.(b)
$M_{SI,old}$ = SI flow rate entering the reactor vessel from Calculation N-880-015
$M_{S,new}$ = New mass spilled out of reactor vessel
$M_{S,old}$ = mass spilled out of reactor vessel from Calculation N-880-015
S_O = Spillage fraction from Calculation N-880-015
S_N = Adjusted spillage fraction

By including spillage in the model, artificially lowering the reactor vessel water temperature below saturation will be avoided, resulting in increased containment pressure and temperature.
The following table shows the calculation of the adjusted spillage fraction from t= 573.273 seconds to t=7200 seconds into the LOCA.

SPILLAGE FRACTION FROM TIME T=573.273 SECONDS TO T=7200 SECONDS

TIME (seconds)	SAFETY INJECTION FLOW RATES (10^6 lb/hr) from Calculation N-0880-015 p. 13	New SIS flow rate	SPILLAGE FRACTION from Calculation N-0880-015 p. 13	Adjusted for new parameters
573.300	2.710	3.12	.884	.90
600	2.710	3.12	.885	.90
700	2.710	3.12	.887	.90
800	2.710	3.12	.890	.90
900	2.710	3.12	.893	.91
1000	2.710	3.12	.896	.91
1500	2.710	3.12	.906	.92
2000	2.710	3.12	.918	.93
2280	2.710	.630	.923 (interpolated)	.67
3000	2.710	.630	.926	.68
4000	.422	.630	.528	.68
5000	.422	.630	.557	.70
6000	.422	.630	.586	.72
7200 (2 hours)	.422	.630	.601 (interpolated)	.73

c. LONG-TERM RECIRCULATION MODE CHARACTERISTICS

c.1 Long-Term Recirculation Mode Start Time

Per Emergency Operating Instruction SO23-12-3 (Reference 6.3.d, Action 23b), at approximately two hours into the LOCA, the high pressure portion of the Safety Injection System will be realigned by the Operator for simultaneous hot and cold injection. Per System Description SD-SO23-740 (Reference 6.7.e, Section 3.3.3), in this mode of operation the Safety Injection System is aligned so that approximately 50 percent of the flow delivered

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by each HPSI pump goes into the hot legs, and approximately 50 percent goes into the cold legs.

c.2 Long-Term Recirculation Mode Flow Rates

c.2.(a) Containment Spray System Long-Term Recirculation Mode Flow Rate

During the long-term recirculation mode no changes are made to the Containment Spray System flow rate established during the recirculation mode. As in the recirculation mode, a CSS long-term recirculation mode volumetric flow rate of 1991 gallons/minute is modeled. This flow rate is determined by Calculation M-0014-009 (Reference 6.1.b, page 15), and is for the condition of CSS Pump degradation of 7.5 percent, and 225 °F sump water.

The time of occurrence of peak containment pressure and temperature is dependent on the start of the CSS injection mode. Therefore, the CSS long-term recirculation mode flow rate will have no impact on the containment peak pressure or temperature. However, decreasing the CSS long-term recirculation mode flow rate will reduce the amount of spray water available to remove energy from the containment air space, thereby sustaining the initially high containment pressures and temperatures over the long term.

At a long term recirculation mode water temperature of 225 °F, the containment spray flow rate of 1991 gallons/minute has a specific volume of 0.016812 ft^3/pound (Reference 6.16, page 86), and will be modeled in Card Series 801 with a mass flow rate of:

$$\dot{M} = [(1991 \text{ gallons/min}) \div (0.016812 \text{ ft}^3/\text{lbm})] \times (0.13368 \text{ ft}^3/\text{gallon}) \times (60 \text{ min/hour})$$
$$\dot{M} = 9.5e5 \text{ pounds/hour}$$

c.2.(b) Safety Injection System Long-Term Recirculation Mode Flow Rate

Per ESFAS System Description SD-SO23-720 (Reference 6.7.d, SDCN 1-1), upon generation of a RAS, the LPSI pumps are stopped, and the suction of the HPSI and CS pumps transfer from just the RWST to the combined path of the RWST and Containment Sump and then operator action isolates the RWST from the HPSI and CS pump suction lines.

A maximum Safety Injection scenario is modeled to ensure consistency with the SI assumptions employed in the LOCA mass and energy release model. CE Letter S-CE-2604 (Reference 6.2.a) provides the 9.82 ft^2 double ended suction leg slot (DESLS) break mass and energy release data. The mass and energy release calculations will be modeled with both HPSI headers and two of the three HPSI pumps operational.

Per Appendix H to CE Letter S-CE-2604, each HPSI pumps delivers 660 gallons/minute. Therefore the total SIS injection mode flow rate after the start of recirculation is:

$$Q_{SI,recirc} = 2 \text{ pumps} \times 660 \text{ gpm/HPSIP}$$
$$Q_{SI,recirc} = 1320 \text{ gal/min}$$

At a recirculation mode water temperature of 225 °F, the safety injection flow rate of 1320 gallons/minute has a specific volume of 0.016812 ft³/pound (Reference 6.16, page 86), and will be modeled in Card Series 801 with a mass flow rate of:

$$\dot{M} = [(1320 \text{ gallons/min}) \div (0.016812 \text{ ft}^3\text{/lbm})] \times (0.13368 \text{ ft}^3\text{/gallon}) \times (60 \text{ min/hour})$$
$$\dot{M} = 6.3e5 \text{ pounds/hour}$$

The introduction of safety injection water into the reactor coolant system provides additional mass and energy that will be eventually introduced into the containment air space. The introductory text to CE Letter S-CE-2604 states that the LOCA (blowdown) analysis has been performed conservatively assuming maximum safety injection flow rates. This conclusion is echoed in Appendix I to CE Letter S-CE-2604 (Section 6.2.1.3.7) which states that maximum safety injection flows are conservative for calculating containment peak pressures, and that maximum SIS flows were used in the generation of all LOCA mass and energy release data.

c.3 Long-Term Recirculation Mode Water Temperature

Per ESFAS System Description SD-SO23-720 (Reference 6.7.d, SDCN 1-1), upon generation of a RAS, the LPSI pumps are stopped, and the suction of the HPSI and CS pumps transfer from just the RWST to the combined path of the RWST and Containment Sump and then operator action isolates the RWST from the HPSI and CS pump suction lines. Previous analysis contained in Calculation N-4080-002 (Reference 6.1.g, page 7) indicates that the containment sump water temperature is above 110 °F after the first two hours of the LOCA event. And, as previously discussed, the maximum allowable RWST temperature is 100 °F. In this calculation, it is assumed that only the Containment Sump supplies the water to the HPSI and CS pumps during the long-term recirculation mode. When the source of water is the containment sump, the temperature of the CS and the SI is the time dependent temperature of the sump and the COPATTA code will use the internally calculated sump temperature. This conservatively maximizes the temperature of the long-term recirculation mode water.

Maximizing the long-term recirculation mode water temperature increases the CSS long-term recirculation 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.

The introduction of safety injection water into the reactor coolant system provides additional mass and energy that will be eventually introduced into the containment air space. An increase in the safety injection water temperature results in a decrease in the amount of energy required to convert the safety injection liquid water to steam. Therefore, maximizing the safety injection water temperature reduces the fraction of the decay and sensible heat used to raise the SI water to the saturation temperature, and increases the fraction of decay and sensible heat which goes into boiling the reactor vessel water. By boiling off more RV water, the quantity of steam generated is greater than with a lower SI long-term recirculation mode water temperature.

c.4. Long-Term Recirculation Mode Safety Injection System Spillage

Per System Description SD-SO23-740 (Reference 6.7.e, Section 3.3.3), in the long-term recirculation mode of operation the Safety Injection System (SIS) is aligned so that approximately 50 percent of the flow delivered by each HPSI pump goes into the hot legs from the reactor vessel to the steam generators, and approximately 50 percent goes into the cold legs (i.e., the reactor coolant pumps suction and discharge piping from the steam generators to the reactor vessel). This flow alignment is consistent with the post-LOCA Emergency Operating Instruction SO23-12-3 (Reference 6.3.d, Attachment 17).

Not all of the Safety Injection water remains in the reactor vessel after being introduced by the SI flow. All of the cold leg injection inflow from a single HPSI pump will spill out via the break.

With the double ended suction leg slot (DESLS) break of a cold leg, all hot leg injection flow will reach the vessel core. At 2 hrs, the decay heat energy is about 1.5e8 BTU/hr (Design Input Item 4.6 for Card Series 101) and the sensible energy is about 1.26e7 BTU/hr (Design Input Item 4.7 for Card Series 201). Therefore, 1.63e8 BTU/hr (1.5e8 + 1.26e7) is the energy rate at 2 hours equivalent to the mass of water lost as steam via decay heat and sensible heat boiling the reactor water away. This water loss is replaced by the HPSI flow into the vessel. Any HPSI flow above the mass of water lost due to decay and sensible heats

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will spill out onto the floor. The energy required to convert saturated water at 225 °F to saturated steam at an assumed containment pressure of 22 psig (confirmed by summary of results) is 974.7 Btu/lbm (1168.0 - 193.28 from Steam Tables, Reference 6.16, pages 87 and 94). Therefore, the Safety Injection coolant mass flow that will be needed to replace the water mass loss due the boil-off is:

$$\dot{M} = (1.63e8 \text{ BTU/hour}) \div (974.7 \text{ BTU/pound})$$
$$\dot{M} = 1.67e5 \text{ pounds/hour}$$

Per Section c.2.(b) the mass flow rate of the two HPSI pumps is 6.3e5 pounds/hour. This is 3.15e5 pounds/hour for each HPSI pump. The mass of water spilled from the vessel will be approximately 1.48 pounds/hour (3.15e5 - 1.67e5). This gives a spillage fraction of about 0.5.

Although the reactor vessel boil-off rate due to decay heat and sensible energy is less than the rate of the hot leg injection inflow, all of the excess hot leg injection inflow will spill only after passing through the reactor vessel. Since this excess flow is not immediately spilled after the introduction by the SIS, it is not considered as spilled flow in the Card Series 801 input.

Since each of the two HPSI pumps supplies the same flow rate, this scenario implies that 50 percent of the long-term recirculation mode SI flow will spill. Therefore, the spillage factor that modeled in Card Series 801 for times greater than 2 hours will be 0.50.

At the start of long-term recirculation mode at two hours, the decay heat and sensible energy boiloff rate is equivalent to about one-half the flow rate from a single HPSI pump.

4.11 CARD SERIES 1101

a. ITEMS 5 and 6: AIR COOLER HEAT REMOVAL RATES

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 5×10^{-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 temperature determined by previous LOCA P-T analyses has been below 300 °F, data for 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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REV

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 (Calc M-0072-036, pg 10) 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	LOCA Peak Temperature*
290	4.569e+07	Saturated Condition
300	4.882e+07	Saturated Condition
≥ 320	N/A	Superheated Condition

* Previously identified in Calculation N-4080-002 (Reference 6.1.g, page 6)

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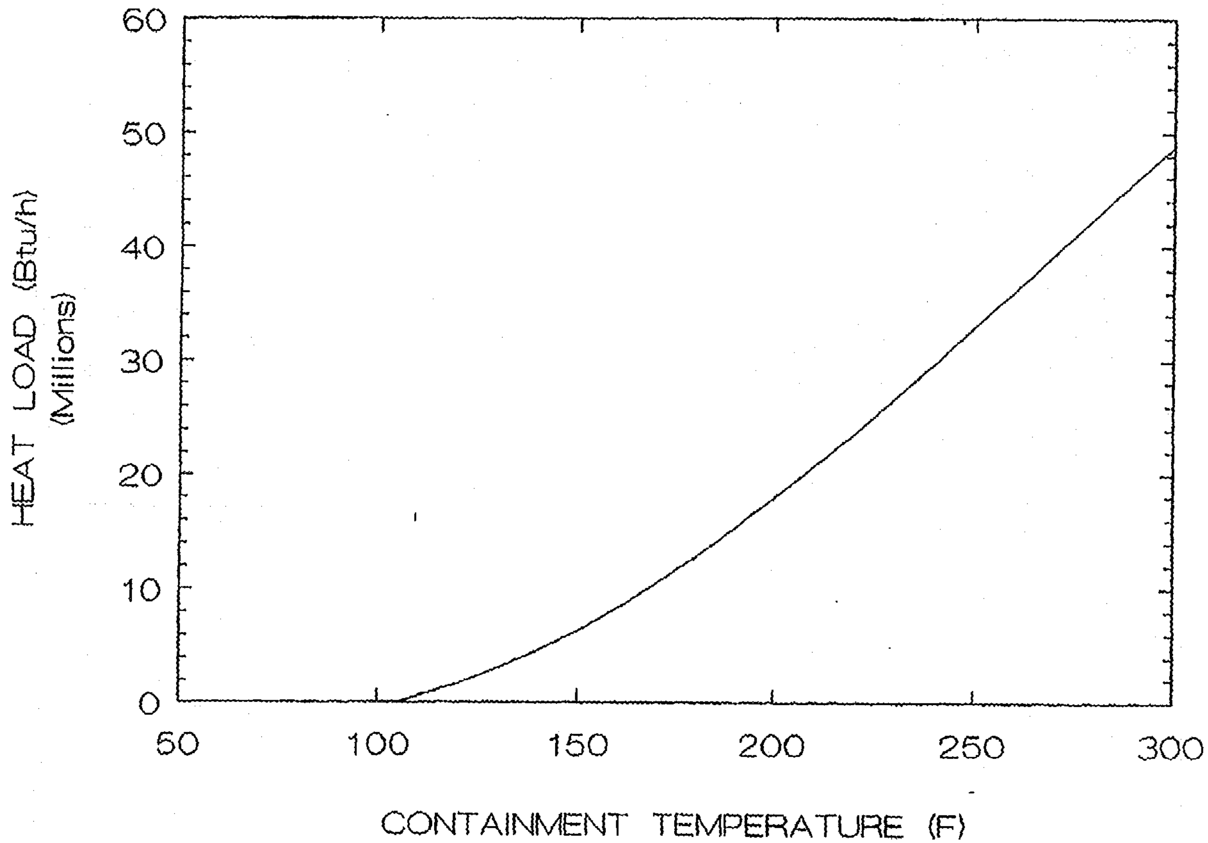
LOCA WITH LOP - AIR COOLER UNIT PERFORM.



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4.12 CARD SERIES 1201

a. ITEMS 2 and 3: CONTAINMENT SPRAY HEAT TRANSFER EFFICIENCY

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 660 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

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

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4.13 HEAT SINK DATA SERIES

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

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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 4.13.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 4.13.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.

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 4.13.a.

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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

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.

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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.i, 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.

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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.

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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 4.13.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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4.14 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).

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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 (ρ) 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

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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 ρ is equal to 0.060 lbm/ft^3, and C_p is equal to 0.241 BTU/lbm-°F. Crane Technical Paper 410 (Reference 6.17, 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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5 METHODOLOGY

The DESLS LOCA break with a total break area of 9.82 ft^2 is evaluated in this calculation. The evaluations utilized the Bechtel COPATTA computer code (Reference 6.5.b) to model the containment response to the break.

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 emergency cooling units, 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 07/28/77).

b. SONGS Units 2&3 Calculation M-0014-009, Revision 0, "Containment Spray Pumps In Service Testing Minimum Requirements".

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 M-0026-002, Revision 1, "Component Cooling Water System - Sizing of CCW Pumps" (dated 01/31/77).

e. SONGS Units 2&3 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification".

f. SONGS Units 2&3 Calculation N-0880-015, Revision 0, "Double Ended Pump Suction LOCA Long term Mass/Energy Release and COPATTA Analysis (NRC Question 022.31)".

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)

i. SONGS Units 2&3 Calculation N-4080-005, Revision 0, "MSLB Analysis for Environmental Qualification".

j. SONGS Units 2&3 Calculation N-0240-006, Revision 0, "RWST Tech Spec Requirement".

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-3129, dated July 28, 1976. (CDM number C760728G-43-40-2).

c. Letter from CE to BPC, S-CE-3242 dated September 13, 1976. (CDM number C760913G-18-18-2).

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

e. E-Mail message from Tom Yackle to Gary Johnson and Bernie Carlisle, "Containment Spray Assessment", dated July 30, 1992. A copy of this reference is provided in Section 9.

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.

d. SONGS 2&3 Emergency Operating Instruction SO23-12-3, "Loss of Coolant Accident", Revision 8.

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".

d. NUREG-0800, Standard Review Plan 15.6.5, Revision 2, July 1981, "Loss-of-Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary".

e. NRC Branch Technical Position (BTP) ASB 9-2, Revision 2, July 1981, "Residual Decay Energy for Light-Water Reactors for Long-Term Cooling" (Attachment to SRP 9.2.5).

