SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL℠ Company

Dwight E. Nunn
Vice President

August 24, 2001

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

Subject: **San Onofre Nuclear Generating Station Units 2 and 3**
Docket Nos 50-361 and 50-362
Proposed Change Number (PCN) 528
Request to revise Technical Specification 5.5.2.15, "Containment Leakage Rate Testing Program"

Gentlemen:

Pursuant to 10 CFR 50.90, Southern California Edison (SCE) hereby requests the following amendment: Revise the calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, from 55.1 psig to 45.9 psig, and the calculated peak containment internal pressure for the design basis Main Steam Line Break from 56.6 psig to 56.5 psig in Technical Specification 5.5.2.15, "Containment Leakage Rate Testing Program." SCE has recalculated the aforementioned peak pressures and determined that the revised pressures are appropriate. SCE has evaluated this request under the standards set forth in 10 CFR 50.92(c) and determined that a finding of "no significant hazards consideration" is justified.

SCE requests the amendment be implemented within 60 days of approval.

SCE is making no formal commitments that would derive from NRC approval of the proposed amendment.

If you have any questions or require additional information, please contact Mr. Jack Rainsberry at 949-368-7420.

Sincerely,

A017

P. O. Box 128
San Clemente, CA 92674-0128
949-368-1480
Fax 949-368-1490

Attachments:

1. Notarized Affidavits
2. Licensee's Evaluation
3. Existing Technical Specification page, Unit 2
4. Existing Technical Specification page, Unit 3
5. Markup of Technical Specification page, Unit 2
6. Markup of Technical Specification page, Unit 3
7. Retyped Technical Specification page, Unit 2
8. Retyped Technical Specification page, Unit 3
9. SCE Calculation N-4080-026 Revision 1, including CCN-4, "Containment P-T Analysis For Design Basis LOCA"
10. SCE Calculation N-4080-027 Revision 1, including CCN-4, "Containment P-T Analysis For Design Basis MSLB"

cc: E. W. Merschoff, Regional Administrator, NRC Region IV (less Att. 9 and 10)
C. C. Osterholtz, NRC Senior Resident Inspector, San Onofre Units 2 and 3 (less Att. 9 and 10)
J. E. Donoghue, NRC Project Manager, San Onofre Units 2 and 3
S. Y. Hsu, Department of Health Services, Radiologic Health Branch (less Att. 9 and 10)

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Application of SOUTHERN, CALIFORNIA EDISON COMPANY, ET AL. for a class 103 License to Acquire, Possess, and Use a Utilization Facility as Part of Unit No. 2 of the San Onofre Nuclear Generating Station	)	Docket No. 50-361 Amendment Application No. 211

SOUTHERN CALIFORNIA EDISON COMPANY, ET AL. pursuant to 10CFR50.90, hereby submit Amendment Application No. 211. This amendment application consists of Proposed Change No. PCN-528 to Facility Operating License NPF-10. PCN-528 is a request to revise the calculated peak containment internal pressures for the design basis loss of coolant accident and main steam line break accident of Technical Specification 5.5.2.15 for San Onofre Nuclear Generating Station Unit 2.

Subscribed on this 24th day of August, 2001.

Respectfully Submitted,

SOUTHERN CALIFORNIA EDISON COMPANY

By: _____
Dwight E. Nunn
Vice President

State of California

County of San Diego

On 8/24/01 before me Mariane Sanchez, personally appeared Dwight E. Nunn, personally known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument. WITNESS my hand and official seal.

Signature _____

MARIANE SANCHEZ
Commission #1196482
Notary Public - California
San Diego County
My Comm. Expires Oct 14, 2002

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Application of SOUTHERN, CALIFORNIA EDISON COMPANY, ET AL. for a class 103 License to Acquire, Possess, and Use a Utilization Facility as Part of Unit No. 3 of the San Onofre Nuclear Generating Station	)	Docket No. 50-362 Amendment Application No. 196

SOUTHERN CALIFORNIA EDISON COMPANY, ET AL. pursuant to 10CFR50.90, hereby submit Amendment Application No. 196. This amendment application consists of Proposed Change No. PCN-528 to Facility Operating License NPF-15. PCN-528 is a request to revise the calculated peak containment internal pressures for the design basis loss of coolant accident and main steam line break accident of Technical Specification 5.5.2.15 for San Onofre Nuclear Generating Station Unit 3.

Subscribed on this 24th day of August, 2001.

Respectfully Submitted,

SOUTHERN CALIFORNIA EDISON COMPANY

By: Dwight E. Nunn
Vice President

State of California

County of San Diego

On 8/24/01 before me, Mariane Sanchez, personally appeared Dwight E. Nunn, personally known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument. WITNESS my hand and official seal.

MARIANE SANCHEZ
Commission #1196482
Notary Public - California
San Diego County
My Comm. Expires Oct 14, 2002

Signature Mariane Sanchez

ATTACHMENT 2

LICENSEE'S EVALUATION

1.0 INTRODUCTION

This letter is a request to amend Operating Licenses NPF-10 and NPF-15 for San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2 & 3), respectively.

The proposed change would revise the Operating Licenses to amend Technical Specification (TS) 5.5.2.15, "Containment Leakage Rate Testing Program," by changing the stated calculated values for peak containment internal pressure for the design basis Loss Of Coolant Accident (LOCA) and Main Steam Line Break (MSLB) accident. The current LOCA value of 55.1 psig would be changed to 45.9 psig and the current MSLB value of 56.6 psig would be changed to 56.5 psig. Southern California Edison has performed recalculations which result in the amended values.

2.0 DESCRIPTION OF PROPOSED AMENDMENT

Southern California Edison (SCE) is requesting a change to the operating licenses for San Onofre Nuclear Generating Station Units 2 and 3 to revise the calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, from 55.1 psig to 45.9 psig, and the calculated peak containment internal pressure for the design basis Main Steam Line Break from 56.6 psig to 56.5 psig in Technical Specification 5.5.2.15, "Containment Leakage Rate Testing Program." SCE has recalculated the aforementioned peak pressures and determined that the revised pressures are appropriate.

3.0 BACKGROUND

The NRC issued Amendments 144 and 135 to the operating licenses for SONGS 2 & 3, respectively, on November 6, 1998. These amendments implemented Option B to Appendix J of 10 CFR 50 for SONGS 2 & 3, and added the Containment Leakage Rate Testing Program to the Technical Specifications (TS), including Section 5.5.2.15, which contained values for calculated peak containment internal pressures for the design basis LOCA and the design basis MSLB accident. The former pressure, designated as P_a, was given as 55.1 psig. The latter pressure (to which P_a will conservatively be assumed to be equal) was given as 56.6 psig.

The design internal pressure for the SONGS 2 & 3 containment buildings is 60 psig. Calculated internal pressure for the design basis LOCA is determined by SCE in calculation N-4080-026 (Attachment 9) using the Bechtel proprietary computer program COPATTA. Calculated internal pressure for the design basis MSLB accident is determined by SCE in calculation N-4080-027 (Attachment 10), also using the COPATTA program.

The NRC issued Amendments 149 and 141 to the SONGS 2 & 3 operating licenses on February 12, 1999. These amendments, inter alia, authorized a reduction in the minimum cold leg temperature of the Reactor Coolant System (RCS) during power operation. Analyses by ABB-CE (now Westinghouse) in support of these amendments documented that mass and energy releases to containment from design basis large LOCA and MSLB events with the plant operating at a reduced cold leg temperature would be bounded by operation at the higher, and still allowed, original cold leg temperature. However, SCE elected to upgrade the design basis containment pressure-temperature response analyses for large LOCA and MSLB events.