6.5 Bechtel Computer Programs

a. Bechtel Standard Application Program MAP-121, DECAY, Version V01, "ANS and NRC Decay Heat Generation", User's, Theoretical, and Validation Manuals.

b. Bechtel Standard Application 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).

b. DBD-SO23-TR-EQ, Revision 0, "Environmental Qualification Topical Report" (dated 12/27/91)

6.7 System Descriptions

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

b. SD-S023-390, Revision 1, "Chemical and Volume Control System".

c. SD-SO23-400, Revision 2, "Component Cooling Water System".

d. SD-SO23-720, Revision 1, "Engineered Safety Features Actuation System".

e. SD-SO23-740, Revision 3, Safety Injection, Containment Spray, and Shutdown Cooling Systems".

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6.8 Drawings

a. P&ID 40111A, Revision 26, Reactor Coolant System-System No. 1201.

b. P&ID 40114A, Revision 10, Containment Spray System-System No. 1206.

c. P&ID 40114B, Revision 14, Containment Spray System-System No. 1206.

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

6.9 Vendor Documents

a. CE Technical Manual "Shutdown Cooling Heat Exchanger" for SONGS Unit 2 (SO23-932-15-0).

b. CE Technical Manual "Shutdown Cooling Heat Exchanger" for SONGS Unit 3 (SO23-932-14-0).

6.10 The "Equipment Qualification Condition Monitoring Program Assessment" of March 1988 (CDM# 1814-AH704-M0001)

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 W. M. Kay and A. L. London, Compact Heat Exchangers, (Palo Alto), National Press, 1955.

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

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

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

6.18 SO123-XXIV-37.26.12, Revision 0, PCN 0-1, "Environmental Qualification (EQ) Master List".

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

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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
ECCS	Emergency Core Cooling System
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
LOP	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

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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 one case, and the following TITLE CARD will be used:

```
* LOCA WITH A LOSS OF OFFSITE POWER
```

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=0,2,1,0,1,0,0,0,0/
```

The entries in Card Series 0 include:

ITEM 2: IHEAT = 2

A value of 2 indicates that a single heat exchanger is modeled for containment spray only per Design Input Item 4.1.a.

ITEM 3: NOIT = 1

A value of 1 disables the option to iterate for the estimated time to peak pressure. If a value of 0 is modeled, Item 10 on Card Series 1 indicates the first guess for the estimated time of peak pressure to be used in the modified Tagami condensation heat transfer coefficient calculation. If a value of 1 is modeled, Item 10 on Card Series 1 indicates the actual time of peak pressure to be used in the modified Tagami condensation heat transfer coefficient calculation.

For the version of the COPATTA code that is used for this analysis, a value of 0 for the NOIT variable gives an application error. Because of this, in this calculation, no iterations for the peak pressure will be performed by the code. Instead, an assumed peak pressure will be input based on peak pressure used in previous analysis (See Item 10 on Card Series 1).

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.

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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.b), 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.

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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:

```
&LIST POOL=1, 1.0e7, 16.2, 2.305e6, 120, 0.6, 20, 582.945, 1, 18, 0.00, 14.7, 0.50/
```

The entries in Card Series 1 include:

ITEM 2: TFNL = 1.0e7 seconds

Calculations will be terminated at 1.0×10^7 seconds

Per Procedure SO123-XXIV-37.26.12 (Reference 6.18, Attachment 5, Section D.2.a), the duration of an accident can be as long as 120 days. To facilitate the use of this analysis in Environmental Qualification efforts with the creation of an extended pressure-temperature profile, the duration of the run will be set to the time of 1.0×10^7 seconds (approx. 116 days) which envelops the time needed to return the containment to ambient temperature and pressure and meets the intent of the EQ requirement to provide long term analysis out to 120 days post-accident.

ITEM 3: PAIR = 16.2 psia

The initial pressure inside the Containment prior to the start of the LOCA 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 cubic feet, as discussed in Design Input Item 4.2.b.

ITEM 5: TAIR = 120 °F

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

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ITEM 6: HUM = 0.6

The relative humidity of the atmosphere inside the Containment prior to the start of the LOCA 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 LOCA mass and energy release is 582.945 °F, as discussed in Design Input Item 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

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.

Since the option to iterate for peak pressure is disabled (Item 3 on Card Series 0 is one), the TCHECK variable is not used. 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 = 18 seconds

The THSDD value indicates the first guess for the estimated time of peak pressure to be used in the modified Tagami condensation heat transfer coefficient calculation. The LOCA pressure-temperature analyses of Calculation N-4080-002 (Reference 6.1.g, pages 6 and 195) modeled a THSDD value of 18 seconds and the same will be used as an assumption in this calculation.

ITEM 11: EVAP = 0.0

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.

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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, 1.68e5, 2934, 0, 120, 573.273/
```

The entries in Card Series 2 include:

ITEM 2: MWATR = 0 lbs

The amount of water to be introduced as a step input at the time blowdown starts is modeled as 0 pounds.

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 = 1.68e5 lbm

The variable MLEFT is the mass 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). At time PHELP (Item 8 in this Card Series 2) if the volume occupied by MLEFT exceeds the volume given by REVOL (Item 5 in this Card Series 2), then the volume occupied by MLEFT is decreased to the point where it is equal to REVOL.

The volume given by REVOL is the true volume left in the primary system available to be evaporated by reactor decay heat or metal water reaction heat. Therefore, if the variable MLEFT is assigned a value greater than the mass equivalent to the volume of REVOL, then the COPATTA Code will be forced to employ the correct volume as specified by REVOL.

The actual mass of water left in the vessel at time PHELP (573.273 seconds) will be equivalent to the REVOL volume of 2934 ft^3 volume divided by the specific volume of saturated water at the containment pressure present at the time PHELP. Card Series 301 data gives a break enthalpy of 1181.57 Btu/lbm which is the enthalpy at the saturated temperature of 306.6 °F and a saturated liquid specific volume of 0.017516 ft^3/lbm

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(Reference 6.16, page 94). At this specific volume, the REVOL water volume is equivalent to 1.675e5 lbm (2934 ft^3 ÷ 0.017516 ^{3}/lbm). Therefore, the variable MLEFT will be rounded up to 1.68e5 pounds.

ITEM 5: REVOL = 2934 ft^3

The reactor volume below the pipe rupture is 2934 cubic feet, as discussed in Design Input Item 4.3.a.

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

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 Calculation N-4080-002 (Reference 6.1.g, page 21) employed an arbitrary value of 120 °F, this analysis will also model an arbitrary value of 120 °F.

ITEM 8: PHELP = 573.273 seconds

The time at which mass and energy balance calculations for the water within the reactor vessel will begin is 573.273 seconds, as discussed in Design Input Item 4.3.b.

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 LOCA analysis: Therefore, this Card Series is entered in the input data file as:

```
&LIST POOL=3, 0, 0, 0, 0, 0, 1.00e7, 0, 0, 0, 0/
```

The entries in Card Series 3 include:

ITEM 2: 0 seconds

The HVAC start time is 0.0 seconds.

ITEM 3: 0 ft^3/minute

The initial HVAC volume addition rate is 0 cubic feet/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 cubic feet/minute.

ITEM 7: 1.00e7 seconds

The HVAC stop time is 1.00e7 seconds. This is the time up to which the analysis is run.

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ITEM 8: 0 ft^3/minute

The final HVAC volume addition rate is 0 cubic feet/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 cubic feet/minute.

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 emergency cooling units 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, 1, 6860, 216, 105, 3.0e6, 0, 0, 0, 0, 0, 0, 0, 0/
```

The entries in Card Series 4 include:

ITEM 2: IHEX = 1

A value of 1 indicates that a single pass shell and U-tube (2 tube passes) heat exchanger is modeled in this analysis, as discussed in Design Input Item 4.4.a.

ITEM 3: HEX (1) = 6860 ft^2

The primary heat exchanger surface area is modeled as 6860 square feet. As discussed in Assumption 3.3.a, to address possible plugging and corrosion, a two percent reduction in the surface area has been assumed.

ITEM 4: HEX (2) = 216 BTU/hr-ft^2-°F

The overall heat exchanger heat transfer coefficient is 216 BTU/hr-ft^2-°F as discussed in Design Input Item 4.4.b.

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ITEM 5: HEX (3) = 105 °F

The primary heat exchanger coolant inlet temperature is 105 °F as discussed in Design Input Item 4.4.c.

ITEM 6: HEX (4) = 3.0e6 lbm/hr

The primary heat exchanger coolant flow rate is 3.0×10^6 lbm/hr as discussed in Design Input Item 4.4.d.

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.b, 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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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.b, 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	REV
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

8.1.7 <u>CARD SERIES 5</u>: Air Cooler Information

Card Series 5 provides for the selection of the number of containment emergency cooling units (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 emergency cooling units, and starts the units 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, the 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 :

```
&LIST POOL=5, 2, 35, 1.0e7, 0, 0, 0, 105/
```

The entries in Card Series 5 include:

ITEM 2: 2

There are two containment emergency cooling units modeled in this analysis as discussed in Assumption 3.4.a.

ITEM 3: 35 seconds for LOCA with a loss of offsite power.

The value represents the emergency cooling units' starting time as discussed in Design Input Item 4.5.a.

ITEM 4: 1.0e7 seconds

The shutoff time for the emergency cooling units is modeled as 1.0×10^7 seconds. Use of this time will ensure that the containment cooling units will operate for the duration of the accident, as discussed in Assumption 3.4.b.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 4.5.b.

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.b, 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 (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 (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	REV
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

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.b, page 3-25), if NOPEN is equal to zero, then the other variables may be omitted from the Card Series LEAK.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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)

This Card Series is discussed in Design Input Item 4.6. Card Series 101 is entered in the input data file as shown below. Decay heat for times prior to 573.273 seconds are incorporated into the CE supplied blowdown data of Card Series 301, and need not be entered in Card Series 101.

In Card Series 401, a constant scaling factor of unity is applied to the decay power generation rate data contained in this Card Series 101. This Card Series 401 scaling factor will direct 100 percent of the reactor core decay power into the energy inventory of the reactor vessel water.

In Card Series 701, a constant scaling factor of zero is applied to the decay power generation rate data contained in this Card Series 101. The Card Series 701 scaling factor will direct 0 percent of the reactor core decay power into the containment atmosphere.

```
&LIST POOL=101,
          0.0000,     0.0000,
     5.73273e+02,     0.0000,
      5.7327E+02, 3.2931E+08,
      6.0000E+02, 3.2624E+08,
      8.0000E+02, 3.0812E+08,
      1.0000E+03, 2.9449E+08,
      2.0000E+03, 2.2734E+08,
      4.0000E+03, 1.7963E+08,
      6.0000E+03, 1.5728E+08,
      8.0000E+03, 1.4506E+08,
      1.0000E+04, 1.3706E+08,
      2.0000E+04, 1.1366E+08,
      4.0000E+04, 8.9771E+07,
      6.0000E+04, 7.8463E+07,
      8.0000E+04, 7.2141E+07,
      1.0000E+05, 6.7894E+07,
      2.0000E+05, 5.4991E+07,
      4.0000E+05, 4.1412E+07,
      6.0000E+05, 3.4734E+07,
      8.0000E+05, 3.0911E+07,
      1.0000E+06, 2.8363E+07,
      2.0000E+06, 2.1296E+07,
      4.0000E+06, 1.4713E+07,
```

```
6.0000E+06,  1.1629E+07,
1.0000E+07,  8.5482E+06/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	R E V ⇩
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

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. In this analysis, Card Series 201, in combination with Card Series 401 and 701, is also used to input the depressurization energy (i.e., the sensible heat addition occurring at the end of the post-Reflood phase) to be added to the reactor vessel. The combined reactor metal-water reaction and depressurization energy table includes up to 25 sets of the following data, entered in columnar form:

1. time (seconds)
2. energy release rate (BTU/hour)

This Card Series is discussed in Design Input Item 4.7. Card Series 201 is entered in the input data file as shown below.

In Card Series 401, a constant scaling factor of zero is applied to the Zirconium metal-water reaction energy release rate data contained in this Card Series 201. In Card Series 401, a constant scaling factor of unity is applied to the sensible heat addition data contained in this Card Series 201. These Card Series 401 scaling factors will direct 0 percent of the metal-water reaction energy into the energy inventory of the reactor vessel water, and 100 percent of the sensible heat energy into the reactor vessel water.

In Card Series 701, a constant scaling factor of one is applied to the Zirconium metal-water reaction energy release rate data contained in this Card Series 201. In Card Series 701, a constant scaling factor of zero is applied to the sensible heat addition data contained in this Card Series 201. The Card Series 701 scaling factors will direct 100 percent of the metal-water reaction energy into the containment atmosphere, and 0 percent of the sensible heat energy into the containment atmosphere.

```
&LIST POOL=201,
                 0,  2.5836e7,
            211.10,  2.5836e7,
            211.10,         0,
           573.273,         0,
           573.273,  1.2635e7,
          8.64e+04,  1.2635e7,
          8.64e+04,         0,
          1.00e+07,         0/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

R E V ⇓

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 4.8. 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,           0,           0,
       0.025,  2.7068e+08,  5.4632e+02,
       0.075,  2.6757e+08,  5.4681e+02,
       0.175,  2.8058e+08,  5.4848e+02,
        0.20,  3.3993e+08,  5.4933e+02,
       0.225,  3.3506e+08,  5.4967e+02,
        0.25,  3.3534e+08,  5.5012e+02,
        0.40,  3.1384e+08,  5.5312e+02,
        0.75,  2.9337e+08,  5.6162e+02,
        0.85,  2.7364e+08,  5.6237e+02,
         1.0,  2.4650e+08,  5.6329e+02,
         1.2,  2.2548e+08,  5.6429e+02,
         2.0,  2.0756e+08,  5.6709e+02,
         3.0,  1.8229e+08,  5.7573e+02,
         4.0,  1.5767e+08,  5.9697e+02,
         5.0,  1.3255e+08,  6.3045e+02,
         6.0,  1.1328e+08,  6.5884e+02,
         8.0,  9.4860e+07,  6.7161e+02,
        10.0,  7.8800e+07,  6.8765e+02,
        12.0,  5.4454e+07,  7.6610e+02,
        13.5,   3.566e+07,   8.640e+02,
        14.5,   2.888e+07,   7.502e+02,
        15.0,   2.627e+07,   7.199e+02,
        16.0,   1.768e+07,   6.699e+02,
        17.1,   1.119e+07,   6.556e+02,
        17.2,   1.140e+07,   6.386e+02,
        17.3,   9.065e+06,   6.213e+02,
        18.5,   6.152e+06,   6.439e+02,
        19.3,   8.806e+06,   4.605e+02,
        19.8,   7.146e+06,   4.881e+02,
        20.6,   4.172e+06,   5.348e+02,
        20.8,   1.016e+07,   3.317e+02,
        21.4,   3.629e+06,   3.700e+02,
        21.6,    1.77e+06,    3.66e+02,
        21.8,     3.0e+05,     3.4e+02,
        22.0,        0.00,        0.00,
        22.0,        0.00,        0.00,
       22.25,  5.8302e+05,  1.3000e+03,
       23.25,  9.2236e+05,  1.3000e+03,
       24.25,  1.5463e+06,  1.3000e+03,
       25.25,  2.0444e+06,  1.3000e+03,
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