Therefore, new mass and energy release rate data were generated by ABB-CE for a spectrum of large LOCA and MSLB events using conservative analysis input parameters from Cycles 9 and 10, including applicable instrument total loop uncertainties and a maximum value for cold leg temperature. These new mass and energy release calculations were performed in conformance with NUREG-0800, Section 6.2.1.3 (LOCA) and Section 6.2.1.4 (secondary system pipe ruptures). Applicable portions of Appendix K methodology described in reports CENPD-132 (Reference 9.1) and CENPD-133 (Reference 9.2), including supplements issued in 1985, were incorporated in the LOCA mass and energy release calculations.

The subsequent recalculations performed by SCE have resulted in the revised peak containment internal pressures being requested by this submittal for inclusion in TS 5.5.2.15.

A discussion of the containment peak pressure analysis, including a description of the COPATTA program, is found in Section 6.2.1.1.3.1 of the SONGS 2 & 3 Updated Final Safety Analysis Report (UFSAR). The calculated design basis peak containment internal pressures are found in Table 6.2-9 of the UFSAR.

4.0 REGULATORY REQUIREMENTS & GUIDANCE

Although SCE was not required to recalculate the design basis peak containment internal pressures, SCE elected to do so using new mass and energy release rate data. The Safety Evaluation Report issued by the NRC for Amendments 149 and 141 for T_{cold} reduction found acceptable the SCE determination that calculated peak containment internal pressures would not be affected by the Amendments. SCE has similarly determined in our April 3, 2001 submittal requesting an increase of 1.4% in the SONGS 2 & 3 licensed power levels that under that proposed change, peak containment internal pressures would be bounded by existing analyses. The NRC approved the requested power uprate in Amendments 180 and 171 issued on July 6, 2001.

An NRC letter (Christopher I. Grimes) to the Nuclear Energy Institute (David J. Modeen) dated November 2, 1995, provides an acceptable format for Technical Specifications establishing a Primary Containment Leakage Rate Testing Program implementing Option B of Appendix J to 10 CFR 50. The format includes a numerical value for P_a, the peak calculated containment internal pressure for the design basis loss of coolant accident. SONGS 2 & 3 adopted this format when Option B was implemented in 1998. Discussions between SCE and NRC staff at that time lead to the inclusion in the SONGS 2 & 3 TS of the numerical value for the peak calculated containment internal pressure for the design basis MSLB accident as well, and a commitment to test to the larger MSLB value.

Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports…," gives guidance on the initial conditions and engineered safety features which should be addressed in a safety analysis of post-accident containment environment. The Safety Evaluation Report issued by the NRC as NUREG-0712 for SONGS 2 & 3 operation finds, in Section 6.2.1.1, "Containment Pressure Analysis," that the COPPATA computer code and its attendant methodology are satisfactory for calculating peak containment internal pressures.

5.0 TECHNICAL ANALYSIS

5.1 Design Basis

The design peak containment internal pressure is 60 psig. The proposed values of 56.5 psig for the MSLB accident and 45.9 psig for the LOCA are less than the design pressure, and also less than the current TS values of 56.6 psig and 55.1 psig, respectively. The methodology used to compute the calculated pressures was approved by the NRC in the Safety Evaluation Report, NUREG-0712, for SONGS 2 & 3 operation.

SCE Calculation N-4080-027 (Attachment 10) evaluates the containment pressure and temperature response to a spectrum of large MSLB events. The analysis utilizes new MSLB mass and energy release data from the Nuclear Steam Supply System (NSSS) vendor (ABB-CE, now Westinghouse). It also utilizes updated passive (structural) heat sink data, incorporates applicable instrument total loop uncertainties, and includes transient containment spray flow modeling not previously used in SONGS 2 & 3 analyses. It also incorporates main steam backflow into containment through inter-connected steam piping supplying the turbine-driven auxiliary feedwater pump. Calculated peak containment internal pressure is rounded up to the next higher 0.1 psig.

The calculated results show that the limiting MSLB for containment peak pressure is the 102% of 3390 MWt 8.85 square foot area MSLB with one main steam isolation valve failure to close. This case produces a calculated peak containment internal pressure of 56.5 psig. As was demonstrated in the original plant licensing analyses, the large steam generator mass and energy inventories and large diameter main steam lines in the Combustion Engineering NSSS at SONGS 2 & 3, combined with accident modeling which provides dry steam flow throughout the event, caused the MSLB event to produce a higher short-term containment internal pressure than that produced by the large break LOCA event.

SCE calculation N-4080-026 (Attachment 9) evaluates the containment pressure and temperature response to a spectrum of LOCAs. The analysis utilizes new LOCA mass and energy release data from the NSSS vendor (ABB-CE, now Westinghouse). The most severe LOCA event for containment design is the Double Ended (Pump) Discharge Leg Slot break with a diesel generator single failure. This event produces a peak containment pressure of 45.9 psig. The Double Ended Hot Leg Slot break with a diesel generator single failure produces a peak containment pressure of 45.8 psig, slightly lower than that from the pump discharge leg break. The hot leg break, however, is slightly more limiting from the standpoint of long-term containment cooldown, and is identified for environmental qualification purposes as the bounding event for post-LOCA long-term containment cooldown.

In summary, the NRC has found the computer program and methodology used to calculate peak containment internal pressure to be satisfactory. SCE has recalculated the peak containment internal pressure for the MSLB and LOCA events, resulting in different, somewhat lower, calculated pressures than before. The calculated pressures stated in TS 5.5.2.15 should be revised to the recalculated pressures.

5.2 Risk Information

PCN-528 is not a risk-informed amendment request. Peak containment internal pressures are calculated deterministically.

6.0 REGULATORY ANALYSIS

Southern California Edison (SCE) is requesting a change to the operating licenses for San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2 & 3) to revise the calculated peak containment internal pressure related to the design basis loss-of-coolant accident (LOCA), P_a, from 55.1 psig to 45.9 psig, and the calculated peak containment internal pressure for the design basis Main Steam Line Break (MSLB) from 56.6 psig to 56.5 psig in Technical Specification 5.5.2.15, "Containment Leakage Rate Testing Program." SCE has recalculated the aforementioned peak pressures utilizing the Bechtel proprietary computer program COPATTA. The COPATTA code and associated methodology have been reviewed by the NRC staff and approved for use in calculating peak containment internal pressure for design basis accidents.

SCE in its recalculation has used new LOCA and MSLB mass and energy release data from the nuclear steam supply system vendor (ABB-CE, now Westinghouse), conservatively based on the maximum reactor coolant temperature authorized by approved license amendments. The recalculation also utilizes updated passive (structural) heat sink data, incorporates applicable instrument total loop uncertainties, and includes transient containment spray flow modeling not previously used in SONGS 2 & 3 analyses. The MSLB event analysis also incorporates main steam backflow into containment through inter-connected steam piping supplying the turbine-driven auxiliary feedwater pump.

The design internal pressure for the SONGS 2 & 3 containment buildings is 60 psig. The recalculated values of 45.9 psig for the design basis LOCA and 56.5 psig for the MSLB are less than the design pressure.

SCE has requested and the NRC has approved a revision to the SONGS 2 & 3 operating licenses to change the full power license limit on reactor power from 3390 megawatts thermal to a new limit of 3438 megawatts thermal, an increase of 1.4%. The recalculation of containment internal pressure assumes an initial reactor power level of 102% of 3390 megawatts thermal, and thus bounds the containment internal pressure results under the approved increase in licensed reactor power.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner,

(2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 NO SIGNIFICANT HAZARDS CONSIDERATION

Southern California Edison has evaluated whether or not a significant hazards consideration is involved with the proposed amendments by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

Response: No.