```
   26.25,  2.4255e+06,  1.3000e+03,
   27.75,  2.8736e+06,  1.3000e+03,
   28.00,  1.8443e+06,  1.3000e+03,
   36.00,  1.8201e+06,  1.3000e+03,
   44.50,  1.7920e+06,  1.3000e+03,
   44.75,  2.7987e+06,  1.3000e+03,
   75.00,  2.6467e+06,  1.3000e+03,
  100.00,  2.5190e+06,  1.3000e+03,
  125.00,  2.3921e+06,  1.3000e+03,
  150.00,  2.2677e+06,  1.3000e+03,
  175.00,  2.1401e+06,  1.3000e+03,
  200.00,  2.0116e+06,  1.3000e+03,
  211.10,  1.9553e+06,  1.3000e+03,
 211.101,  2.2478e+06,  1.1865e+03,
 211.336,  2.2378e+06,  1.1865e+03,
 211.573,  2.2279e+06,  1.1865e+03,
 211.812,  2.2179e+06,  1.1865e+03,
 212.052,  2.2080e+06,  1.1865e+03,
 213.026,  2.1615e+06,  1.1877e+03,
 215.073,  2.0469e+06,  1.1878e+03,
 216.989,  1.9466e+06,  1.1879e+03,
 219.039,  1.8464e+06,  1.1880e+03,
 221.233,  1.7463e+06,  1.1881e+03,
 222.894,  1.6748e+06,  1.1883e+03,
 225.021,  1.5891e+06,  1.1884e+03,
 226.920,  1.5179e+06,  1.1885e+03,
 228.953,  1.4468e+06,  1.1887e+03,
 231.139,  1.3760e+06,  1.1889e+03,
 233.014,  1.3194e+06,  1.1891e+03,
 235.017,  1.2631e+06,  1.1892e+03,
 237.167,  1.2070e+06,  1.1894e+03,
 238.890,  1.1647e+06,  1.1900e+03,
 240.719,  1.1232e+06,  1.1898e+03,
 242.668,  1.0816e+06,  1.1900e+03,
 245.484,  1.0265e+06,  1.1902e+03,
 246.897,  9.9907e+05,  1.1904e+03,
 249.420,  9.5821e+05,  1.1906e+03,
 251.151,  9.3110e+05,  1.1908e+03,
 254.936,  8.7746e+05,  1.1911e+03,
 259.251,  8.2462e+05,  1.1914e+03,
 262.929,  7.8563e+05,  1.1917e+03,
 267.086,  7.4729e+05,  1.1919e+03,
 271.855,  7.0974e+05,  1.1921e+03,
 281.634,  6.4948e+05,  1.1925e+03,
 292.060,  6.0412e+05,  1.1925e+03,
 302.415,  5.7236e+05,  1.1923e+03,
 311.215,  5.5256e+05,  1.1919e+03,
 321.094,  5.3597e+05,  1.1820e+03,
 331.360,  5.2312e+05,  1.1820e+03,
 340.999,  5.1401e+05,  1.1819e+03,
 351.095,  5.0663e+05,  1.1819e+03,
 361.352,  5.0080e+05,  1.1819e+03,
 371.311,  4.9637e+05,  1.1818e+03,
 391.750,  4.8974e+05,  1.1818e+03,
 411.491,  4.8546e+05,  1.1819e+03,
 432.076,  4.8233e+05,  1.1593e+03,
 452.069,  4.8013e+05,  1.1817e+03,
 471.774,  4.7851e+05,  1.1816e+03,
 524.047,  4.7578e+05,  1.1816e+03,
 573.273,  4.7426e+05,  1.1816e+03,
 573.273,        0.00,        0.00,
1.00e+07,        0.00,        0.00/
```

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), the metal-water reaction (Card Series 201), and the sensible heat addition occurring at the end of the post-Reflood phase (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)

The decay power multiplier is the fraction of the decay power presented in Card Series 101 that is added to the reactor vessel. As discussed in Design Input Item 4.6, for times earlier than 573.273 seconds, decay power (or core decay heat) is considered in the CE supplied mass and energy release data of Card Series 301, and no Card Series 101 core decay heat is added to the energy inventory in the reactor vessel. Therefore, for times earlier than 573.273 seconds, the decay power multiplier is set to zero. For times later than 573.273 seconds, all of the core decay heat that is modeled in Card Series 101 is added to the energy inventory in the reactor vessel. Therefore, for times later than 573.273 seconds, the decay power multiplier is set to unity.

The metal-water reaction multiplier is the fraction of the metal-water reaction energy as presented in Card Series 201, and the fraction of the sensible heat addition occurring at the end of the post-Reflood phase as presented in Card Series 201, that is added to the reactor vessel.

As discussed in Design Input Item 4.7.a, the Zirconium metal-water reaction energy release is modeled as a constant energy release rate over the time interval between the start of the LOCA and the end of the reflood phase at time 211.1 seconds. This metal-water reaction energy is released via the blowdown into the containment air space; none of the metal-water reaction energy is released to the energy inventory in the reactor vessel. Therefore, for times earlier than 211.1 seconds the metal-water reaction multiplier as used to address the metal-water reaction energy is set to zero. For times later than 211.1 seconds no metal-water reaction energy is released; therefore, for times later than 211.1 seconds the metal-water reaction multiplier as used to address the metal-water reaction energy is set to zero.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94						

As discussed in Design Input Item 4.7.b, at the end of the post-reflood phase a significant amount of sensible heat energy remains stored in various RCS components. As time passes and the primary coolant decreases in temperature, this stored energy will be released back to the primary coolant. This sensible heat energy is modeled as entering the Reactor Vessel over the time interval between the end of the post-reflood phase at time 573.273 seconds and the end of the first day of the accident (24 hours, equal to 86,400 seconds). For times earlier than 573.273 seconds, no sensible heat energy is released; therefore, the metal-water reaction multiplier as used to address the sensible heat energy is set to zero. For times between 573.273 and 86400 seconds, all of the sensible heat energy that is modeled in Card Series 201 is added to the energy inventory in the reactor vessel. Therefore, for times between 573.273 and 86400 seconds, the metal-water reaction multiplier as used to address the sensible heat energy is set to unity. For times later than 86400 seconds, no sensible heat energy is released; therefore, the metal-water reaction multiplier as used to address the sensible heat energy is set to zero.

Card Series 401 shall be entered in the input data file as:

```
&LIST POOL=401,
           0,  0,  0,
       211.1,  0,  0,
     573.273,  0,  0,
     573.273,  1,  1,
    8.64e+04,  1,  1,
    8.64e+04,  1,  0,
    1.00e+07,  1,  0/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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,  0,
        1.0e+07,  0,  0/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

8.1.15 CARD SERIES 601: (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 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)

In this analysis Card Series 601 is used to model spillage of the Safety Injection flow that is implicitly addressed in the mass and energy release data provided in CE Letter S-CE-2604 (Reference 6.2.a). As discussed in Design Input Item 4.9.a, 27.272 × 10^6 BTU of energy, and 245322 lbm of mass will spill into the sump at the following uniform rates over the time period of 28.00 to 211.10 seconds:

$$\dot{M}_{\text{Reflood Phase spillage rate}} = 4.823 \times 10^6 \text{ lbm/hour}$$

$$\dot{E}_{\text{Reflood Phase spillage rate}} = 5.362 \times 10^8 \text{ BTU/hour}$$

The rest of the parameters to be entered into Card Series 601 are as discussed in Design Input Item 4.9 and as shown below.

```
&LIST POOL=601,
           0.00,      0.00,       0.00,
          28.00,      0.00,       0.00,
          28.00, 4.823e+06, 5.362e+08,
        211.101,  8.73e+05,    7.7e+07,
        211.336,  8.83e+05,    7.8e+07,
        211.573,  8.93e+05,    7.9e+07,
        211.812,  9.03e+05,    7.9e+07,
        212.052,  9.13e+05,    8.0e+07,
        213.026,  9.60e+05,    8.4e+07,
        215.073,  1.07e+06,    9.5e+07,
        216.989,  1.17e+06,    1.0e+08,
        219.039,  1.27e+06,    1.1e+08,
        221.233,  1.37e+06,    1.2e+08,
        222.894,  1.45e+06,    1.3e+08,
        225.021,  1.53e+06,    1.3e+08,
        226.920,  1.60e+06,    1.4e+08,
        228.953,  1.67e+06,    1.5e+08,
        231.139,  1.75e+06,    1.5e+08,
        233.014,  1.80e+06,    1.6e+08,
        235.017,  1.86e+06,    1.6e+08,
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

```
237.167,  1.91e+06,  1.7e+08,
238.890,  1.96e+06,  1.7e+08,
240.719,  2.00e+06,  1.8e+08,
242.668,  2.04e+06,  1.8e+08,
245.484,  2.09e+06,  1.8e+08,
246.897,  2.12e+06,  1.9e+08,
249.420,  2.16e+06,  1.9e+08,
251.151,  2.19e+06,  1.9e+08,
254.936,  2.24e+06,  2.0e+08,
259.251,  2.30e+06,  2.0e+08,
262.929,  2.34e+06,  2.1e+08,
267.086,  2.37e+06,  2.1e+08,
271.855,  2.41e+06,  2.1e+08,
281.634,  2.47e+06,  2.2e+08,
292.060,  2.52e+06,  2.2e+08,
302.415,  2.55e+06,  2.2e+08,
311.215,  2.57e+06,  2.3e+08,
321.094,  2.59e+06,  2.3e+08,
331.360,  2.60e+06,  2.3e+08,
340.999,  2.61e+06,  2.3e+08,
351.095,  2.61e+06,  2.3e+08,
361.352,  2.62e+06,  2.3e+08,
371.311,  2.62e+06,  2.3e+08,
391.750,  2.63e+06,  2.3e+08,
411.491,  2.64e+06,  2.3e+08,
432.076,  2.64e+06,  2.3e+08,
452.069,  2.64e+06,  2.3e+08,
471.774,  2.64e+06,  2.3e+08,
524.047,  2.65e+06,  2.3e+08,
573.273,  2.65e+06,  2.3e+08,
573.273,      0.00,     0.00,
1.00e+07,     0.00,     0.00/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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), and the sensible heat addition occurring at the end of the post-Reflood phase (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 incudes 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)

The decay power multiplier is the fraction of the decay power presented in Card Series 101 that is added to the containment atmosphere. As discussed in Design Input Item 4.6, for times earlier than 573.273 seconds, decay power (or core decay heat) is considered in the CE supplied mass and energy release data of Card Series 301, and no Card Series 101 core decay heat is added to the energy inventory in the containment atmosphere. Therefore, for times earlier than 573.273 seconds, the decay power multiplier is set to zero. For times later than 573.273 seconds, all of the core decay heat that is modeled in Card Series 101 is added to the energy inventory in the reactor vessel and not the containment atmosphere. Therefore, for times later than 573.273 seconds, the decay power multiplier is set to zero.

The metal-water reaction multiplier is the fraction of the metal-water reaction energy as presented in Card Series 201, and the fraction of the sensible heat addition occurring at the end of the post-Reflood phase as presented in Card Series 201, that is added to the containment atmosphere.

As discussed in Design Input Item 4.7.a, the Zirconium metal-water reaction energy release is modeled as a constant energy release rate over the time interval between the start of the LOCA and the end of the reflood phase at time 211.1 seconds. This metal-water reaction energy is released via the blowdown into the containment air space. Therefore, for times earlier than 211.1 seconds the metal-water reaction multiplier as used to address the metal-water reaction energy is set to unity. For times later than 211.1 seconds no metal-water reaction energy is released; therefore, for times later than 211.1 seconds the metal-water reaction multiplier as used to address the metal-water reaction energy is set to zero.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

As discussed in Design Input Item 4.7.b, at the end of the post-reflood phase a significant amount of sensible heat energy remains stored in various RCS components. As time passes and the primary coolant decreases in temperature, this stored energy will be released back to the primary coolant. This sensible heat energy is modeled as entering the Reactor Vessel over the time interval between the end of the post-reflood phase at time 573.273 seconds and the end of the first day of the accident (24 hours, equal to 86,400 seconds). For times earlier than 573.273 seconds, no sensible heat energy is released; therefore, the metal-water reaction multiplier as used to address the sensible heat energy is set to zero. For times between 573.273 and 86400 seconds, all of the sensible heat energy that is modeled in Card Series 201 is added to the energy inventory in the reactor vessel, and not to the containment atmosphere. Therefore, for times between 573.273 and 86400 seconds, the metal-water reaction multiplier as used to address the sensible heat energy is set to zero. For times later than 86400 seconds, no sensible heat energy is released; therefore, the metal-water reaction multiplier as used to address the sensible heat energy is set to zero.

This analysis does not model water addition to the containment atmosphere. Therefore, Card Series 701 shall be entered in the input data file as:

```
&LIST POOL=701,
            0,  0,  1,  0,
        211.1,  0,  1,  0,
        211.1,  0,  0,  0,
      573.273,  0,  0,  0,
     8.64e+04,  0,  0,  0,
     1.00e+07,  0,  0,  0/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

8.1.17 CARD SERIES 801: (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 4.10. When the source of water is the containment sump, the temperature of the CS and the SI is the time dependent temperature of the sump (modeled in COPATTA as 0 °F). Card Series 801 shall be entered in the input data file as:

```
&LIST POOL=801,
           0,          0,          0,      0,  100,  100,
          60,          0,          0,      0,  100,  100,
          60,  8.02e+05,          0,      0,  100,  100,
     573.273,  8.02e+05,          0,      0,  100,  100,
     573.273,  8.02e+05,  3.12e+06,   0.90,  100,  100,
         800,  8.02e+05,  3.12e+06,   0.90,  100,  100,
         900,  8.02e+05,  3.12e+06,   0.91,  100,  100,
        1500,  8.02e+05,  3.12e+06,   0.92,  100,  100,
        2280,  8.02e+05,  3.12e+06,   0.93,  100,  100,
        2280,  9.50e+05,  6.30e+05,   0.67,    0,    0,
        3000,  9.50e+05,  6.30e+05,   0.68,    0,    0,
        4000,  9.50e+05,  6.30e+05,   0.68,    0,    0,
        5000,  9.50e+05,  6.30e+05,   0.70,    0,    0,
        7200,  9.50e+05,  6.30e+05,   0.73,    0,    0,
        7200,  9.50e+05,  6.30e+05,   0.50,    0,    0,
     1.00+e7,  9.50e+05,  6.30e+05,   0.50,    0,    0/
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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)

However, no arbitrary air addition is modeled in this analysis. Therefore, Card Series 901 shall be entered as:

```
&LIST POOL=901,
            0.0,  0,  0,
        1.0e+07,  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 of the following 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 problem 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 DBA LOCA 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 3.5.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 3.5.b.

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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 3.5.a (same as at the start of the cycle).

ITEM 7: 2 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 3.5.b (same as at the start of the cycle).

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8.1.20 CARD SERIES 1101: (Table 12)

As defined by Item 2 of Card Series 5, two containment emergency cooling units (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 LOCA input data file as:

```
&LIST POOL=1101, 1, 21, 105,
          105,      0.000,
          120,  1.670e+06,
          130,  3.020e+06,
          140,  4.570e+06,
          150,  6.320e+06,
          160,  8.270e+06,
          170,  1.040e+07,
          180,  1.273e+07,
          190,  1.523e+07,
          200,  1.788e+07,
          210,  2.068e+07,
          220,  2.361e+07,
          230,  2.664e+07,
          240,  2.974e+07,
          250,  3.291e+07,
          260,  3.611e+07,
          270,  3.931e+07,
          280,  4.252e+07,
          287,  4.474e+07,
          290,  4.569e+07,
          300,  4.882e+07/
```

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.

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 Card Series 4, Item 5 and Card Series 5, Item 8.

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 4.11.a.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 the Shutdown Cooling Heat Exchanger (SDCHX) is modeled as the primary heat exchanger; no secondary heat exchanger is 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 4.12. Card Series 1201 is entered in the input data file as:

```
&LIST POOL=1201,
          0.0,  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/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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,
       3e+03,   5.0,  50.0,   2,
       1e+04,  50.0,   500,   7,
       1e+05,  50.0, 1e+04,   1,
       1e+06,  50.0, 1e+05,   1,
       1e+07,  50.0, 5e+05,   1,
       2e+07,  50.0, 5e+05,   1/
```

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). The present analysis uses a higher calculational frequency than that suggested in N2.3.2 in order to improve accuracy of the results. Finer timesteps are particularly important for the heat sink energy at long times (See section 8.3.2).

As shown in the following tables, for an analysis run time of 1×10^7 seconds (Card Series 1, Item 2), this data will generate a total of 20,790 internal calculations, 321 energy balance printouts and 50 heat sink printouts:

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 3e3	2,300	5.0	460
3e3 to 1e4	7,000	50.0	140
1e4 to 1e5	90,000	50.0	1800
1e5 to 1e6	900,000	50.0	18,000
1e6 to 1e7	9,000,000	50.0	180,000
		Total Number of calculations :	202,050.00

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0	R. Nakano	01/18/94	J. Elliott	01/20/94						

ENERGY BALANCE PRINTOUT FREQUENCY

TIME INTERVAL (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 3e3	2,300	50	46
3e3 to 1e4	7,000	500	14
1e4 to 1e5	90,000	10,000	9
1e5 to 1e6	900,000	100,000	9
1e6 to 1e7	9,000,000	500,000	18
		Total Number of Energy Balance Printouts:	321

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 3e3	46	2	23
3e3 to 1e4	14	7	2
1e4 to 1e5	9	1	9
1e5 to 1e6	9	1	9
1e6 to 1e7	18	1	18
		Total Number of Heat Sink Printouts:	82

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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 nominal 120-day (actual 116-day) post-accident period. 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.

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 4.13.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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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, 2, 2, 1, 1/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 4.13.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

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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, 2, 2, 1, 1/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94						

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 4.13.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

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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, 2, 2, 0, 2/
```

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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

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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/
```

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/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94						

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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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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, 2, 2, 0, 2/
```

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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, 2, 2, 2, 2/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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.

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Subject Containment P/T Analysis for Design Basis LOCA Sheet No. 145

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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, 2, 2, 0, 2/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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 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.i, 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 4.13.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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Subject Containment P/T Analysis for Design Basis LOCA   Sheet No. 147

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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, 2, 2, 2, 2/
```

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.i, 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 6.1.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.

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, 2, 2, 0, 2/
```

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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.i, 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 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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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, 2, 2, 0, 2/
```

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 a refinement of those determined in Calculation N-4080-005 (Reference 6.1.i, pages 47 through 50) for Heat Sink 12 which in turn represent 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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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, 2, 2, 0, 2/
```

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.i, 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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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, 2, 2, 0, 2/
```

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.i, 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

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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 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, 2, 2, 0, 2/
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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.i, 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.

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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, 2, 2, 0, 2/
```

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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.i, 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.