The proposed change would revise the Operating Licenses for San Onofre Nuclear Generating Station Units 2 and 3 to amend Technical Specification (TS) 5.5.2.15, "Containment Leakage Rate Testing Program," by changing the stated calculated values for peak containment internal pressure for the design basis Loss Of Coolant Accident (LOCA) and Main Steam Line Break (MSLB) accident. The current LOCA value of 55.1 psig would be changed to 45.9 psig and the current MSLB value of 56.6 psig would be changed to 56.5 psig.

The proposed change does not affect the probability of occurrence of an accident previously evaluated because it relates solely to the consequences of hypothesized accidents given that the accident has already occurred.

The proposed change does not increase the calculated peak containment internal pressure for the LOCA and MSLB accidents, and thus does not increase their consequences.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

Response: No.

The proposed change relates to two accidents, MSLB and LOCA, already evaluated in the Updated Final Safety Analysis Report. Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

The recalculated peak containment internal pressures for the MSLB and LOCA accidents are less than the containment design pressure and less than the previously calculated pressures. Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, Southern California Edison concludes that the proposed amendment(s) present no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

8.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component, the containment buildings, located within the restricted area, as defined in 10 CFR 20. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

9.0 REFERENCES

9.1 CENPD-132, through Supplement 3-P-A, "Calculational Methods For the C-E Large Break LOCA Evaluation Model For the Analysis of C-E and W Designed NSSS," June 1985

9.2 CENPD-133, through Supplement 5, "CEFLASH-4A, "A FORTRAN77 Digital Computer Program For Reactor Blowdown Analysis," June 1985

ATTACHMENT 3

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

EXISTING TECHNICAL SPECIFICATION PAGE, UNIT 2

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is 55.1 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.6 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 4

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

EXISTING TECHNICAL SPECIFICATION PAGE, UNIT 3

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is 55.1 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.6 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 5

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

MARKUP OF TECHNICAL SPECIFICATION PAGE, UNIT 2

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is ~~55.1~~45.9 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.~~6~~5 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 6

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

MARKUP OF TECHNICAL SPECIFICATION PAGE, UNIT 3

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is ~~55.1~~45.9 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.~~6~~5 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 7

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

RETYPED TECHNICAL SPECIFICATION PAGE, UNIT 2

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is 45.9 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.5 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 8

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

RETYPED TECHNICAL SPECIFICATION PAGE, UNIT 3

5.5 Procedures, Programs, and Manuals (continued)

5.5.2.14 Configuration Risk Management Program (CRMP) (Continued)

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out of service conditions while in the LCO Condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues, and external events, qualitatively or quantitatively.

5.5.2.15 Containment Leakage Rate Testing Program

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

The calculated peak containment internal pressure related to the design basis loss-of-coolant accident, P_a, is 45.9 psig (P_a will conservatively be assumed to be equal to the calculated peak containment internal pressure for the design basis Main Steam Line Break (56.5 psig) for the purpose of containment testing in accordance with this Technical Specification).

The maximum allowable containment leakage rate, L_a, at P_a, shall be 0.10% of containment air weight per day.

Leakage rate acceptance criteria are:

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

b. Air lock testing acceptance criteria are:

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

2) For each door, the leakage rate is $\leq 0.01\ L_a$ when pressurized to ≥ 9.0 psig.

ATTACHMENT 9

SAN ONOFRE NUCLEAR GENERATING STATION
PCN-528

CALCULATION N-4080-026 REVISION 1, INCLUDING CCN-4
CONTAINMENT P-T ANALYSIS FOR DESIGN BASIS LOCA

Southern California Edison Company INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN) COVER PAGE	CALC. NO. N-4080-026	ICCN NO./ PRELIM. CCN NO. N-2	PAGE 1	TOTAL NO. OF PAGES 15
SUMMARY CHANGE ◉ NO ○ YES	BASE CALC. REV. 1 / UNIT 2 & 3	CCN CONVERSION : CCN NO. CCN- 4		CALC. REV. 1
	CALCULATION SUBJECT : CONTAINMENT P-T ANALYSIS FOR DESIGN BASIS LOCA			
CALCULATION CROSS-INDEX ☒ New/Updated index included ☐ Existing index is complete	ENGINEERING SYSTEM NUMBER / PRIMARY STATION SYSTEM DESIGNATOR 1201 / XB1			Q-CLASS II
Site Programs/Procedure Impact? ◉ NO ○ YES, AR No.	CONTROLLED PROGRAM OR DATABASE ACCORDING TO SO123-XXIV-5.1 ☒ PROGRAM ☐ DATA BASE	PROGRAM / DATABASE NAME (S) NE100/COPATTA ☐ ALSO, LISTED BELOW		VERSION/RELEASE NO.(S) G1-15

1. BRIEF DESCRIPTION OF ICCN / CCN:

1. Add Appendix D to the calculation and identify the appendix on the Table of Contents (sheet 4 of the calculation).
2. Correct typo on sheet 57: Change injection phase volumetric flow to RCS for case 8 FROM 1183.2gpm TO 11839.2gpm.
3. Correct Ref. 6.23 on sheet 61 FROM SO23-12-13, Rev. 15 dated 8/12/98 TO SO23-12-3, Rev. 16, dated 11/24/99.

Appendix D evaluates the impact of reducing the perfomance of the containment emergency air cooling units (ECUs) by 6% relative to the design basis performance defined in Table 1 of Calculation M-0072-036, Revision 0. The reduced ECU perfomance is caused by a potential reduction in component cooling water (CCW) flow to the ECUs when the spent fuel pool heat exchanger is valved in to an operating CCW train following a design basis LOCA.

The evaluation concludes that:

1. The existing analyses for short-term containment peak pressure and temperature responses are completely unaffected by the potential reduction in CCW flow to the ECUs. The peak post-LOCA containment pressures and temperatures for all cases analyzed in Revision 1 occur well before the spent fuel pool HX would be realigned to an operating CCW train for post-LOCA cooling.
2. The existing analyses for long-term containment cooldown may be considered to remain applicable. A COPATTA reanalysis of the limiting LOCA for long-term cooldown (DEHLS LOCA with diesel generator failure) including 6% ECU degradation from time zero produced a containment temperature versus time plot which closely matched the current analysis of record (AOR) with maximum increases in vapor temperature of about 1F from about 8 hours to 2 days post-LOCA. A 1F increase in long-term containment temperature during the first few days of cooldown is not a significant change. A consideration of the conservatism in the COPATTA ECU model suggests that for most of the transient, especially following the first day of the accident, ECU performance will improve as the total heat load declines and the CCW temperature drops below the 105F design value used in the analysis. Therefore, the long-term cooldown curves developed in the Revision 1 calculation remain applicable and bounding

INITIATING DOCUMENT (DCP, FCN, OTHER) NCR991001180, Disposition Item 1 REV. 1

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

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

3. APPROVAL : DISCIPLINE / ESC : NF Engring & Anal

P. Barbour 3/29/01	3-29-01	
ORIGINATOR (Print name/sign/date)	FLS (Signature/date)	OTHER (Signature/date)
M. I. Drucker 3/29/2001		
IRE (Print name/sign/date)	OTHER (Signature/date)	OTHER (Signature/date)

4. CONVERSION TO CCN DATE 4/2/01 SCE CDM - SONGS

SCE 26-122-1 REV. 3 8/99 (REFERENCE: SO123-XXIV-7.15)