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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, 2, 2, 0, 2/
```

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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

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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, 2, 2, 0, 2/
```

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.g, 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 4.13.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 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 of Concrete Region = 0.00075 ft + 0.66667 ft + 0.00035 ft + 4.21108 ft = 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, 2, 2, 1, 1/
```

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, 2, 2, 0, 2/
```

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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/ft³-°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 is:

$k = 25$ BTU/hr-ft-°F
$\rho C_p = 54$ BTU/ft³-°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 is:

$k = 0.8$ BTU/hr-ft-°F
$\rho C_p = 30$ BTU/ft³-°F

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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 is:

$k = 10$ 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 is:

$k = 0.1$ 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 is:

$k = 0.0174$ BTU/hr-ft-°F
$\rho C_p = 0.0103$ BTU/ft^3-°F

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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/
```

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Project or DCP/MMP SONGS Units 2 & 3 Calc. No. N-4080-026 CCN CONVERSION: CCN NO. CCN --

Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 171

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

8.2 COPATTA CODE INPUT

A Copy of the input file for the LOCA is presented in this section.

8.2.1 Input File for LOCA with a Loss of Offsite Power

```
* LOCA WITH A LOSS OF OFFSITE POWER
 &LIST POOL=0,2,1,0,1,0,0,0,0/
 &LIST POOL=1, 1e7, 16.2, 2.305e6, 120, 0.6, 20, 582.945, 1, 18, 0.00, 14.7, 0.50/
 &LIST POOL=2, 0, 0, 1.68e5, 2934, 0, 120, 573.273/
 &LIST POOL=3, 0, 0, 0, 0, 0, 1.00e7, 0, 0, 0, 0/
 &LIST POOL=4, 1, 6860, 216, 105, 3.0e6, 0, 0, 0, 0, 0, 0, 0, 0/
 &LIST POOL=5, 2, 35, 1.0e7, 0, 0, 0, 105/
 &LIST POOL=6, 0, 0, 0/
 &LEAK NOPEN=0/
 &LIST POOL=101,
              0.0000,     0.0000,
         5.73273e+02,     0.0000,
          5.7327E+02, 3.2931E+08,
          6.0000E+02, 3.2624E+08,
          8.0000E+02, 3.0812E+08,
          1.0000E+03, 2.9449E+08,
          2.0000E+03, 2.2734E+08,
          4.0000E+03, 1.7963E+08,
          6.0000E+03, 1.5728E+08,
          8.0000E+03, 1.4506E+08,
          1.0000E+04, 1.3706E+08,
          2.0000E+04, 1.1366E+08,
          4.0000E+04, 8.9771E+07,
          6.0000E+04, 7.8463E+07,
          8.0000E+04, 7.2141E+07,
          1.0000E+05, 6.7894E+07,
          2.0000E+05, 5.4991E+07,
          4.0000E+05, 4.1412E+07,
          6.0000E+05, 3.4734E+07,
          8.0000E+05, 3.0911E+07,
          1.0000E+06, 2.8363E+07,
          2.0000E+06, 2.1296E+07,
          4.0000E+06, 1.4713E+07,
          6.0000E+06, 1.1629E+07,
          1.0000E+07, 8.5482E+06/
 &LIST POOL=201,
               0,  2.5836e7,
          211.10,  2.5836e7,
          211.10,         0,
         573.273,         0,
         573.273,  1.2635e7,
        8.64e+04,  1.2635e7,
        8.64e+04,         0,
        1.00e+07,         0/
 &LIST POOL=301,
               0,          0,          0,
           0.025, 2.7068e+08, 5.4632e+02,
           0.075, 2.6757e+08, 5.4681e+02,
           0.175, 2.8058e+08, 5.4848e+02,
            0.20, 3.3993e+08, 5.4933e+02,
           0.225, 3.3506e+08, 5.4967e+02,
            0.25, 3.3534e+08, 5.5012e+02,
```

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Sheet No. 172

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

```
  0.40,  3.1384e+08,  5.5312e+02,
  0.75,  2.9337e+08,  5.6162e+02,
  0.85,  2.7364e+08,  5.6237e+02,
   1.0,  2.4650e+08,  5.6329e+02,
   1.2,  2.2548e+08,  5.6429e+02,
   2.0,  2.0756e+08,  5.6709e+02,
   3.0,  1.8229e+08,  5.7573e+02,
   4.0,  1.5767e+08,  5.9697e+02,
   5.0,  1.3255e+08,  6.3045e+02,
   6.0,  1.1328e+08,  6.5884e+02,
   8.0,  9.4860e+07,  6.7161e+02,
  10.0,  7.8800e+07,  6.8765e+02,
  12.0,  5.4454e+07,  7.6610e+02,
  13.5,   3.566e+07,   8.640e+02,
  14.5,   2.888e+07,   7.502e+02,
  15.0,   2.627e+07,   7.199e+02,
  16.0,   1.768e+07,   6.699e+02,
  17.1,   1.119e+07,   6.556e+02,
  17.2,   1.140e+07,   6.386e+02,
  17.3,   9.065e+06,   6.213e+02,
  18.5,   6.152e+06,   6.439e+02,
  19.3,   8.806e+06,   4.605e+02,
  19.8,   7.146e+06,   4.881e+02,
  20.6,   4.172e+06,   5.348e+02,
  20.8,   1.016e+07,   3.317e+02,
  21.4,   3.629e+06,   3.700e+02,
  21.6,     1.77e+06,   3.66e+02,
  21.8,      3.0e+05,    3.4e+02,
  22.0,         0.00,       0.00,
  22.0,         0.00,       0.00,
 22.25,  5.8302e+05,  1.3000e+03,
 23.25,  9.2236e+05,  1.3000e+03,
 24.25,  1.5463e+06,  1.3000e+03,
 25.25,  2.0444e+06,  1.3000e+03,
 26.25,  2.4255e+06,  1.3000e+03,
 27.75,  2.8736e+06,  1.3000e+03,
 28.00,  1.8443e+06,  1.3000e+03,
 36.00,  1.8201e+06,  1.3000e+03,
 44.50,  1.7920e+06,  1.3000e+03,
 44.75,  2.7987e+06,  1.3000e+03,
 75.00,  2.6467e+06,  1.3000e+03,
100.00,  2.5190e+06,  1.3000e+03,
125.00,  2.3921e+06,  1.3000e+03,
150.00,  2.2677e+06,  1.3000e+03,
175.00,  2.1401e+06,  1.3000e+03,
200.00,  2.0116e+06,  1.3000e+03,
211.10,  1.9553e+06,  1.3000e+03,
211.101, 2.2478e+06,  1.1865e+03,
211.336, 2.2378e+06,  1.1865e+03,
211.573, 2.2279e+06,  1.1865e+03,
211.812, 2.2179e+06,  1.1865e+03,
212.052, 2.2080e+06,  1.1865e+03,
213.026, 2.1615e+06,  1.1877e+03,
215.073, 2.0469e+06,  1.1878e+03,
216.989, 1.9466e+06,  1.1879e+03,
219.039, 1.8464e+06,  1.1880e+03,
221.233, 1.7463e+06,  1.1881e+03,
222.894, 1.6748e+06,  1.1883e+03,
225.021, 1.5891e+06,  1.1884e+03,
226.920, 1.5179e+06,  1.1885e+03,
228.953, 1.4468e+06,  1.1887e+03,
231.139, 1.3760e+06,  1.1889e+03,
```

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

```
          233.014,  1.3194e+06,  1.1891e+03,
          235.017,  1.2631e+06,  1.1892e+03,
          237.167,  1.2070e+06,  1.1894e+03,
          238.890,  1.1647e+06,  1.1900e+03,
          240.719,  1.1232e+06,  1.1898e+03,
          242.668,  1.0816e+06,  1.1900e+03,
          245.484,  1.0265e+06,  1.1902e+03,
          246.897,  9.9907e+05,  1.1904e+03,
          249.420,  9.5821e+05,  1.1906e+03,
          251.151,  9.3110e+05,  1.1908e+03,
          254.936,  8.7746e+05,  1.1911e+03,
          259.251,  8.2462e+05,  1.1914e+03,
          262.929,  7.8563e+05,  1.1917e+03,
          267.086,  7.4729e+05,  1.1919e+03,
          271.855,  7.0974e+05,  1.1921e+03,
          281.634,  6.4948e+05,  1.1925e+03,
          292.060,  6.0412e+05,  1.1925e+03,
          302.415,  5.7236e+05,  1.1923e+03,
          311.215,  5.5256e+05,  1.1919e+03,
          321.094,  5.3597e+05,  1.1820e+03,
          331.360,  5.2312e+05,  1.1820e+03,
          340.999,  5.1401e+05,  1.1819e+03,
          351.095,  5.0663e+05,  1.1819e+03,
          361.352,  5.0080e+05,  1.1819e+03,
          371.311,  4.9637e+05,  1.1818e+03,
          391.750,  4.8974e+05,  1.1818e+03,
          411.491,  4.8546e+05,  1.1819e+03,
          432.076,  4.8233e+05,  1.1593e+03,
          452.069,  4.8013e+05,  1.1817e+03,
          471.774,  4.7851e+05,  1.1816e+03,
          524.047,  4.7578e+05,  1.1816e+03,
          573.273,  4.7426e+05,  1.1816e+03,
          573.273,        0.00,        0.00,
         1.00e+07,        0.00,        0.00/
 &LIST POOL=401,
                0,  0,  0,
            211.1,  0,  0,
          573.273,  0,  0,
          573.273,  1,  1,
         8.64e+04,  1,  1,
         8.64e+04,  1,  0,
         1.00e+07,  1,  0/
 &LIST POOL=501,
              0.0,  0,  0,
          1.0e+07,  0,  0/
 &LIST POOL=601,
             0.00,        0.00,        0.00,
            28.00,        0.00,        0.00,
            28.00,  4.823e+06, 5.362e+08,
          211.101,   8.73e+05,   7.7e+07,
          211.336,   8.83e+05,   7.8e+07,
          211.573,   8.93e+05,   7.9e+07,
          211.812,   9.03e+05,   7.9e+07,
          212.052,   9.13e+05,   8.0e+07,
          213.026,   9.60e+05,   8.4e+07,
          215.073,   1.07e+06,   9.5e+07,
          216.989,   1.17e+06,   1.0e+08,
          219.039,   1.27e+06,   1.1e+08,
          221.233,   1.37e+06,   1.2e+08,
          222.894,   1.45e+06,   1.3e+08,
          225.021,   1.53e+06,   1.3e+08,
          226.920,   1.60e+06,   1.4e+08,
```

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 174

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	R E V ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

```
        228.953,   1.67e+06,   1.5e+08,
        231.139,   1.75e+06,   1.5e+08,
        233.014,   1.80e+06,   1.6e+08,
        235.017,   1.86e+06,   1.6e+08,
        237.167,   1.91e+06,   1.7e+08,
        238.890,   1.96e+06,   1.7e+08,
        240.719,   2.00e+06,   1.8e+08,
        242.668,   2.04e+06,   1.8e+08,
        245.484,   2.09e+06,   1.8e+08,
        246.897,   2.12e+06,   1.9e+08,
        249.420,   2.16e+06,   1.9e+08,
        251.151,   2.19e+06,   1.9e+08,
        254.936,   2.24e+06,   2.0e+08,
        259.251,   2.30e+06,   2.0e+08,
        262.929,   2.34e+06,   2.1e+08,
        267.086,   2.37e+06,   2.1e+08,
        271.855,   2.41e+06,   2.1e+08,
        281.634,   2.47e+06,   2.2e+08,
        292.060,   2.52e+06,   2.2e+08,
        302.415,   2.55e+06,   2.2e+08,
        311.215,   2.57e+06,   2.3e+08,
        321.094,   2.59e+06,   2.3e+08,
        331.360,   2.60e+06,   2.3e+08,
        340.999,   2.61e+06,   2.3e+08,
        351.095,   2.61e+06,   2.3e+08,
        361.352,   2.62e+06,   2.3e+08,
        371.311,   2.62e+06,   2.3e+08,
        391.750,   2.63e+06,   2.3e+08,
        411.491,   2.64e+06,   2.3e+08,
        432.076,   2.64e+06,   2.3e+08,
        452.069,   2.64e+06,   2.3e+08,
        471.774,   2.64e+06,   2.3e+08,
        524.047,   2.65e+06,   2.3e+08,
        573.273,   2.65e+06,   2.3e+08,
        573.273,       0.00,      0.00,
       1.00e+07,       0.00,      0.00/
&LIST POOL=701,
            0,  0,  1,  0,
        211.1,  0,  1,  0,
        211.1,  0,  0,  0,
      573.273,  0,  0,  0,
     8.64e+04,  0,  0,  0,
     1.00e+07,  0,  0,  0/
&LIST POOL=801,
          0,         0,          0,     0,  100,  100,
         60,         0,          0,     0,  100,  100,
         60,  8.02e+05,          0,     0,  100,  100,
    573.273,  8.02e+05,          0,     0,  100,  100,
    573.273,  8.02e+05,   3.12e+06,  0.90,  100,  100,
        800,  8.02e+05,   3.12e+06,  0.90,  100,  100,
        900,  8.02e+05,   3.12e+06,  0.91,  100,  100,
       1500,  8.02e+05,   3.12e+06,  0.92,  100,  100,
       2280,  8.02e+05,   3.12e+06,  0.93,  100,  100,
       2280,  9.50e+05,   6.30e+05,  0.67,    0,    0,
       3000,  9.50e+05,   6.30e+05,  0.68,    0,    0,
       4000,  9.50e+05,   6.30e+05,  0.68,    0,    0,
       5000,  9.50e+05,   6.30e+05,  0.70,    0,    0,
       7200,  9.50e+05,   6.30e+05,  0.73,    0,    0,
       7200,  9.50e+05,   6.30e+05,  0.50,    0,    0,
     1.00e+7,  9.50e+05,   6.30e+05,  0.50,    0,    0/
&LIST POOL=901,
        0.0,  0,  0,
```

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

```
          1.0e+07,  0,  0/
  &LIST POOL=1001,
           0,  100,  2.0,
          24,  100,  2.0/
  &LIST POOL=1101, 1, 21, 105,
          105,      0.000,
          120,  1.670e+06,
          130,  3.020e+06,
          140,  4.570e+06,
          150,  6.320e+06,
          160,  8.270e+06,
          170,  1.040e+07,
          180,  1.273e+07,
          190,  1.523e+07,
          200,  1.788e+07,
          210,  2.068e+07,
          220,  2.361e+07,
          230,  2.664e+07,
          240,  2.974e+07,
          250,  3.291e+07,
          260,  3.611e+07,
          270,  3.931e+07,
          280,  4.252e+07,
          287,  4.474e+07,
          290,  4.569e+07,
          300,  4.882e+07/
  &LIST POOL=1201,
          0.0,  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,
             400,   1.0,   10.0,   5,
             700,   2.0,   20.0,   5,
           3e+03,   5.0,   50.0,   2,
           1e+04,  50.0,    500,   7,
           1e+05,  50.0,  1e+04,   1,
           1e+06,  50.0,  1e+05,   1,
           1e+07,  50.0,  5e+05,   1,
           2e+07,  50.0,  5e+05,   1/
  &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,
```

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

```
                    21, 4.06363/
  &LIST POOL=101201, 4, 1, 5, 2, 2, 2, 2/
  &LIST POOL=101300, 0, 0/
  &LIST POOL=101400, 2, 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, 2, 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, 2, 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,
                    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, 2, 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, 2, 2, 2, 2/
 * HS #9 - S.G. CMPRTMNT WALLS, UNLINED REFL CNL WALLS/OTH INT WALLS
```

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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&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, 2, 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, 2, 2, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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, 2, 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/
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0	R. Nakano	01/18/94	J. Elliott	01/20/94						

```
 &LIST POOL=118300, 0, 0/
 &LIST POOL=118400, 2, 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, 2, 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, 2, 2, 0, 2/
 &LIST POOL=410001,
               25,      54,
              0.8,      30,
               18,      54,
              0.1,      20,
           0.0174,  0.0103/
 &LIST POOL=500000 /
```

8.3 COPATTA CODE OUTPUT

8.3.1 Output Employed for Summary of Results

Several plots are presented in Section 2 of this analysis. The COPATTA Code output data used to generate these plots are tabulated in this section.

a. The following data which is extracted from the COPATTA Code output is presented in Table 8.3-1:

Containment pressure (psia) from the COPATTA output and the containment gauge pressure (psig) with respect to the outside environment pressure of 14.7 psia. The containment gauge pressure (psig) is plotted against time in Figure 2-1 for the DBA LOCA case.

Sump temperature (°F) and vapor temperature (°F). The two temperatures (°F) are plotted against time in Figure 2-2 for the DBA LOCA case.

Condensing heat transfer coefficient (Btu/hr-ft^2-°F). This is plotted against time data in Figure 2-3 for the DBA LOCA case.

b. Table 8.3-2 presents the various energies versus time data that is plotted in Figures 2-4A and 2-4B for the DBA LOCA case. All the data was extracted directly from the COPATTA Code output.

c. Table 8.3-3 presents the surface temperatures of various containment heat sinks versus time data that is plotted in Figure 2-5 for the DBA LOCA case. Since heat sink data was not requested for all the times in the COPATTA Code output, the heat sink data provided is only for the times that the program was requested to print it (See Section 8.1.25). The heat sinks are:

HS 2 Containment Building Cylinder above grade
HS 8 Lined refueling canal walls
HS 9 Steam Generator compartment walls, unlined refueling canal walls & other internal walls
HS 15 Miscellaneous carbon steel: thickness < 0.5"
HS 16 Electrical equipment

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
0.05	16.2099	1.5139	110.191	212.916	8.66132
0.1	16.5674	1.8714	115.618	214.52	9.46209
0.2	17.2822	2.5862	125.373	216.548	11.436
0.3	18.1282	3.4322	136.055	218.096	14.0837
0.4	18.9045	4.2085	143.946	217.015	15.8076
0.5	19.6132	4.9172	149.323	215.304	16.9939
0.6	20.3386	5.6426	155.223	214.625	18.8116
0.7	21.0465	6.3505	160.959	215.695	20.1424
0.8	21.7257	7.0297	165.753	216.734	21.2876
0.9	22.3517	7.6557	169.855	217.698	22.514
1	22.9151	8.2191	172.507	217.647	23.5069
1.1	23.4838	8.7878	175.745	217.45	24.5493
1.2	23.9873	9.2913	178.477	217.88	25.6617
1.3	24.5087	9.8127	181.185	217.463	26.6576
1.4	25.0227	10.3267	183.743	217.202	27.5404
1.5	25.5296	10.8336	186.168	217.065	28.3283
1.6	26.0115	11.3155	188.39	217.025	29.0847
1.7	26.5042	11.8082	190.583	217.06	30.5449
1.8	26.9903	12.2943	192.675	217.159	31.8692
1.9	27.4703	12.7743	194.675	217.311	33.0763
2	27.9441	13.2481	196.59	217.506	34.1806
2.1	28.3913	13.6953	198.346	217.737	35.1964
2.2	28.8487	14.1527	200.133	217.99	36.1173
2.3	29.309	14.613	201.846	218.278	36.9921
2.4	29.7582	15.0622	203.475	218.58	38.2468
2.5	30.2015	15.5055	205.043	218.899	39.4165
2.6	30.639	15.943	206.555	219.229	40.5056
2.7	31.0363	16.3403	207.898	219.735	41.5276
2.8	31.4604	16.7644	209.58	220.383	42.4671
2.9	31.8691	17.1731	210.628	220.72	43.3422
3	32.2828	17.5868	211.944	221.059	44.1795
3.1	32.6918	17.9958	213.219	221.401	44.9683

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
3.2	33.0967	18.4007	214.457	221.744	45.7141
3.3	33.4976	18.8016	215.662	222.088	46.8651
3.4	33.8942	19.1982	216.832	222.432	48.2853
3.5	34.2865	19.5905	217.97	222.775	49.7054
3.6	34.6668	19.9708	219.055	223.405	51.1256
3.7	35.0421	20.3461	220.109	224.014	52.5457
3.8	35.3448	20.6488	220.947	224.626	53.9659
3.9	35.752	21.056	222.339	225.213	55.386
4	36.0781	21.3821	222.936	225.695	56.8062
4.1	36.4459	21.7499	223.936	226.162	58.2263
4.2	36.7902	22.0942	224.814	226.615	59.6465
4.3	37.1486	22.4526	225.74	226.902	61.0667
4.4	37.5039	22.8079	226.646	227.185	62.4868
4.5	37.8608	23.1648	227.543	227.465	63.907
4.6	38.1977	23.5017	228.381	227.94	65.3271
4.7	38.5534	23.8574	229.254	228.208	66.7473
4.8	38.8921	24.1961	230.075	228.595	68.1674
4.9	39.2033	24.5073	230.821	229.059	69.5876
5	39.5295	24.8335	231.594	229.421	71.0077
5.25	40.3337	25.6377	233.465	230.341	74.5581
5.5	41.0327	26.3367	235.052	231.27	78.1085
5.75	41.8007	27.1047	237.027	232.136	81.6589
6	42.5318	27.8358	238.343	232.846	85.2093
6.25	43.2545	28.5585	239.872	233.472	88.7597
6.5	43.9588	29.2628	241.334	234.218	92.3101
6.75	44.6482	29.9522	242.737	234.907	95.8604
7	45.3226	30.6266	244.084	235.603	99.4108
7.25	45.9645	31.2685	245.31	236.256	102.961
7.5	46.5356	31.8396	246.444	236.912	106.512
7.75	47.1616	32.4656	247.633	237.539	110.062
8	47.7772	33.0812	248.783	238.06	113.612
8.25	48.3756	33.6796	249.885	238.649	117.163

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
8.5	48.9698	34.2738	250.962	239.052	120.713
8.75	49.5513	34.8553	252.002	239.47	124.264
9	50.116	35.42	252.998	239.939	127.814
9.25	50.6715	35.9755	253.964	240.402	131.364
9.5	51.165	36.469	254.812	240.891	134.915
9.75	51.6298	36.9338	255.603	241.321	138.465
10	52.1886	37.4926	256.615	241.754	142.015
10.5	53.1801	38.4841	258.319	242.557	149.116
11	54.1127	39.4167	259.85	243.286	156.217
11.5	54.9534	40.2574	261.023	243.874	163.318
12	55.8084	41.1124	262.357	244.264	170.419
12.5	56.4266	41.7306	263.308	244.728	177.519
13	57.1137	42.4177	264.35	245.119	184.62
13.5	57.719	43.023	265.26	245.447	191.721
14	58.255	43.559	266.186	245.734	198.822
14.5	58.6004	43.9044	266.558	246.068	205.922
15	58.9523	44.2563	267.412	246.367	213.023
15.5	59.0967	44.4007	267.281	246.641	220.124
16	59.2342	44.5382	267.48	246.883	227.225
16.5	59.3124	44.6164	267.677	247.118	234.326
17	59.3293	44.6333	267.748	247.333	241.426
17.5	59.2948	44.5988	267.567	247.505	248.527
18	59.2447	44.5487	267.5	247.654	255.628
18.5	59.1852	44.4892	267.412	247.783	248.905
19	59.1163	44.4203	267.313	247.923	255.628
19.5	59.0394	44.3434	267.198	248.097	255.628
20	58.958	44.262	267.077	248.25	229.78
21	58.7654	44.0694	266.795	248.537	255.628
22	58.5434	43.8474	266.47	248.715	206.546
23	58.3587	43.6627	266.21	248.777	195.825
24	58.2145	43.5185	266.016	248.834	185.661
25	58.1416	43.4456	266.212	248.887	176.024

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
26	58.1236	43.4276	266.699	248.936	166.888
27	58.1495	43.4535	267.412	248.983	158.226
28	58.2001	43.5041	268.243	249.028	150.013
29	58.2404	43.5444	268.841	248.62	142.227
30	58.2365	43.5405	269.298	248.216	134.845
31	58.2401	43.5441	269.78	247.818	127.846
32	58.2509	43.5549	270.283	247.425	121.21
33	58.2685	43.5725	270.81	247.037	114.918
34	58.2927	43.5967	271.357	246.655	108.954
35	58.3224	43.6264	271.922	246.277	103.298
36	58.3513	43.6553	272.487	245.906	102.435
37	58.3814	43.6854	273.056	245.541	102.38
38	58.4127	43.7167	273.625	245.182	102.327
39	58.4511	43.7551	274.197	244.827	102.278
40	58.487	43.791	274.8	244.478	102.231
41	58.5218	43.8258	275.379	244.135	102.187
42	58.5576	43.8616	275.958	243.796	102.145
43	58.5945	43.8985	276.541	243.462	102.106
44	58.6326	43.9366	277.127	243.133	102.07
45	58.7085	44.0125	277.922	242.809	102.09
46	58.845	44.149	279.052	242.49	102.2
47	58.9817	44.2857	280.179	242.175	102.312
48	59.1188	44.4228	281.304	241.866	102.424
49	59.2559	44.5599	282.423	241.561	102.538
50	59.3934	44.6974	283.538	241.262	102.652
51	59.5309	44.8349	284.648	240.966	102.767
52	59.6687	44.9727	285.754	240.675	102.884
53	59.8067	45.1107	286.856	240.388	103.001
54	59.9521	45.2561	287.974	240.105	103.12
55	60.0907	45.3947	289.071	239.825	103.239
56	60.2295	45.5335	290.163	239.549	103.359
57	60.3686	45.6726	291.251	239.277	103.48

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

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Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
58	60.5075	45.8115	292.332	239.009	103.602
59	60.6466	45.9506	293.41	238.745	103.725
60	60.7858	46.0898	294.481	238.484	103.848
61	60.7941	46.0981	293.548	238.227	104.082
62	60.7962	46.1002	292.54	237.974	104.316
63	60.799	46.103	291.538	237.724	104.55
64	60.8025	46.1065	290.545	237.478	104.784
65	60.8069	46.1109	289.561	237.235	105.018
66	60.8119	46.1159	288.582	236.995	105.253
67	60.8174	46.1214	287.609	236.758	105.487
68	60.8159	46.1199	286.62	236.525	105.721
69	60.8224	46.1264	285.657	236.294	105.955
70	60.8294	46.1334	284.7	236.067	106.189
71	60.837	46.141	283.75	235.842	106.423
72	60.8452	46.1492	282.807	235.621	106.656
73	60.8537	46.1577	281.866	235.402	106.89
74	60.8629	46.1669	280.935	235.186	107.123
75	60.8726	46.1766	280.009	234.973	107.356
76	60.8828	46.1868	279.088	234.763	107.588
77	60.8932	46.1972	278.171	234.555	107.821
78	60.9044	46.2084	277.264	234.351	108.052
79	60.9202	46.2242	276.41	234.149	108.284
80	60.9336	46.2376	275.529	233.949	108.514
81	60.9461	46.2501	274.638	233.752	108.745
82	60.9493	46.2533	273.719	233.557	108.975
83	60.9748	46.2788	272.876	233.365	109.205
84	61.0029	46.3069	272.065	233.175	109.434
85	61.0312	46.3352	271.257	232.988	109.662
86	61.0606	46.3646	270.461	232.803	109.89
87	61.1148	46.4188	270.207	232.631	110.068
88	61.1543	46.4583	270.326	232.463	110.237
89	61.2257	46.5297	270.393	232.3	110.395

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Subject Containment P/T Analysis for Design Basis LOCA Sheet No. 185

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

R E V ⇓

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
90	61.3049	46.6089	270.5	232.136	110.564
91	61.3876	46.6916	270.645	231.975	110.731
92	61.466	46.77	270.762	231.818	110.894
93	61.5542	46.8582	270.942	231.66	111.057
94	61.6333	46.9373	271.044	231.507	111.224
95	61.7114	47.0154	271.111	231.354	111.4
96	61.7912	47.0952	271.238	231.205	111.557
97	61.8698	47.1738	271.331	231.058	111.723
98	61.9454	47.2494	271.409	230.913	111.893
99	62.0321	47.3361	271.588	230.77	112.049
100	62.1066	47.4106	271.654	230.63	112.223
105	62.5131	47.8171	272.188	229.953	113.104
110	62.9187	48.2227	272.727	229.327	113.808
115	63.3938	48.6978	273.25	228.758	114.603
120	63.7601	49.0641	274.102	228.207	115.365
125	64.1652	49.4692	274.403	227.703	116.268
130	64.5608	49.8648	275.103	227.258	116.908
135	64.9563	50.2603	275.614	226.839	117.647
140	65.3468	50.6508	276.079	226.455	118.371
145	65.6828	50.9868	276.179	226.113	119.097
150	66.1323	51.4363	277.168	225.787	119.715
155	66.455	51.759	277.283	225.514	120.458
160	66.895	52.199	278.082	225.241	121.08
165	67.152	52.456	278.138	225.028	121.645
170	67.6709	52.9749	279.353	224.815	122.274
175	67.9271	53.2311	279.253	224.651	122.949
180	68.2905	53.5945	279.562	224.499	123.469
185	68.6609	53.9649	280.02	224.374	124.024
190	69.0964	54.4004	280.961	224.258	124.581
195	69.4464	54.7504	281.219	224.177	125.188
200	69.7692	55.0732	281.398	224.128	125.758
210	70.5057	55.8097	282.52	224.077	126.767

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 186

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
220	71.0368	56.3408	282.898	224.063	127.511
230	71.3732	56.6772	283.296	223.813	127.966
240	71.5525	56.8565	283.531	223.389	128.16
250	71.5529	56.8569	283.505	222.895	128.194
260	71.5215	56.8255	283.466	222.312	128.117
270	71.4355	56.7395	283.362	221.7	127.975
280	71.3168	56.6208	283.219	221.062	127.793
290	71.1806	56.4846	283.055	220.419	127.589
300	71.036	56.34	282.881	219.758	127.373
310	70.8887	56.1927	282.703	219.105	127.153
320	70.7399	56.0439	282.523	218.479	126.93
330	70.5929	55.8969	282.345	217.857	126.709
340	70.4504	55.7544	282.172	217.242	126.495
350	70.2712	55.5752	281.954	216.657	126.291
360	70.1419	55.4459	281.796	216.063	126.093
370	70.0195	55.3235	281.646	215.478	125.903
380	69.9033	55.2073	281.503	214.906	125.722
390	69.7939	55.0979	281.368	214.345	125.55
400	69.6917	54.9957	281.242	213.792	125.386
420	69.5019	54.8059	281.006	212.716	125.08
440	69.3241	54.6281	280.785	211.69	124.792
460	69.1744	54.4784	280.597	210.705	124.545
480	69.0461	54.3501	280.436	209.762	124.33
500	68.9343	54.2383	280.294	208.855	124.139
520	68.8371	54.1411	280.171	207.982	123.97
540	68.7536	54.0576	280.063	207.143	123.821
560	68.6816	53.9856	279.97	206.337	123.69
580	68.5607	53.8647	279.817	205.444	123.481
600	68.3132	53.6172	279.506	204.333	123.073
620	68.0777	53.3817	279.208	203.265	122.679
640	67.8498	53.1538	278.919	202.239	122.295
660	67.6312	52.9352	278.64	201.251	121.921

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
680	67.4194	52.7234	278.37	200.299	121.556
700	67.2137	52.5177	278.106	199.385	121.199
750	66.7269	52.0309	277.477	197.246	120.328
800	66.2643	51.5683	276.874	195.292	119.494
850	65.8297	51.1337	276.303	193.481	118.691
900	65.4238	50.7278	275.766	191.78	117.925
950	65.0414	50.3454	275.255	190.194	117.187
1000	64.6735	49.9775	274.76	188.717	116.465
1050	64.3196	49.6236	274.281	187.338	115.758
1100	64.1014	49.4054	274.125	186.053	115.044
1150	63.9235	49.2275	273.731	184.83	114.309
1200	63.5919	48.8959	273.276	183.694	113.619
1250	63.2701	48.5741	272.831	182.622	112.938
1300	62.9564	48.2604	272.395	181.605	112.264
1350	62.6492	47.9532	271.965	180.641	111.593
1400	62.3478	47.6518	271.54	179.726	110.924
1450	62.0145	47.3185	271.07	178.865	110.265
1500	61.7223	47.0263	270.653	178.035	109.599
1550	61.4337	46.7377	270.24	177.243	108.931
1600	61.1481	46.4521	269.828	176.487	108.259
1650	60.864	46.168	269.416	175.763	107.582
1700	60.5811	45.8851	269.004	175.07	106.899
1750	60.2992	45.6032	268.591	174.405	106.21
1800	60.018	45.322	268.177	173.766	105.514
1850	59.7387	45.0427	267.764	173.151	104.811
1900	59.4588	44.7628	267.347	172.56	104.1
1950	59.1822	44.4862	266.933	171.989	103.381
2000	58.9031	44.2071	266.513	171.438	102.653
2050	58.6285	43.9325	266.098	170.906	101.924
2100	58.3586	43.6626	265.687	170.391	101.201