T:\JETFORM\FORMS\NEDO_GEN\122_1_03.MDF Ver: 03.00.00 8/99
C:\JETDATA\26R1PCN2.DAT DevID: -1.0000 Printed: 03/26/01

Site File Copy

CALCULATION CROSS-INDEX

~~CCN NO.~~/ PRELIM. CCN NO. N-2 | PAGE 2 OF 15

CCN CONVERSION: CCN NO. CCN- 4

Calculation No. N-4080-026 | Sheet No. 3 of 248

Calc. rev. number and responsible FLS 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 change?	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	
1 Sel 12-29-99	Calculations:					
	09/10-ST-98-C-014	0	UFSAR Section 6.2.1	15	YES	AR991200986 Assmt 4
	09/10-ST-98-C-015	0	UFSAR Section 3.11	15	YES	AR991200986 Assmt 2
	09/10-ST-98-016	0	DBD-SO23-TR-AA	2	YES	AR991200986 Assmt 5
	N-4080-003	5	DBD-SO23-TR-EQ	5	YES	AR991200986 Assmt 2
	N-4080-027	1	DBD-SO23-TR-ST	0	YES	AR991200986 Assmt 3
	N-1020-043	0				
1 Sel 12-29-99	M-0072-036	0	Units 2&3 Technical Spec's (Bases to 3.6.1 & 3.6.2)		YES	AR991200986 Assmt 1
	M-0014-009	0				
	C-257-01.06.01	2	Units 2&3 Technical Spec's (5.5.2.15)		YES	AR991200986 Assmt 1
	Miscellaneous:					
	DBD-SO23-TR-ST	0	N-4059-004	1	YES	AR991200986 Assmt 6
	DBD-SO23-400	6	N-4059-005	1	YES	AR991200986 Assmt 6
1 Sel 12-29-99	RGR-U2-C10	2	N-4060-030	1	NO	
	RGR-U3-C10	1				
Sel 3-30-01	CCN 1 To M-0072-036	0				
	DBD-SO23-400	7				

SCE 26-424 REV. 3 8/99 [REFERENCE: SO123-XXIV-7.15]

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99						
	P. Barbour	3/26/01	M.I. Drucker	3/26/01						

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99					
	P. Barbour	3/26/01	M.L. Drucker	3/26/01					

4.13 Pumped safety injection flow for the various cases, both during the injection phase and the recirculation phase are developed in Calculation #2 of Reference 6.2d. The times for recirculation initiation for the various cases are developed in Calculation #3 of Reference 6.2d, and also reported in Table 21 of Reference 6.2a. The values for the various cases are summarized in the following table:

Case	Injection Phase Flow to RCS		Time of Recirculation Initiation (sec)	Recirculation Phase Flow to RCS +		
	Volumetric Flow (gpm) *	Mass Flow (lb_m/sec) **		Volumetric Flow (gpm)	Mass Flow (lb_m/sec)	Mass Flow ++ (lb_m/sec)
1	5676.00	790.25	2437.40	731.0	100.97	97.08
2	8879.4	1238.98	1382.51	1461.9	201.93	194.17
3	8879.4	1238.98	1242.42	1461.9	201.93	194.17
4	5919.6	823.91	2437.25	974.6	134.62	129.44
5	11839.2	1647.81	1375.31	1949.2	269.24	258.89
6	11839.2	1647.81	1235.98	1949.2	269.24	258.89
7	5919.6	823.91	2401.28	974.6	134.62	129.44
8	~~1183.2~~ 11839.2	1647.81	1348.02	1949.2	269.24	258.89
9	11839.2	1647.81	1211.58	1949.2	269.24	258.89

*Pumped SI flow without charging flow
** Pumped SI flow including charging flow
+ Charging pumps off during recirculation
++ Mass flow at 220°F (sp. Vol. = 0.016775 ft^3/lb_m)

The mass flow rates provided by ABB-CE are all calculated for water at 100°F which is the temperature of the water in the RWST used as the source for pumped safety injection prior to sump recirculation. During recirculation, the sump water is warmer than 100°F and the lower density of the warmer water will reduce the mass flow rate of recirculated sump water. Based on preliminary results of this P-T calculation (and confirmed by the final results), an appropriately conservative temperature for recirculated sump water is 220°F. The last column of recirculated mass flow rates are calculated for water at 220°F for use in the COPATTA analysis.

As identified by ABB-CE in Reference 6.2a, only the pump discharge leg LOCA directly spills pumped SI water to the containment sump via the broken pump discharge pipe. Prior to recirculation, the direct pumped SI spillage is included in the Card Series 601 spillage table and the pumped SI flow included in the Card Series 801 table is the net pumped SI flow to the RCS without the spillage flow. After start of recirculation, the direct spillage is included in the SI flow shown in the Card Series 801 table, and a spillage fraction of 0.25 (per ABB-CE) is specified for the pump discharge leg break cases.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99						
	P. Barbour	3/26/01	M.I. Drucker	3/26/01						

6.11 DBD-SO23-400, Revision 6, "Component Cooling Water System Design Basis Document", 1/22/99

6.12 Calculation N-4080-003, Revision 5, including CCN 2, "Containment Spray (CS) and Emergency Cooling Unit (ECU) Actuation Times", 6/10/97

6.13 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification", 1/10/94

6.14 Calculation N-4080-027, Revision 1, "Containment P-T Analysis for Design Basis MSLB". 11/30/99

6.15 Bechtel Standard Computer Program NE100, COPATTA, Version G1-15, "Containment Pressure/Temperature Transient Analysis Code", User and Theoretical Manuals

6.16 Bechtel Nuclear Standard N2.3.2, Revision 0, "Containment Analysis", July, 1975

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

6.18 NE100 (COPATTA) Computer Program Software Installation Report, Revision 2, 8/31/98

6.19 Calculation N-1020-043, Revision 0, "SO23: Single Fuel Assembly Decay Heat", 9/18/91

6.20 Letter, R.W. DeVane (ABB-CE) to J.D. Houchen (Bechtel), S-CE-2604, "FSAR Mass/Energy Release Data for Containment Design, LOCA and MSLB" (including Appendicies A through J), March 1, 1976 [CDM number C760301G-45-2-4SVT]

6.21 Calculation M-0014-009, Revision 0, including CCN 1, CCN 2, and CCN 3, "Containment Spray Pumps In Service Testing Minimum Requirements", 1/22/99

6.22 ASME Steam Tables, 1967

6.23 Station Emergency Operating Instruction, SO23-12-~~13~~ 3, Revision ~~15~~ 16, "Loss of Coolant Accident", ~~8/12/98~~ 11/24/99

6.24 Calculation N-4060-030, Revision 0, "Containment Flooding Level", 2/11/94

6.25 Memorandum to File, P. Barbour, "Input Data for Containment Flood Level Calculation", dated September 10, 1999

APPENDIX D

EVALUATION OF IMPACT OF REDUCED CCW FLOW TO CONTAINMENT ECUs ON POST-LOCA LONG-TERM CONTAINMENT COOLDOWN

D.1 Purpose

Evaluate the impact of degraded emergency air cooling unit (ECU) heat transfer capability, caused by a reduction in component cooling water (CCW) flow to the ECUs, on the long-term post-LOCA cooldown of containment. The evaluation considers a 6% reduction in ECU heat removal rates when the Spent Fuel Pool Heat Exchanger (SFPHX) is connected to the operating CCW system, and the CCW flow rate to each ECU is reduced from the design basis value of 2000 gpm to a minimum value of 1700 gpm.