2150	58.0937	43.3977	265.282	169.893	100.48
2200	57.8358	43.1398	264.884	169.411	99.763

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft^2-°F)
2250	57.5812	42.8852	264.49	168.945	99.0486
2300	57.3384	42.6424	264.116	168.904	98.389
2350	57.1158	42.4198	263.779	169.477	97.9037
2400	56.8954	42.1994	263.443	170.043	97.6135
2450	56.7285	42.0325	263.265	170.605	97.314
2500	56.5927	41.8967	262.98	171.154	97.0112
2550	56.3441	41.6481	262.598	171.707	96.724
2600	56.133	41.437	262.271	172.247	96.4335
2650	55.9236	41.2276	261.946	172.782	96.1439
2700	55.7174	41.0214	261.625	173.309	95.8549
2750	55.513	40.817	261.305	173.831	95.5665
2800	55.3118	40.6158	260.988	174.346	95.2784
2850	55.1123	40.4163	260.673	174.854	94.9909
2900	54.9154	40.2194	260.361	175.357	94.7036
2950	54.72	40.024	260.05	175.853	94.4167
3000	54.5273	39.8313	259.742	176.343	94.1298
3500	52.6975	38.0015	256.753	180.941	91.2102
4000	51.0112	36.3152	253.89	185.006	88.1836
4500	49.4815	34.7855	251.194	188.565	85.2343
5000	48.1465	33.4505	248.758	191.696	82.4939
5500	46.9927	32.2967	246.586	194.415	79.9269
6000	46.0112	31.3152	244.685	196.812	77.4269
6500	45.1436	30.4476	242.962	198.891	75.1352
7000	44.3377	29.6417	241.325	200.702	73.023
7500	43.4859	28.7899	239.552	202.577	70.5811
8000	42.6535	27.9575	237.776	204.384	68.0688
8500	41.9431	27.2471	236.225	205.946	65.8152
9000	41.3299	26.6339	234.858	207.31	63.7571
9500	40.8626	26.1666	233.798	208.509	62.405
10000	40.3574	25.6614	232.634	209.566	61.5095
20000	35.5087	20.8127	220.342	215.431	50.4008
30000	32.8521	18.1561	212.531	211.652	43.7984

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 189

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
40000	30.7096	16.0136	205.487	206.396	38.8706
50000	29.1652	14.4692	199.856	201.194	35.3921
60000	27.9373	13.2413	195.038	196.847	32.6189
70000	27.0427	12.3467	191.286	193.228	30.2761
80000	26.3517	11.6557	188.227	190.414	28.6527
90000	24.8048	10.1088	180.791	187.508	26.1161
100000	23.8314	9.1354	175.613	182.885	24.0539
200000	21.0258	6.3298	157.681	167.984	19.2198
300000	19.9059	5.2099	148.75	161.915	16.7703
400000	18.9703	4.2743	140.146	156.473	15.1295
500000	18.4714	3.7754	135.019	153.085	13.9466
600000	18.0519	3.3559	130.356	150.257	12.7164
700000	17.7818	3.0858	127.162	148.25	11.7625
800000	17.5394	2.8434	124.153	146.462	10.7882
900000	17.3602	2.6642	121.835	145.032	9.99401
1000000	17.2105	2.5145	119.833	143.864	9.80688
1500000	16.7607	2.0647	115.059	140.569	8.94011
2000000	16.6411	1.9451	113.305	135.644	8.46055
2500000	16.5991	1.9031	112.659	133.255	8.2858
3000000	16.5306	1.8346	110.696	131.016	8.1962
3500000	16.5319	1.8359	111.503	128.728	8.01969
4000000	16.4827	1.7867	110.986	126.446	7.8936
4500000	16.4599	1.7639	110.677	125.317	7.84542
5000050	16.4128	1.7168	108.832	124.221	7.8673
5500050	16.4221	1.7261	110.076	123.146	7.77228
6000050	16.4063	1.7103	109.758	122.045	7.7478
6500050	16.3947	1.6987	109.598	121.479	7.7219
7000050	16.3893	1.6933	109.438	120.928	7.71904
7500000	16.3878	1.6918	109.247	120.376	7.7339
8000000	16.3732	1.6772	109.126	119.835	7.6921
8500050	16.3659	1.6699	108.971	119.293	7.68153
9000050	16.3456	1.6496	108.854	118.777	7.61585

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-1
DBA LOCA PRESSURE, TEMPERATURE AND HTC DATA

ELAPSED TIME (Seconds)	PRESSURE (Psia)	GAUGE PRESSURE (Psig)	VAPOR TEMP (°F)	SUMP TEMP (°F)	CONDENSING HTC (Btu/hr-ft²-°F)
9500050	16.3399	1.6439	108.726	118.252	7.60776
10000000	16.335	1.639	108.556	117.676	7.60776

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Subject Containment P/T Analysis for Design Basis LOCA

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS) STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
0.05	25.0485	0.331456	25.38	-0.00002624	0	0	0
0.1	26.6493	0.763169	27.4125	-0.00009559	0	0	0
0.2	29.973	1.66222	31.6352	-0.00002038	0	0	0
0.3	33.974	2.7555	36.7295	0.00138748	0	0	0
0.4	37.9006	3.74946	41.65	0.00473591	0	0	0
0.5	41.7716	4.66152	46.4331	0.00987801	0	0	0
0.6	45.5708	5.57408	51.1449	0.0168506	0	0	0
0.7	49.2521	6.5324	55.7845	0.0257022	0	0	0
0.8	52.8497	7.47295	60.3226	0.0362731	0	0	0
0.9	56.225	8.36379	64.5888	0.0485122	0	0	0
1	59.4289	9.14312	68.5721	0.0622899	0	0	0
1.1	62.4704	9.86365	72.334	0.0774232	0	0	0
1.2	65.3268	10.6065	75.9333	0.0940231	0	0	0
1.3	68.1688	11.2651	79.4339	0.112018	0	0	0
1.4	70.9751	11.925	82.9001	0.131399	0	0	0
1.5	73.7463	12.5858	86.3321	0.152034	0	0	0
1.6	76.4839	13.2459	89.7298	0.173824	0	0	0
1.7	79.1869	13.9062	93.0931	0.197058	0	0	0
1.8	81.8556	14.566	96.4215	0.221972	0	0	0
1.9	84.4905	15.2247	99.7152	0.248455	0	0	0
2	87.092	15.8822	102.974	0.276358	0	0	0
2.1	89.6612	16.5366	106.198	0.305592	0	0	0
2.2	92.192	17.1933	109.385	0.336116	0	0	0
2.3	94.6991	17.8373	112.536	0.367906	0	0	0
2.4	97.169	18.4819	115.651	0.401095	0	0	0
2.5	99.6062	19.1225	118.729	0.435726	0	0	0
2.6	102.011	19.7588	121.77	0.471717	0	0	0
2.7	104.366	20.4075	124.774	0.508987	0	0	0
2.8	106.657	21.0842	127.741	0.547485	0	0	0
2.9	108.97	21.7015	130.671	0.587173	0	0	0

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 192

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

R E V ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS) STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
3	111.247	22.3177	133.564	0.628033	0	0	0
3.1	113.496	22.9278	136.424	0.670037	0	0	0
3.2	115.722	23.5312	139.253	0.713096	0	0	0
3.3	117.925	24.1277	142.053	0.75725	0	0	0
3.4	120.104	24.7174	144.821	0.802929	0	0	0
3.5	122.258	25.3001	147.558	0.850149	0	0	0
3.6	124.341	25.9225	150.264	0.898883	0	0	0
3.7	126.4	26.5372	152.937	0.949111	0	0	0
3.8	128.433	27.1458	155.579	1.00078	0	0	0
3.9	130.436	27.752	158.188	1.05386	0	0	0
4	132.445	28.319	160.764	1.10846	0	0	0
4.1	134.43	28.8802	163.31	1.16453	0	0	0
4.2	136.379	29.448	165.827	1.22208	0	0	0
4.3	138.347	29.9668	168.314	1.28108	0	0	0
4.4	140.296	30.476	170.772	1.34155	0	0	0
4.5	142.228	30.971	173.199	1.4035	0	0	0
4.6	144.09	31.5047	175.595	1.46692	0	0	0
4.7	145.985	31.9749	177.96	1.53168	0	0	0
4.8	147.825	32.469	180.294	1.59777	0	0	0
4.9	149.605	32.9907	182.595	1.66517	0	0	0
5	151.395	33.4691	184.864	1.73388	0	0	0
5.25	155.783	34.6354	190.418	1.91128	0	0	0
5.5	160.045	35.7692	195.814	2.09653	0	0	0
5.75	164.183	36.8637	201.047	2.28946	0	0	0
6	168.242	37.8701	206.112	2.4901	0	0	0
6.25	172.199	38.8437	211.042	2.69828	0	0	0
6.5	176.038	39.8334	215.872	2.91365	0	0	0
6.75	179.799	40.8012	220.601	3.13574	0	0	0
7	183.469	41.7593	225.229	3.3644	0	0	0
7.25	187.089	42.6669	229.756	3.59946	0	0	0
7.5	190.561	43.6201	234.181	3.8404	0	0	0

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Subject Containment P/T Analysis for Design Basis LOCA

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
7.75	193.975	44.5297	238.505	4.08742	0	0	0
8	197.328	45.3986	242.726	4.34023	0	0	0
8.25	200.58	46.2736	246.854	4.59873	0	0	0
8.5	203.808	47.0865	250.894	4.8627	0	0	0
8.75	206.959	47.8899	254.848	5.13171	0	0	0
9	210.019	48.697	258.716	5.40557	0	0	0
9.25	213.009	49.487	262.496	5.68407	0	0	0
9.5	215.867	50.321	266.188	5.96705	0	0	0
9.75	218.753	51.0389	269.792	6.25395	0	0	0
10	221.563	51.7453	273.308	6.54501	0	0	0
10.5	226.9	53.1552	280.055	7.13875	0	0	0
11	231.953	54.4348	286.388	7.74694	0	0	0
11.5	236.691	55.5842	292.275	8.36748	0	0	0
12	241.18	56.5063	297.686	8.99874	0	0	0
12.5	245.225	57.3989	302.624	9.63914	0	0	0
13	248.946	58.1319	307.078	10.2871	0	0	0
13.5	252.243	58.749	310.992	10.9411	0	0	0
14	254.983	59.2971	314.28	11.6003	0	0	0
14.5	256.998	59.9318	316.93	12.2625	0	0	0
15	258.578	60.5074	319.086	12.9261	0	0	0
15.5	259.672	61.1247	320.796	13.59	0	0	0
16	260.373	61.6453	322.018	14.2525	0	0	0
16.5	260.736	62.1261	322.862	14.9122	0	0	0
17	260.851	62.5739	323.425	15.5686	0	0	0
17.5	260.72	62.9524	323.673	16.221	0	0	0
18	260.437	63.2891	323.726	16.8684	0	0	0
18.5	260.104	63.5928	323.697	17.5011	0	0	0
19	259.73	63.9168	323.647	18.1204	0	0	0
19.5	259.298	64.3017	323.599	18.7334	0	0	0
20	258.852	64.6531	323.505	19.3223	0	0	0
21	257.84	65.33	323.17	20.4582	0	0	0

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Subject Containment P/T Analysis for Design Basis LOCA

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
22	256.637	65.805	322.442	21.5004	0	0	0
23	255.618	66.0564	321.674	22.4863	0	0	0
24	254.844	66.2934	321.137	23.4227	0	0	0
25	254.339	66.5165	320.855	24.3143	0	0	0
26	254.054	66.7291	320.783	25.1649	0	0	0
27	253.947	66.9323	320.879	25.9778	0	0	0
28	253.945	67.1267	321.072	26.756	0	0	0
29	253.686	67.4615	321.148	27.5013	0	0	0
30	253.466	67.7875	321.253	28.2149	0	0	0
31	253.282	68.1053	321.387	28.8983	0	0	0
32	253.133	68.4151	321.548	29.5532	0	0	0
33	253.017	68.7175	321.735	30.1809	0	0	0
34	252.932	69.0127	321.945	30.7828	0	0	0
35	252.875	69.3016	322.176	31.3602	0	0	0.00210985
36	252.812	69.5908	322.403	31.9214	0	0	0.0232104
37	252.756	69.8777	322.634	32.4766	0	0	0.044315
38	252.706	70.1624	322.869	33.0255	0	0	0.0654239
39	252.663	70.4448	323.108	33.5684	0	0	0.0865377
40	252.626	70.7251	323.351	34.1055	0	0	0.107658
41	252.595	71.0031	323.598	34.6368	0	0	0.128784
42	252.57	71.2789	323.849	35.1623	0	0	0.149916
43	252.55	71.5526	324.103	35.6823	0	0	0.171053
44	252.537	71.8243	324.361	36.1969	0	0	0.192197
45	252.667	72.094	324.761	36.7062	0	0	0.213349
46	253.026	72.3621	325.388	37.2116	0	0	0.234525
47	253.387	72.6286	326.015	37.7133	0	0	0.255731
48	253.751	72.8935	326.644	38.2115	0	0	0.276968
49	254.117	73.157	327.274	38.7061	0	0	0.298235
50	254.486	73.419	327.905	39.1973	0	0	0.319533
51	254.857	73.6795	328.536	39.685	0	0	0.340861
52	255.23	73.9383	329.169	40.1693	0	0	0.362219

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
53	255.606	74.1956	329.802	40.6501	0	0	0.383603
54	255.985	74.4515	330.436	41.1275	0	0	0.405015
55	256.366	74.7058	331.071	41.6015	0	0	0.426455
56	256.749	74.9587	331.707	42.0722	0	0	0.447921
57	257.134	75.2102	332.344	42.5396	0	0	0.469414
58	257.521	75.4601	332.981	43.0038	0	0	0.490934
59	257.911	75.7086	333.619	43.4648	0	0	0.512481
60	258.302	75.9556	334.257	43.9228	0	0	0.534055
61	258.711	76.2012	334.912	44.3772	0	0.0431664	0.555649
62	259.123	76.4452	335.568	44.8276	0	0.0861095	0.577249
63	259.538	76.6875	336.225	45.2742	0	0.128829	0.598856
64	259.956	76.9284	336.884	45.7169	0	0.171327	0.62047
65	260.377	77.1677	337.544	46.1558	0	0.213605	0.642092
66	260.8	77.4055	338.206	46.5911	0	0.255664	0.663721
67	261.226	77.6417	338.868	47.0228	0	0.297506	0.685357
68	261.655	77.8764	339.531	47.451	0	0.339132	0.707001
69	262.086	78.1097	340.196	47.8756	0	0.380539	0.728651
70	262.519	78.3415	340.861	48.2968	0	0.421733	0.750309
71	262.955	78.5718	341.527	48.7146	0	0.462714	0.771975
72	263.392	78.8007	342.193	49.1292	0	0.503485	0.793648
73	263.832	79.0281	342.861	49.5406	0	0.544046	0.81533
74	264.274	79.2542	343.529	49.9488	0	0.584399	0.83702
75	264.719	79.4789	344.198	50.3538	0	0.624545	0.858718
76	265.165	79.7022	344.867	50.7558	0	0.664486	0.880424
77	265.613	79.9242	345.537	51.1548	0	0.704223	0.902139
78	266.062	80.1448	346.207	51.5508	0	0.743756	0.923862
79	266.514	80.364	346.878	51.944	0	0.783091	0.945594
80	266.967	80.5818	347.548	52.3343	0	0.822236	0.967335
81	267.421	80.7983	348.219	52.722	0	0.861184	0.989085
82	267.877	81.0135	348.89	53.1067	0	0.899931	1.01084
83	268.334	81.2274	349.562	53.4888	0	0.93848	1.03261

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS) STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
84	268.793	81.44	350.233	53.8684	0	0.976846	1.05439
85	269.252	81.6515	350.904	54.2454	0	1.01503	1.07618
86	269.713	81.8618	351.575	54.62	0	1.05304	1.09798
87	270.149	82.0975	352.246	54.9922	0	1.0909	1.1198
88	270.581	82.337	352.918	55.3621	0	1.12877	1.14163
89	271.008	82.5804	353.588	55.7296	0	1.16666	1.16347
90	271.441	82.8174	354.258	56.0952	0	1.20458	1.18533
91	271.874	83.0534	354.928	56.4587	0	1.24252	1.20721
92	272.306	83.2909	355.596	56.8203	0	1.28048	1.22911
93	272.743	83.522	356.265	57.18	0	1.31847	1.25102
94	273.178	83.7548	356.932	57.5379	0	1.35649	1.27296
95	273.616	83.9837	357.599	57.8938	0	1.39453	1.29491
96	274.049	84.2167	358.266	58.2479	0	1.43259	1.31688
97	274.485	84.446	358.931	58.6002	0	1.47068	1.33887
98	274.918	84.677	359.595	58.9506	0	1.50879	1.36088
99	275.355	84.9042	360.259	59.2993	0	1.54693	1.38291
100	275.789	85.1328	360.922	59.6462	0	1.58509	1.40496
105	277.975	86.2417	364.217	61.362	0	1.77635	1.51547
110	280.162	87.3285	367.491	63.0362	0	1.96817	1.62647
115	282.319	88.4198	370.739	64.6722	0	2.16068	1.73796
120	284.533	89.4276	373.961	66.271	0	2.35371	1.84993
125	286.729	90.4233	377.152	67.8364	0	2.54749	1.96239
130	288.872	91.4487	380.321	69.3616	0	2.74146	2.0752
135	291.031	92.4252	383.456	70.8568	0	2.9361	2.18851
140	293.179	93.3784	386.558	72.3232	0	3.13132	2.30228
145	295.29	94.3332	389.623	73.7625	0	3.32714	2.41653
150	297.424	95.2273	392.652	75.1762	0	3.52341	2.53125
155	299.488	96.1538	395.642	76.565	0	3.72034	2.64643
160	301.606	96.9872	398.594	77.9282	0	3.91777	2.76204
165	303.629	97.8752	401.505	79.2685	0	4.11582	2.87811
170	305.694	98.68	404.374	80.5862	0	4.3143	2.99461

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
175	307.683	99.5183	407.201	81.8824	0	4.51345	3.11155
180	309.681	100.305	409.985	83.1573	0	4.713	3.22892
185	311.648	101.075	412.724	84.4138	0	4.913	3.34674
190	313.623	101.794	415.417	85.6504	0	5.11351	3.46498
195	315.547	102.518	418.065	86.869	0	5.31459	3.58366
200	317.424	103.243	420.667	88.0686	0	5.51615	3.70275
210	321.148	104.593	425.74	90.4082	0	5.92055	3.94197
220	324.226	106.157	430.383	92.6697	0	6.32666	4.18252
230	325.957	107.806	433.763	94.84	0	6.73391	4.42399
240	326.744	109.499	436.242	96.9089	0	7.14182	4.66596
250	326.831	111.299	438.13	98.8737	0	7.54993	4.9081
260	326.563	113.067	439.63	100.739	0	7.95801	5.15022
270	326.034	114.855	440.889	102.512	0	8.36594	5.39222
280	325.352	116.64	441.992	104.198	0	8.77359	5.63401