D.2 Introduction and Background

AR 991001180 has identified that CCW flow to the containment Emergency Air Cooling Units (ECUs) may by as low as 1700 gpm during post-LOCA long-term containment cooldown. The decrease in ECU cooling water flow below the design basis value of 2000 gpm occurs when the non-critical CCW loop is re-connected to the operating CCW train critical loop to restore cooling to the Spent Fuel Pool Heat Exchanger (SFPHX). Calculation Change Notice CCN 1 to Calculation M-0072-036 (Ref. D.1) quantifies the reduction in ECU performance to be 5.1% with the containment at 280°F and 4.2% with the containment at 200°F. Assignment 9 of the AR requests Calculation N-4080-026, Revision 1 (containment post-LOCA P-T analysis), be updated to account for a 6% reduction in ECU perfomance, reflecting the potential low CCW flow to the ECUs.

Calculation N-4080-026 currently includes a 2% ECU performance degradation allowance to cover potential CCW flows as low as 1900 gpm to the ECUs. The issue of concern is the impact of an additional 4% degradation in ECU performance on long-term containment cooldown following a design basis LOCA event. A slower containment cooldown may adversely impact the qualification status of electrical equipment and components inside containment which are required to remain operable for the duration of the event. It is emphasized that the ECU flow reduction issue has absolutely no impact on short-term containment peak pressures and temperatures calculated in the current analysis. The reduced CCW flow to the ECUs occurs only after the SFPHX is realigned to the CCW system, well after the short-term peak post-accident containment conditions have occurred.

D.3 Summary of Results and Conclusions

It is the conclusion of the evaluation in this Appendix that the long-term containment cooldown results presented in Revision 1 of this calculation, which are based on an ECU performance equal to 98% of the design basis values defined in Revision 0 to M-0072-036 [Ref. D.1, w/o CCN 1], may be considered to remain bounding, even with CCW flow to the ECUs as low as 1700 gpm versus the design basis flow rate of 2000 gpm per ECU. This conclusion is supported by the discussion of results provided below.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

Figures D-1 and D-2 show the containment pressures and temperatures, respectively, for the design basis DEDLS LOCA from the current analysis of record (with 2% ECU degradation) and the results from a second COPATTA analysis using 6% ECU degradation. Figures D-3 and D-4 show the same kind of information for the design basis DEHLS LOCA event. The curves of containment conditions with 6% ECU degradation fall virtually on top of the current AOR cases with discernable increases only appearing after several thousand seconds (1 to 2 hours) into the event. These analyses are conservative since they model the degraded ECU performance beginning at the start of the event whereas the degradation in performance would actually occur only after operator re-alignment of the SFPHX several hours post-LOCA. Inspection of the actual COPATTA results show a maximum increase in containment pressure of about 0.4 psig at about 5 to 7 hours post-LOCA when the pressures are in the range of 20 to 25 psig and decreasing. The results also show a maximum increase in containment vapor temperature of about 1.2°F and containment sump water temperature of about 0.9°F occurring approximately 8 to 12 hours post-LOCA. After reaching these maximum differences, containment pressures and temperatures gradually decrease and approach the values calculated in the current AOR. These changes in containment conditions are not considered to be significant considering the uncertainties inherent in the long-term modeling of containment post-LOCA performance.

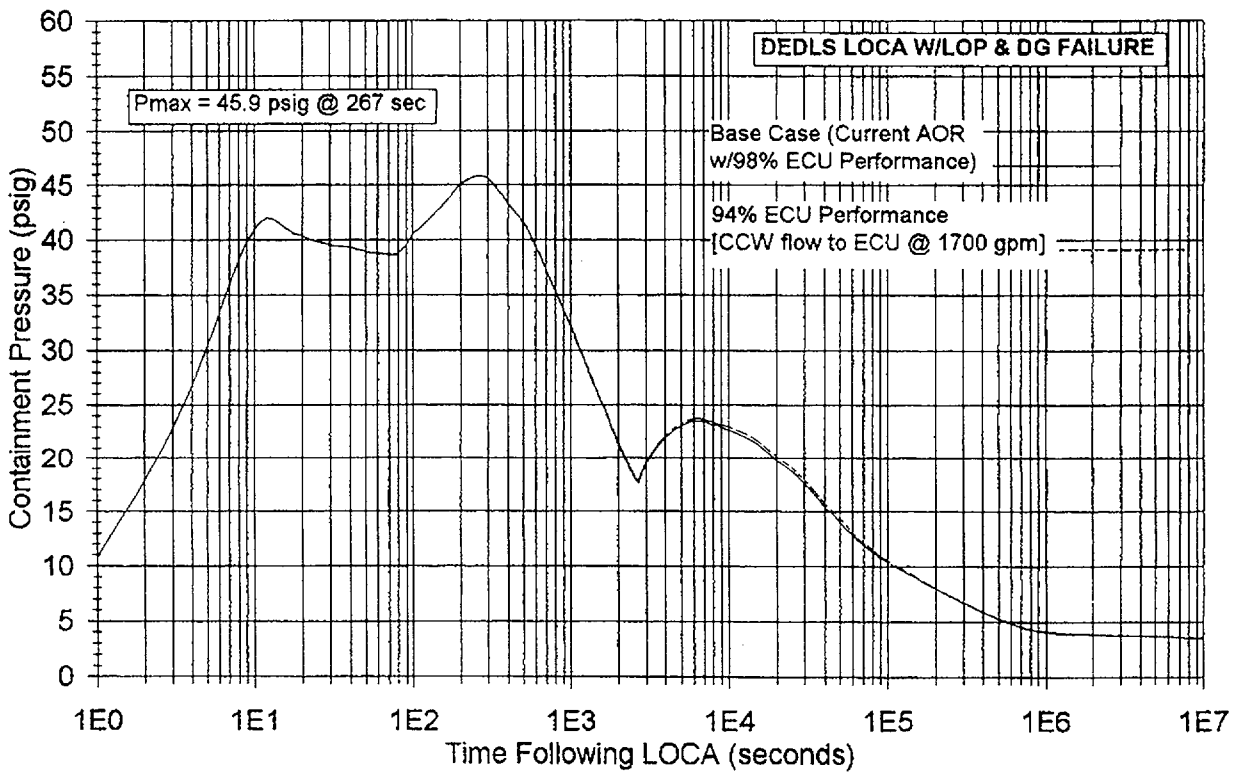
A significant conservatism is included in the containment post-LOCA response analyses which provides further support for considering the current AOR as definitive and bounding for the long-term containment response. The containment analysis assumes the temperature of the cooling water supplied by the CCW system remains constant at the design basis maximum value of 105°F throughout the event. In reality, the CCW temperature would be substantially less than this maximum value at the start of the event and not approach 105°F until after sump water recirculation is initiated and cooling of the containment spray flow in the Shutdown Heat Exchanger (SDHX) begins. Then, as containment cooldown proceeds, the heat load from the ECUs and the SDHX gradually decreases and the CCW temperature also declines in response to the decrease in total CCW heat load.

Table 3-1 of DBD-SO23-400 (Ref. D.2) shows the peak post-LOCA heat load on one CCW system train is 151.44×10^6 Btu/hr, including 54.4×10^6 Btu/hr from one train of ECUs and 68.4×10^6 Btu/hr from one SDHX. The combined peak containment post-LOCA heat load is 122.8×10^6 Btu/hr, or 81% of the CCW heat load. Figures D-5 and D-6 present the ECU and SDHX heat loads on the CCW system taken from the current AOR COPATTA analysis results for the DBA cases 1 (DEDLS LOCA) and 7 (DEHLS LOCA), respectively. The DEDLS LOCA (Case 1) is more limiting with respect to heat load on the CCW system, yielding a peak combined ECU and SDHX heat load of 117×10^6 Btu/hr at about 7000 seconds (~ 2 hours post-LOCA). ***[Note: The total containment heat load in Reference D.2 is based on the previous containment LOCA P-T analysis in Supplement A to Revision 0 of this calculation, and is bounding with respect to the current AOR.]*** The important point to note is that the high design basis post-LOCA containment heat loads are relatively short-lived. At one day post-LOCA the containment heat load on the CCW system had decreased by 35% to about 76×10^6 Btu/hr. The substantial reduction in CCW heat load with time will result in a corresponding decrease in CCW temperature. Any reduction in CCW temperature will increase the effectiveness of the ECUs and the SDHX and increase the rate of containment depressurization and cooldown relative to that documented in the current AOR.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-1

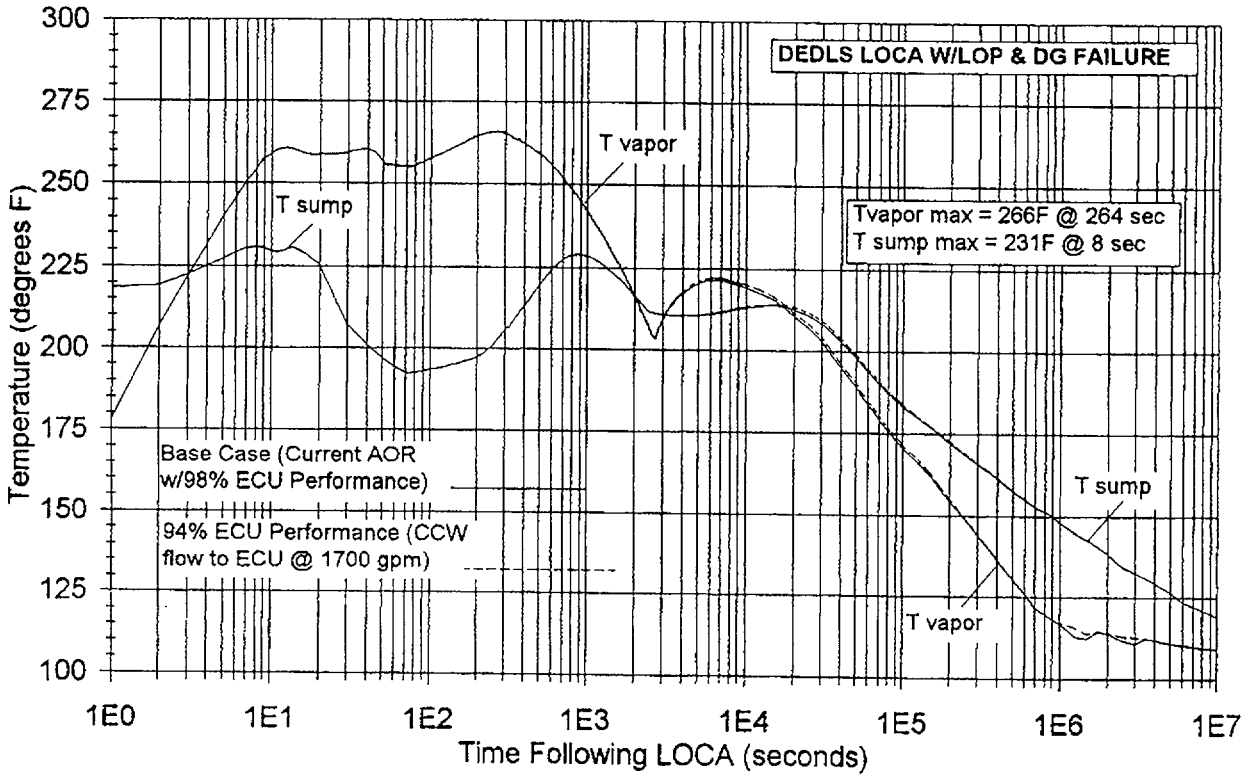
CASE 1 - DEDLS LOCA W/LOP & DG FAILURE CONTAINMENT PRESSURE



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-2

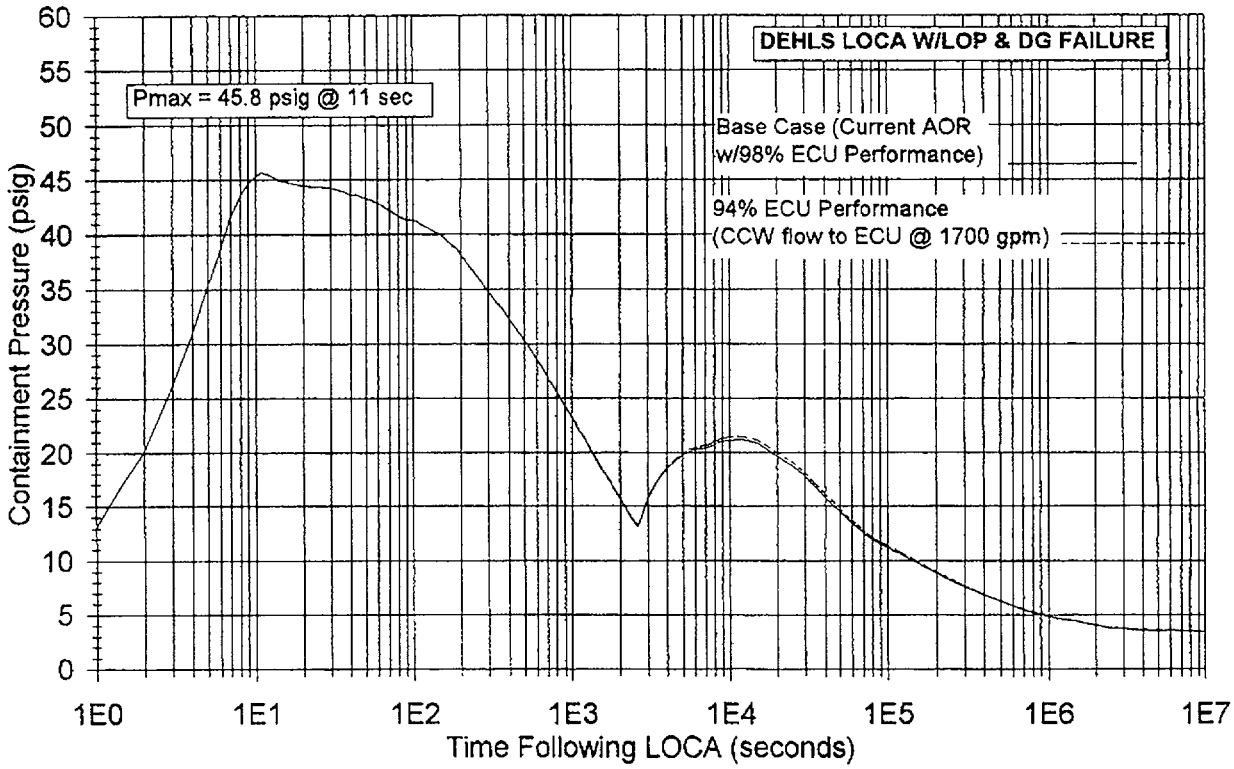
CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONTAINMENT TEMPERATURES