290	324.584	118.424	443.008	105.806	0	9.1809	5.87554
300	323.775	120.191	443.966	107.342	0	9.58783	6.1168
310	322.953	121.949	444.902	108.814	0	9.99437	6.35775
320	322.127	123.712	445.839	110.228	0	10.4005	6.59841
330	321.31	125.462	446.772	111.589	0	10.8063	6.83876
340	320.52	127.197	447.718	112.9	0	11.2116	7.07883
350	319.712	128.97	448.682	114.164	0	11.6165	7.31856
360	318.99	130.678	449.667	115.386	0	12.021	7.55799
370	318.303	132.373	450.675	116.568	0	12.4252	7.79716
380	317.65	134.057	451.707	117.713	0	12.829	8.0361
390	317.032	135.731	452.762	118.824	0	13.2325	8.2748
400	316.448	137.393	453.841	119.903	0	13.6357	8.51329
420	315.363	140.693	456.057	121.977	0	14.4414	8.98969
440	314.346	143.975	458.321	123.943	0	15.2461	9.46527
460	313.482	147.217	460.699	125.813	0	16.0498	9.94005
480	312.732	150.429	463.161	127.601	0	16.8527	10.4142
500	312.069	153.619	465.688	129.315	0	17.655	10.8877

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Subject Containment P/T Analysis for Design Basis LOCA

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
520	311.485	156.79	468.274	130.965	0	18.4567	11.3607
540	310.972	159.941	470.913	132.556	0	19.2579	11.8333
560	310.523	163.078	473.6	134.096	0	20.0586	12.3055
580	309.809	166.139	521.467	135.586	0	20.8589	12.7773
600	308.423	169.04	522.937	137.015	0	21.6581	13.2482
620	307.098	171.922	524.453	138.389	0	22.4559	13.7179
640	305.819	174.788	526.007	139.715	0	23.2524	14.1865
660	304.584	177.639	527.593	141	0	24.0477	14.654
680	303.388	180.476	529.209	142.246	0	24.8417	15.1205
700	302.226	183.31	530.852	143.457	0	25.6345	15.586
750	299.445	190.362	535.053	146.349	0	27.6119	16.7456
800	296.82	197.376	539.372	149.066	0	29.5823	17.8995
850	294.339	204.326	543.776	151.649	0	31.5462	19.0479
900	292.016	211.204	548.256	154.114	0	33.504	20.1913
950	289.813	218.045	552.799	156.472	0	35.4559	21.3298
1000	287.693	224.851	557.396	158.734	0	37.4022	22.4638
1050	285.648	231.624	562.04	160.906	0	39.3431	23.5935
1100	283.588	238.385	566.705	163.015	0	41.28	24.72
1150	281.669	245.044	571.39	165.057	0	43.2146	25.8445
1200	279.761	251.747	576.111	167.022	0	45.1442	26.965
1250	277.904	258.422	580.86	168.916	0	47.0687	28.0816
1300	276.089	265.072	585.631	170.745	0	48.9884	29.1944
1350	274.31	271.699	590.417	172.516	0	50.9032	30.3033
1400	272.562	278.305	595.215	174.232	0	52.8133	31.4086
1450	270.805	284.933	600.023	175.896	0	54.7186	32.5101
1500	269.109	291.498	604.838	177.509	0	56.6187	33.6078
1550	267.43	298.042	609.655	179.078	0	58.5143	34.7018
1600	265.766	304.568	614.473	180.603	0	60.4052	35.7924
1650	264.111	311.077	619.288	182.088	0	62.2916	36.8795
1700	262.465	317.569	624.098	183.533	0	64.1734	37.9632
1750	260.824	324.044	628.904	184.941	0	66.0506	39.0435

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
1800	259.188	330.503	633.701	186.313	0	67.9233	40.1204
1850	257.562	336.946	638.489	187.651	0	69.7913	41.1938
1900	255.935	343.374	643.267	188.957	0	71.6547	42.2639
1950	254.314	349.784	648.036	190.228	0	73.5135	43.3305
2000	252.694	356.181	652.797	191.465	0	75.3677	44.3932
2050	251.093	362.561	657.562	192.669	0	77.2171	45.452
2100	249.523	368.928	662.34	193.847	0	79.0613	46.507
2150	247.982	375.28	667.131	195.001	0	80.9002	47.5582
2200	246.47	381.616	671.931	196.132	0	82.7338	48.6058
2250	244.981	387.954	676.741	197.24	0	84.5622	49.6498
2300	243.62	392.494	679.843	198.328	0.234518	86.3929	50.6902
2350	242.436	394.327	680.37	199.4	0.824514	88.2278	51.7275
2400	241.265	396.14	680.893	200.457	1.41975	90.0554	52.7618
2450	240.075	397.945	681.407	201.505	2.02011	91.8764	53.7935
2500	238.936	399.679	681.909	202.544	2.62555	93.6923	54.8235
2550	237.764	401.473	682.412	203.564	3.23608	95.5008	55.8505
2600	236.642	403.205	682.915	204.565	3.85165	97.3018	56.8744
2650	235.532	404.918	683.415	205.551	4.47216	99.0958	57.8954
2700	234.437	406.609	683.911	206.521	5.09755	100.883	58.9135
2750	233.354	408.282	684.403	207.478	5.72777	102.663	59.9289
2800	232.284	409.933	684.891	208.42	6.36276	104.436	60.9416
2850	231.226	411.564	685.373	209.348	7.00245	106.201	61.9515
2900	230.179	413.175	685.85	210.263	7.6468	107.959	62.9587
2950	229.143	414.768	686.322	211.166	8.29574	109.71	63.9633
3000	228.118	416.34	686.788	212.055	8.94921	111.454	64.9652
3500	218.277	431.041	691.124	220.281	15.7031	128.541	74.8484
4000	208.94	444.012	694.646	227.536	22.8603	144.943	84.462
4500	200.656	455.278	697.702	233.934	30.3728	160.66	93.8303
5000	193.552	465.224	700.556	239.674	38.1949	175.749	102.974
5500	187.382	473.863	703.072	244.918	46.2889	190.178	111.906
6000	181.773	481.689	705.134	249.789	54.6209	204.013	120.652

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

REV ⇓

Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
6500	176.972	488.468	706.918	254.29	63.1602	217.321	129.24
7000	172.734	494.428	708.465	258.566	71.8797	230.177	137.683
7500	168.147	500.633	709.907	262.5	80.7676	242.614	145.991
8000	163.688	506.641	711.277	266.082	89.8427	254.582	154.133
8500	159.898	511.839	712.533	269.423	99.0738	266.148	162.121
9000	156.609	516.382	713.656	272.613	108.441	277.401	169.98
9500	153.615	520.391	714.569	275.728	117.926	288.396	177.727
10000	150.913	523.947	715.317	278.716	127.516	299.169	185.382
20000	124.502	545.61	709.383	327.653	328.777	488.357	325.525
30000	110.265	536.541	685.352	361.686	529.516	652.491	450.1
40000	98.5195	522.543	659.007	385.003	721.46	802.057	563.273
50000	90.237	508.094	635.806	400.67	903.502	939.668	666.356
60000	83.5234	495.946	616.547	412.883	1076.5	1069.03	761.783
70000	78.7242	485.681	601.193	422.736	1242.13	1191.28	850.81
80000	75.0166	477.684	589.263	431.219	1401.83	1308.42	934.835
90000	66.6362	470.016	572.703	434.57	1556.71	1418.87	1013.47
100000	61.3853	456.674	553.735	430.539	1704.13	1515.08	1081
200000	46.6452	413.213	494.453	412.879	2966.5	2295.14	1604.57
300000	40.8826	395.347	470.382	393.995	4063.47	2878.42	1986.26
400000	36.1727	379.273	449.148	369.018	5058.92	3326.83	2281.67
500000	33.7167	369.193	436.371	343.351	5970.61	3664.85	2512.45
600000	31.6987	360.764	425.721	318.998	6827.77	3926.29	2702.33
700000	30.4085	354.76	418.297	297.612	7639.83	4125.25	2858.26
800000	29.2779	349.41	411.699	278.778	8418.09	4275.86	2991.55
900000	28.4526	345.127	406.504	263.681	9165.98	4383.34	3105.85
1000000	27.7704	341.641	402.263	251.347	9890.8	4457.56	3204.17
1500000	25.4807	331.826	389.919	221.339	13297.7	4525.06	3536.81
2000000	24.9512	316.76	371.877	216.307	16337.9	4365.38	3721.13
2500000	24.7719	309.463	363.142	221.285	19036	4225.98	3868.74
3000000	24.6315	302.618	354.918	224.558	21528.3	4105.23	3997.09
3500000	24.4939	295.631	346.536	227.603	23812.9	4002.17	4105.66

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Table 8.3-2
DBA LOCA ENERGY DATA

ELAPSED TIME (Seconds)	ENERGY (Million of BTUS)						
	STEAM & AIR	SUMP	TOTAL	HEAT SINK	HEAT EXCHANGER	CONT SPRAY	AIR COOLER
4000000	24.2484	288.672	338.064	233.133	25887.1	3915.01	4193.65
4500000	24.1425	285.224	333.901	241.715	27802.2	3838.85	4265.89
5000050	24.1295	281.864	329.927	253.003	29617.6	3769.03	4328.14
5500050	23.9819	278.593	325.905	266.896	31333.2	3705.69	4380.42
6000050	23.9257	275.229	321.878	283.525	32948.8	3648.55	4422.72
6500050	23.8722	273.499	319.786	302.851	34485.7	3596.11	4457
7000050	23.862	271.815	317.787	323.891	35974.1	3546.67	4486.17
7500000	23.8799	270.125	315.811	346.586	37413	3500.11	4510.21
8000000	23.8026	268.476	313.779	370.955	38797.3	3456.88	4529.1
8500050	23.7785	266.82	311.795	397.027	40133.6	3416.5	4542.61
9000050	23.6566	265.255	309.806	424.789	41421.8	3380.25	4550.05
9500050	23.6383	263.648	307.879	452.214	42665.8	3351.2	4550.3
10000000	23.6331	261.889	305.803	478.788	43856.7	3323.05	4550.3

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Table 8.3-3

DBA LOCA SURFACE TEMPERATURES FOR VARIOUS HEAT SINKS

ELAPSED TIME (Seconds)	HS 2 (°F)	HS 8 (°F)	HS 9 (°F)	HS 15 (°F)	HS 16 (°F)
0.05	118.46	119.99	120	119.84	119.99
5	159.66	128.7	183.71	157.11	135.89
10	195.62	149.55	226.26	194.2	180.77
15	219.14	175.87	246.65	220.62	228.11
20	225.65	198.14	250.63	230.68	254.68
30	218.12	212.12	243.81	232.65	263.87
40	216.97	216.6	240.54	237.53	265.23
50	222.03	221.31	242.89	244.65	266.12
60	226.93	225.97	245.69	250.75	267.53
70	230.86	230.14	247.45	255.23	268.58
80	234.34	233.77	249.01	258.77	269.13
90	237.51	236.99	250.59	261.67	269.61
100	240.54	239.95	252.38	264.26	270.39
150	252.64	251.88	260.36	273.21	275.53
200	261.46	260.67	266.98	279.19	280.58
250	266.73	266.5	270.47	282.46	283.27
300	268.7	268.77	271.05	282.76	283.21
350	269.52	269.59	271.08	282.75	283.03
400	269.94	269.96	271.09	282.71	282.79
500	270.37	270.35	271.1	282.54	282.62
600	270.54	270.59	271.04	282.32	282.37
700	269.91	269.99	270.19	282.02	281.95
800	269.21	269.29	269.39	281.59	281.29
900	268.51	268.6	268.64	281.09	280.52
1000	267.85	267.95	267.95	280.55	279.71
1100	267.41	267.44	267.57	279.99	278.87
1200	266.85	266.96	266.92	279.41	278.06
1300	266.23	266.35	266.28	278.81	277.24
1400	265.62	265.73	265.65	278.19	276.41
1500	264.98	265.11	265.01	277.56	275.58
1600	264.37	264.49	264.37	276.9	274.74
1700	263.74	263.87	263.74	276.24	273.91

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Table 8.3-3
DBA LOCA SURFACE TEMPERATURES FOR VARIOUS HEAT SINKS

ELAPSED TIME (Seconds)	HS 2 (°F)	HS 8 (°F)	HS 9 (°F)	HS 15 (°F)	HS 16 (°F)
1800	263.11	263.24	263.1	275.56	273.08
1900	262.47	262.61	262.45	274.87	272.24
2000	261.76	261.91	261.71	274.16	271.41
2100	261.02	261.17	260.96	273.45	270.58
2200	260.29	260.44	260.23	272.73	269.75
2300	259.59	259.74	259.53	272.01	268.92
2400	258.99	259.12	258.94	271.28	268.12
2500	258.53	258.66	258.51	270.58	267.35
2600	257.97	258.11	257.94	269.87	266.61
2700	257.43	257.56	257.39	269.18	265.89
2800	256.89	257.02	256.85	268.48	265.18
2900	256.36	256.49	256.32	267.79	264.48
3000	255.84	255.97	255.8	267.11	263.8
6500	240.11	240.24	240.06	246.25	244.08
10000	230.07	230.2	230.05	234.26	233.49
20000	218.08	218.19	218.14	220.42	220.72
30000	210.94	211.06	210.99	212.63	212.9
40000	204.03	204.17	204.09	205.6	205.92
50000	198.66	198.8	198.74	199.9	200.17
60000	193.99	194.14	194.08	195.05	195.29
70000	190.25	190.41	190.37	191.27	191.46
80000	187.17	187.33	187.3	188.22	188.39
90000	180.84	181.24	180.78	181.15	180.79
100000	175.6	175.61	175.63	175.64	175.83
200000	157.54	158.84	159.83	157.67	157.77
300000	148.63	151.58	152.55	148.75	148.8
400000	140.64	144.76	145.35	140.14	140.2
500000	135.43	139.64	139.88	134.95	135.05
600000	131.07	135.08	135.01	130.28	130.39
700000	127.74	131.44	131.17	126.9	127.19
800000	124.8	128.16	127.75	123.96	124.18
900000	122.35	125.38	124.89	121.69	121.85

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Table 8.3-3
DBA LOCA SURFACE TEMPERATURES FOR VARIOUS HEAT SINKS

ELAPSED TIME (Seconds)	HS 2 (°F)	HS 8 (°F)	HS 9 (°F)	HS 15 (°F)	HS 16 (°F)
1000000	120.29	123.01	122.48	119.57	119.85
1500000	114.53	116.06	115.58	114.1	114.62
2000000	112.33	113.32	113.21	112.35	112.87
2500000	111.6	112.63	112.5	111.79	112.36
3000000	111.11	112.11	112.09	111.33	111.93
3500000	110.6	111.52	111.52	110.79	111.45
4000000	110.11	110.95	110.95	110.27	110.9
4500000	109.81	110.63	110.65	110.01	110.61
5000050	109.53	110.33	110.34	109.72	110.31
5500050	109.28	110.05	110.07	109.45	110.04
6000050	109.01	109.74	109.75	109.14	109.71
6500050	108.84	109.58	109.59	108.99	109.57
7000050	108.7	109.41	109.44	108.83	109.39
7500000	108.54	109.25	109.23	108.67	109.24
8000000	108.43	109.13	109.12	108.53	109.08
8500050	108.29	108.97	108.97	108.38	108.92
9000050	108.18	108.86	108.85	108.28	108.85
9500050	108.07	108.77	108.75	108.15	108.73
10000000	108.07	108.77	108.75	108.15	108.73

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

8.3.2 Additional Output Interpretation

The drop in the total heat sink energy at later times results from the fact that the temperatures of the heat sinks that are not exposed to the sump drop below the initial temperature of 120 °F. Cooling a heat sink below the initial temperature of 120 °F produces a negative net heat transfer. However, after about 1E6 seconds while the overall containment is cooling down, the heat sink energy is increasing due to energy transfer from the sump to the very large heat sinks exposed to the sump. The rest of the heat sinks are approximately at equilibrium with the containment vapor and therefore there is a very small amount of energy transfer from those heat sinks to the containment. The energy transfer into the heat sinks in contact with the sump dominates the small loss in energy of the other heat sinks, and thus there is an increase in the overall integrated heat sink energy.

The following boundary conditions are modeled for the various heat sinks in the containment. All the 20 heat sinks modeled fall into one of the 4 categories shown.

	Left Boundary	Right Boundary
1	vapor	outside air
2	sump	insulated
3	vapor	vapor
4	vapor	insulated

To explain the increase in the total heat sink energy at later times, the temperature of one heat sink from each one of the above categories is shown in Table 8.3-4 for times greater than 1E6. The representative heat sinks chosen are:

HS 2 Containment Building Cylinder above grade-vapor/outside air
HS 4 Basemat (other than reactor Basemat)-sump/insulated
HS 8 Lined refueling canal walls-vapor/vapor
HS 9 Steam Generator compartment walls, unlined refueling canal walls & other internal walls-vapor/insulated

As can be seen from Table 8.3-4, the temperatures of HS2, HS8 and HS9 drop below the initial temperature of 120 °F, while the temperature of HS4 is remains above 120 °F . The heat sinks not in contact with the sump are approximately at equilibrium with the containment atmosphere which is below 120 °F after about 12 days. The sump water temperature remains above 120 °F for about 90 days, which, when combined with the slow rate of heat transfer modeled in the program, causes the large sump heat sinks to reach their maximum energy inventories after the heat sinks exposed to vapor have cooled back to near ambient conditions.