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-3

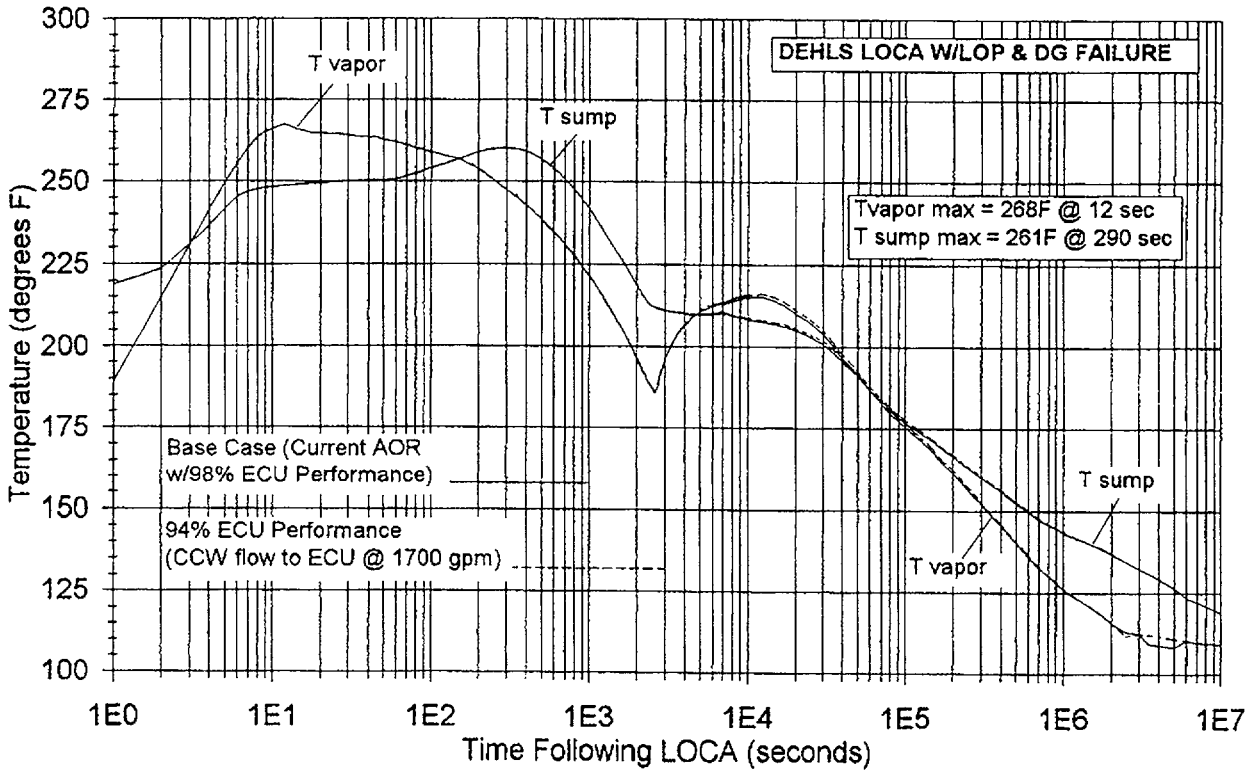
CASE 7 - DEHLS LOCA W/LOP & DG FAILURE CONTAINMENT PRESSURE



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-4

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE CONTAINMENT TEMPERATURES

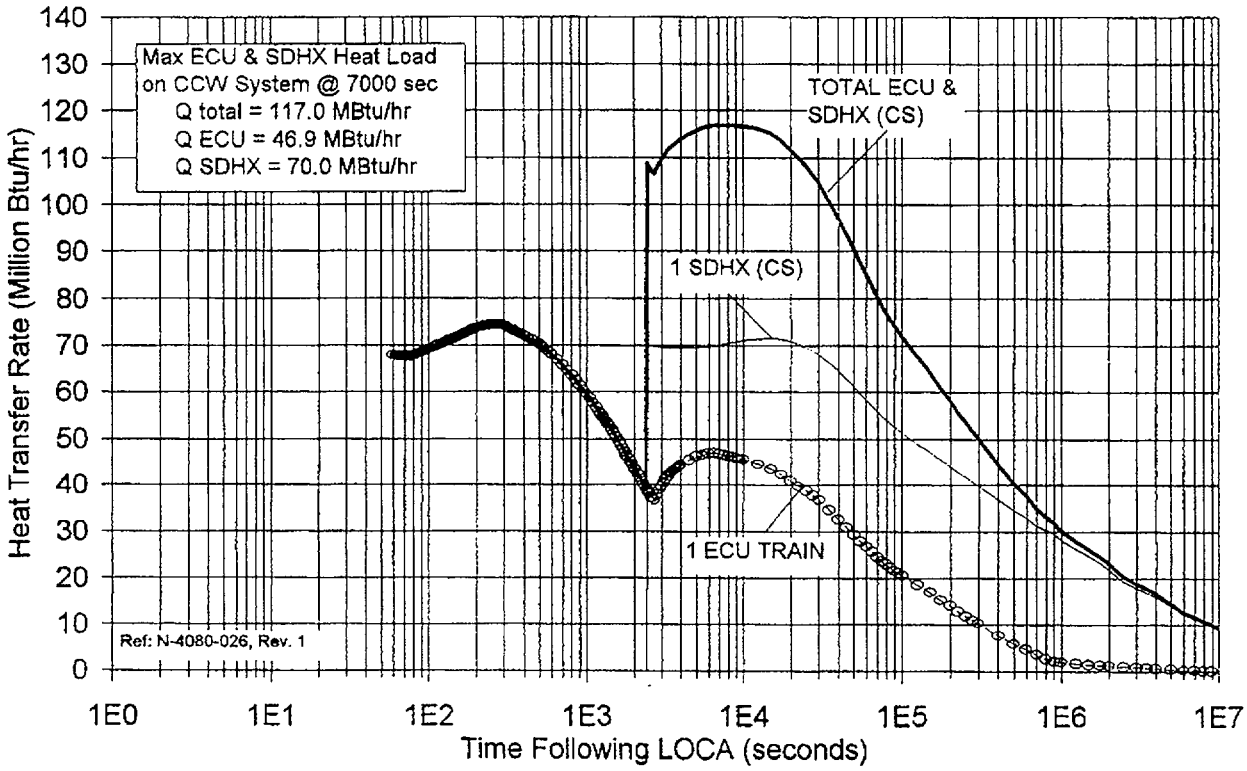


REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-5

ECU & SDHX (CS) HEAT LOADS ON CCW

DEDLS LOCA W/LOP & DG FAILURE - Case 1

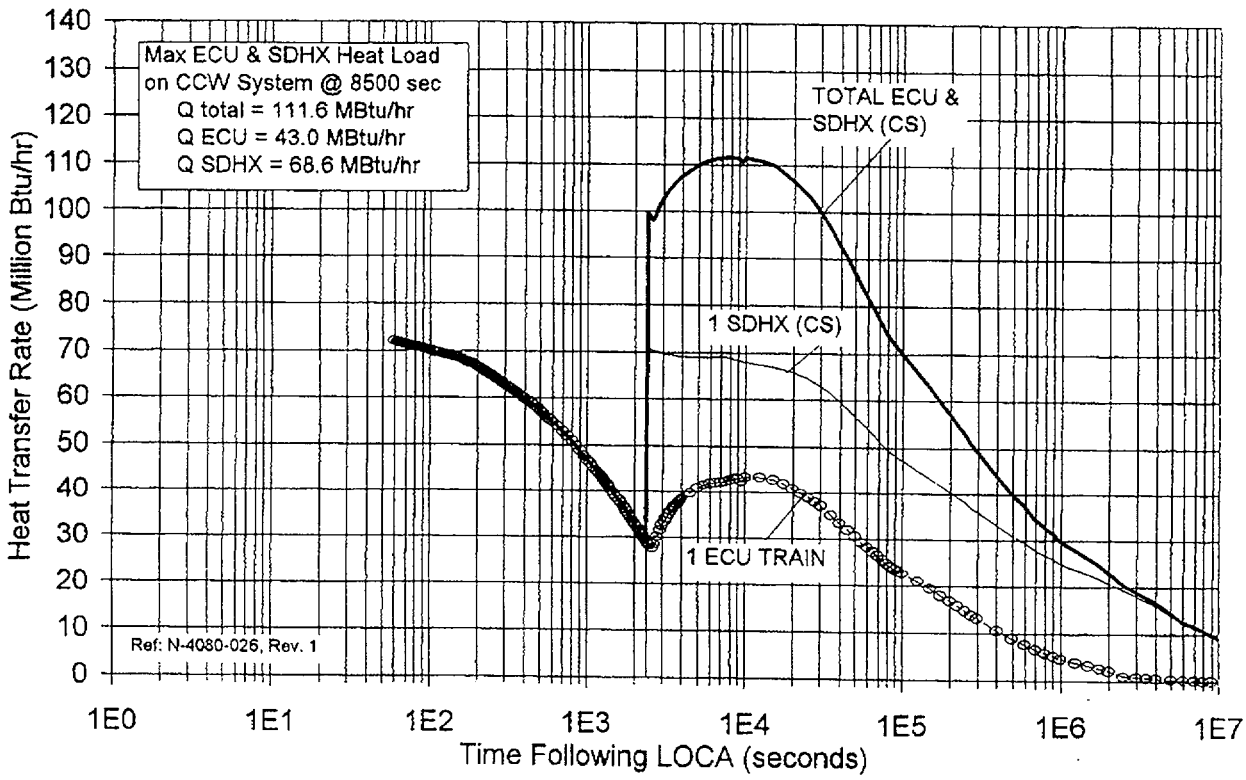


REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

FIGURE D-6

ECU & SDHX (CS) HEAT LOADS ON CCW

DEHLS LOCA W/LOP & DG FAILURE - Case 7



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

D.4 Calculations

The input file for Case 1, the bounding DEDLS LOCA for peak pressure and for Case 7, the bounding DEHLS LOCA for long-term containment cooldown were edited to change the ECU performance table (COPATTA Card Series 1101) to provide heat removal rates equal to 94% of the design basis values provided in Table 1 of calculation M-0072-036, Revision 0 (internal fouling factor of 0.0005). The table below presents the design basis and 94% values used for this evaluation. The ECU heat transfer rates with 2% performance degradation used in the current containment post-LOCA P-T response AOR are shown on page 112 of this calculation.

Emergency Air Cooling Unit Performance

Vapor (saturation) Temperature (°F)	Single ECU Design Basis Heat Removal Rate (Btu/hr)	94% Design Basis ECU Heat Removal Rate (Btu/hr)
105	0	0
120	1.67E6	1.570E6
130	3.02E6	2.839E6
140	4.57E6	4.296E6
150	6.32E6	5.941E6
160	8.27E6	7.774E6
170	10.40E6	9.776E6
180	12.73E6	11.966E6
190	15.23E6	14.316E6
200	17.88E6	16.807E6
210	20.68E6	19.439E6
220	23.61E6	22.193E6
230	26.64E6	25.042E6
240	29.74E6	27.956E6
250	32.91E6	30.935E6
260	36.11E6	33.943E6
270	39.31E6	36.951E6
280	42.52E6	39.969E6
287	44.74E6	42.056E6
290	45.69E6	42.949E6
300	48.82E6	45.891E6

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
	P. Barbour	3/26/01	M. I. Drucker	3/26/01						

D.5 References

D.1 CCN 1 to M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification", 5/30/2000

D.2 DBD-SO23-400, Revision 7, "Component Cooling Water System Design Basis Document", 9/30/00

CALCULATION TITLE PAGE

ICCN NO./ PRELIM. CCN NO.	PAGE OF

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

CCN CONVERSION: CCN NO. CCN-

Subject : CONTAINMENT P-T ANALYSIS FOR DESIGN BASIS LOCA Sheet 1 of 248

System Number/Primary Station System Designators 1201 / XB1 SONGS Unit 2 & 3 Q-Class II

Tech. Spec./LCS Affecting? ○ NO ◉ YES Section No. B3.6.1 & B3.6.2 Equipment Tag No. N/A

Site Programs/Procedure Impact? ○ NO ◉ YES, AR No. 991200986

CONTROLLED COMPUTER PROGRAM/ DATABASE	☒ PROGRAM ☐ DATABASE According to SO123-XXIV-5.1	PROGRAM/ DATABASE NAME(S) NE100/COPATTA ☐ ALSO, LISTED BELOW	VERSION/ RELEASE NO. (S) G1-15

RECORD OF ISSUES

REV. DISC	DESCRIPTION	TOTAL SHTS. LAST SHT	PREPARED (Print name/sign/date)	APPROVED (Signature/date)	