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Table 8.3-4
SURFACE TEMPERATURES FOR HEAT SINKS

TIME	HS2	HS4	HS8	HS9
1000000	120.29	138.6399	123.01	122.48
1500000	114.53	136.8313	116.06	115.58
2000000	112.33	134.3802	113.32	113.21
2500000	111.6	132.5316	112.63	112.5
3000000	111.11	130.9672	112.11	112.09
3500000	110.6	129.3869	111.52	111.52
4000000	110.11	127.7794	110.95	110.95
4500000	109.81	126.637	110.63	110.65
5000050	109.53	125.6979	110.33	110.34
5500050	109.28	124.8071	110.05	110.07
6000050	109.01	123.9316	109.74	109.75
6500050	108.84	123.2845	109.58	109.59
7000050	108.7	122.7371	109.41	109.44
7500000	108.54	122.2332	109.25	109.23
8000000	108.43	121.743	109.13	109.12
8500050	108.29	121.2604	108.97	108.97
9000050	108.18	120.7874	108.86	108.85
9500050	108.07	120.3222	108.77	108.75
10000000	108.07	120.3222	108.77	108.75

8.4 MASS AND ENERGY BALANCES

To ensure reasonableness of the results, mass and energy balances are performed for a selection of times from the COPATTA Code output.

a. Table 8.4-1 presents the mass balance for the DBA LOCA

b. Table 8.4-2 presents the energy balance for the DBA LOCA.

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.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.4-1 (Sheet 1 of 3)
MASS BALANCE FOR DBA LOCA

MASS BALANCE	ELAPSED TIME SINCE BREAK (seconds)				
	17[c]	22[d]	60[e]	210[f]	240[g]
PROGRAM INPUTS[a]					
Initial Steam	6.809	6.809	6.809	6.809	6.809
Initial Air	163.198	163.198	163.198	163.198	163.198
Break Flow (CS 301)	503.460	512.704	535.855	633.447	647.015
ECCS Spillage (CS 601)	0.0	0.0	39.803	144.583	156.936
CS Flow (CS 801)	0.0	0.0	0.0	33.417	40.100
SI Flow (CS 801)	0.0	0.0	0.0	0.0	0.0
Reactor Vessel Water[b]	0.0	0.0	0.0	0.0	0.0
Total Program Input	673.47	682.71	745.67	981.45	1,014.06
PROGRAM INVENTORY[a]					
Steam	220.246	216.477	215.189	274.366	279.394
Air	163.198	163.198	163.198	163.198	163.198
Sump	290.023	303.033	367.284	543.915	571.491
Reactor Vessel	0.0	0.0	0.0	0.0	0.0
Total Program Inventory	673.47	682.71	745.67	981.48	1,014.08
Difference In Totals[a] with respect to Program Inputs	0.00	0.00	0.00	0.03	0.02
Percent Difference with respect to Program Inputs	0.00%	0.00%	0.00%	0.00%	0.00%

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Table 8.4-1 (Sheet 2 of 3)
MASS BALANCE FOR DBA LOCA

MASS BALANCE	ELAPSED TIME SINCE BREAK (seconds)			
	580(k)	2300(j)	1E5(j)	1E7(k)
PROGRAM INPUTS(a)				
Initial Steam	6.809	6.809	6.809	6.809
Initial Air	163.198	163.198	163.198	163.198
Break Flow (CS 301)	697.265	697.265	697.265	697.265
ECCS Spillage (CS 601)	396.333	396.333	396.333	396.333
CS Flow (CS 801)	115.844	494.564	494.564	494.564
SI Flow (CS 801)	5.200	1478.54	1478.54	1478.54
Reactor Vessel Water(b)	168	168	168	168
Total Program Input	1,552.65	3,404.71	3,404.71	3,404.71
PROGRAM INVENTORY(a)				
Steam	264.084	204.788	40.927	7.431
Air	163.198	163.198	163.198	163.198
Sump	957.432	2867.82	3027.04	3057.99
Reactor Vessel	167.956	168.930	173.554	179.812
Total Program Inventory	1,552.67	3,404.74	3,404.72	3,408.43
Difference In Totals(a) with respect to Program Inputs	0.02	0.03	0.01	3.72
Percent Difference with respect to Program Inputs	0.00%	0.00%	0.00%	0.11%

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Table 8.4-1 (Sheet 3 of 3)
MASS BALANCE FOR DBA LOCA

Notes:

(a) Water, Steam and Air masses are presented in 1000 pound increments.

(b) 1.68E5 lbm (1182 Btu/lbm) of water appear at the start of the reactor water vessel calculations at 573.273 seconds.

(c) The time of 17 seconds corresponds to the peak pressure before the end of blowdown phase.

(d) The time of 22 seconds corresponds to the end of blowdown phase.

(e) The time of 60 seconds corresponds to the establishment of a fully developed containment spray injection phase flow rate of 1612 gallons/minute.

(f) The time of 210 seconds corresponds to the nearest output time step for the end of the core reflood phase at 211.1 seconds.

(g) The time of 240 seconds corresponds to the nearest output time step for the occurrence of the pressure peak of 58.9 psig at 241 seconds.

(h) The time of 580 seconds corresponds to the nearest output time step for the end of CE data at the end of the froth period at 573.273 seconds.

(i) The time of 2300 seconds corresponds to the nearest output time step for the start of recirculation at 2280 seconds.

(j) The time of 1E5 seconds corresponds to the nearest output time step for the end of the first day (86400 seconds) after the accident.

(k) The time of 1E7 seconds corresponds to the end of the code run.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.4-2 (Sheet 1 of 3)
ENERGY BALANCE FOR DBA LOCA

ENERGY BALANCE	ELAPSED TIME SINCE BREAK (seconds)				
	17[b]	22[c]	60[d]	210[e]	240[f]
PROGRAM INPUTS[a]					
Initial Water Vapor/Air	23.326	23.326	23.326	23.326	23.326
Break Flow (CS 301)	315.548	320.462	350.551	477.419	493.604
ECCS Spillage (CS 601)	0.0	0.0	4.410	15.570	16.652
CS Flow (CS 801)	0.0	0.0	0.0	2.272	2.727
SI Flow (CS 801)	0.0	0.0	0.0	0.0	0.0
RCS sensible Heat (CS 201)	0.122	0.158	0.431	1.507	1.514
Core Decay Heat (CS 101)	0.0	0.0	0.0	0.0	0.0
Air Cooler Removal (CS 5)	-0.0	-0.0	-0.534	-3.942	-4.666
Total Program Input	339.00	343.95	378.18	516.15	533.16
PROGRAM INVENTORY[a]					
Steam	240.551	236.372	237.256	300.617	306.167
Air	20.300	20.265	21.046	20.530	20.576
Cont. Atmosphere (Steam+Air)	260.85	256.64	258.30	321.15	326.74
Sump	62.574	65.805	75.956	104.593	109.499
Reactor Vessel	0.0	0.0	0.0	0.0	0.0
Structural Heat Sinks	15.569	21.500	43.923	90.482	96.909
Recirculation HX	0.0	0.0	0.0	0.0	0.0
Total Program Inventory	338.99	343.95	378.18	516.23	533.15
Difference In Totals[a] with respect to Program Inputs	-0.01	0.00	0.00	0.08	-0.01
Percent Difference with respect to Program Inputs	0.00%	0.00%	0.00%	0.02%	0.00%

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Subject Containment P/T Analysis for Design Basis LOCA

Sheet No. 212

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	R. Nakano	01/18/94	J. Elliott	01/20/94					

Table 8.4-2 (Sheet 2 of 3)
ENERGY BALANCE FOR DBA LOCA

ENERGY BALANCE	ELAPSED TIME SINCE BREAK (seconds)			
	580[a]	2300[b]	1E5[c]	1E7[f]
PROGRAM INPUTS[a]				
Initial Water Vapor/Air	68.854	68.854	68.854	68.854
Break Flow (CS 301)	553.076	553.076	553.076	553.076
ECCS Spillage (CS 601)	37.590	37.590	37.590	37.590
CS Flow (CS 801)	7.877	33.627	33.627	33.627
SI Flow (CS 801)	0.354	100.530	100.530	100.530
RCS sensible Heat (CS 201)	1.535	7.572	302.742	302.742
Core Decay Heat (CS 101)	0.548	127.850	2666.14	48060.3
Air Cooler Removal (CS 5)	-12.777	-50.690	-1081.00	-4550.30
Total Program Input	657.06	878.41	2,681.56	44,606.42
PROGRAM INVENTORY[a]				
Steam	289.178	223.488	43.672	7.776
Air	20.631	20.132	17.714	15.857
Cont. Atmosphere (Steam+Air)	309.81	243.62	61.39	23.63
Sump	166.139	392.494	456.674	261.889
Reactor Vessel	45.519	43.729	35.676	20.280
Structural Heat Sinks	135.586	198.328	430.539	478.788
Recirculation HX	0.0	0.235	1704.13	43856.7
Total Program Inventory	657.05	878.41	2,688.41	44,641.29
Difference In Totals[a] with respect to Program Inputs	-0.01	0.00	6.85	34.87
Percent Difference with respect to Program Inputs	0.00%	0.00%	0.26%	0.08%

Table 8.4-2 (Sheet 3 of 3)
ENERGY BALANCE FOR DBA LOCA

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 17 seconds corresponds to the peak pressure before the end of blowdown phase.

(c) The time of 22 seconds corresponds to the end of blowdown phase.

(d) The time of 60 seconds corresponds to the establishment of a fully developed containment spray injection phase flow rate of 1612 gallons/minute.

(e) The time of 210 seconds corresponds to the nearest output time step for the end of the core reflood phase at 211.1 seconds.

(f) The time of 240 seconds corresponds to the nearest output time step for the occurrence of the pressure peak of 58.9 psig at 241 seconds.

(g) The time of 580 seconds corresponds to the nearest output time step for the end of CE data at the end of the froth period at 573.273 seconds.

(h) The time of 2300 seconds corresponds to the nearest output time step for the start of recirculation at 2280 seconds.

(i) The time of 1E5 seconds corresponds to the nearest output time step for the end of the first day (86400 seconds) after the accident.

(j) The time of 1E7 seconds corresponds to the end of the code run.

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

9 COPIES OF MISCELLANEOUS REFERENCES

COPY OF REFERENCE 6.2.e

[2] From: PAUL BARBOUR at NESL3 10/25/93 9:18AM (5241 bytes: 97 ln)
To: MARK DRUCKER at NESL2
Subject: Containment Spray Assessment
------------------------Forwarded ------------------------
From: TOM YACKLE at NESL5 7/30/92 9:33AM (5049 bytes: 97 ln)
To: GARY S JOHNSON at NESL3, BERNIE CARLISLE at NESL4
cc: MALCOLM ANDERSON, PAUL BARBOUR at NESL3, BILL FLOURNOY at NESL3,

RICHARD GOLD at NESL4
Subject: Containment Spray Assessment
------------------------Message Contents ------------------------
Comment below. Tom

Paul Barbour and I discussed this effect of reduced spray on the PT analyses and what effect the lowered spray flow might have. In the process, we discovered some conflicting assumptions that will be good news for the LOCA impact and might mean that it will not be necessary to modify the spray orifices to increase spray flow.

Here's the scoop:

The design basis LOCA mass energies are based on maximum SI flows which require two HPSI's and two LPSI's and all 12 penetration MOV's to be functional. The generic assumption for the PT analysis assumes loss of one train of containment cooling (spray and containment coolers). The only common mode single failure that can produce the train failure in the containment cooling systems is power related. Further examination of the power supplies indicates that:

DG or 4 KV bus failure kills all pumps.

480 V bus failure kills not only the CS and CCS MOV's but two of the LPSI MOV's and four HPSI MOV's.

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Sheet No. 215

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	R. Nakano	01/18/94	J. Elliott	01/20/94						

Therefore, these two assumptions are dependent on two independant not one common single failure to produce these conditions (CS failure and a CCS related failure) which exceeds the design basis requirements. The limiting single failure for the LOCA PT assessment can credit the addition of one train of containment coolers (crediting both trains) when considering the flows from a single train of REDUCED spray flow. This is inherantly OK since two trains of coolers is 100% of required cooling by design. Two trains of CS and one cooler train is inherantly OK as well relative to the existing analysis.

MSLB PT analysis:

This analysis will still be bounded by a train failure assumption for limiting single failure. The peak temperature turns immediately after initiation of spray when only the presence of spray not the flow rate is critical. The spray header fill time calculation needs to be reviewed to determine the ramifications of lower spray delivery on the initiation time of spray. This review is in progress. We have initiated a new calculation basis for MSLB review that calculates a worst case delivery rate to the containment at the original design pressure of 60 psig with degraded pumps acceptable to the existing IST data (7.3% degradation). If the MSLB PT assessment remains acceptable, does not cause an EQ impacting change in the PT profiles and does not remove all margin for future problems, it seems reasonable to leave the existing orifices alone. The containment spray calculation could go ahead and complete the analysis that shows as acceptable the removal of the spray system orifices even though we have no plans to change them now. Then that future NCR condition (perhaps a new PT analysis) could have its solution already analyzed.

NCR or No NCR:

I'm not sure the second option requires an NCR or not. It's my understanding that until we have an unanalyzed change there is no requirement for an NCR. Technically we would have to take the new spray data and incorporate it into our design information related to the PT analyses. Can this be handled through NEDOTRAK via the CS

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I vote for NEDOTRAK via the calc. cross reference. We have tried this in other examples and it seems to work. On the output side state the impact and have the other DM provide a log number. This covers your organization and they are on the hook from that point on. Of course, if NCR conditions are satisfied, then so be it. Tom

calcs cross reference showing a change required in the PTs knowing the results will be acceptable or would an NCR be required? I would like to get a concensus from both DM's on the final approach to be taken in regards to this issue so that I can be prepared to make the proper response when the calc is about to be issued.

If you have any questions or input that might change our direction (holes in our approach), give me a call at 51265 so that the groups can stay on the path that provides a satisfactory conclusion to this important issue.

Thanks, GSJ

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0	R. Nakano	01/18/94	J. Elliott	01/20/94					

R E V ⇓

APPENDIX A (COPATTA Code I/O File Information)

The COPATTA Code input file is presented in Section 8 (page 171) of this calculation.

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

FILE TITLE: LOCA WITH LOSS OF OFFSITE POWER.
RUNDATE: 1-13-94
RUNTIME: 11:19:09
LAST SHEET: Page 562

Reference 5

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