1	GENERAL REVISION Replaces Rev. 0 including CCN1 & CCNT2 & CCNT3	248	ORIG. P. BARBOUR 12/17/99	FLS [signature] 12-29-99	OTHER
NFM		248	IRE J.M. GILMER 12/21/99	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER

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

NOTE:

This calculation is complete. Copies of the COPATTA Code input files are included for each case. All required output values are included to support the results and conclusions, including all plots. The complete COPATTA output files have been archived on CD-ROM, in addition, and are provided to CDM.

This calculation was prepared using "Word Perfect 6.1" word processing software. The WP6.1 software was not used for any computational portions of this calculation.

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

CALCULATION TITLE PAGE

ICCN NO./ PRELIM CCN NO.	PAGE ___ OF ___

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

Sheet 1

System Number/Primary Station System Designator ~~BLDG~~ / XB1 , ~~BBB~~ 1201

SONGS Unit 2&3 Q-Class II*

Tech Spec Affecting? [ ] NO [X] YES, Section No. B3.6.1.4

Equipment Tag No. N/A

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

RECORD OF ISSUES

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

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

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

ICCN NO./ PRELIM. CCN NO.	PAGE ____ OF ____
	CCN CONVERSION: CCN NO. CCN-

Calculation No. N-4080-026

Sheet No. 3 of 248

Calc. rev. number and responsible FLS 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 change?	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	
1 Sef 12-29-99	Calculations:					
	09/10-ST-98-C-014	0	UFSAR Section 6.2.1	15	YES	AR991200986 Assmt 4
	09/10-ST-98-C-015	0	UFSAR Section 3.11	15	YES	AR991200986 Assmt 2
	09/10-ST-98-016	0	DBD-SO23-TR-AA	2	YES	AR991200986 Assmt 5
	N-4080-003	5	DBD-SO23-TR-EQ	5	YES	AR991200986 Assmt 2
	N-4080-027	1	DBD-SO23-TR-ST	0	YES	AR991200986 Assmt 3
	N-1020-043	0				
1 Sef 12-29-99	M-0072-036	0	Units 2&3 Technical Spec's (Bases to 3.6.1 & 3.6.2)		YES	AR991200986 Assmt 1
	M-0014-009	0				
	C-257-01.06.01	2	Units 2&3 Technical Spec's (5.5.2.15)		YES	AR991200986 Assmt 1
	Miscellaneous:					
	DBD-SO23-TR-ST	0	N-4059-004	1	YES	AR991200986 Assmt 6
	DBD-SO23-400	6	N-4059-005	1	YES	AR991200986 Assmt 6
1 Sef 12-29-99	RGR-U2-C10	2	N-4060-030	1	NO	
	RGR-U3-C10	1				

SCE 26-424 REV. 3 8/99 [REFERENCE: SO123-XXIV-7.15]

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99					

1 PURPOSE

1.1 Objective

The objective of this calculation is to evaluate the containment pressure and temperature response to a spectrum of large loss of coolant accidents (LOCAs) for SONGS Units 2 and 3, and to identify the limiting LOCA events from the standpoint of maximum containment pressure, vapor and sump water temperatures, and slowest long-term containment cooldown following the LOCA event. The analysis utilizes new LOCA mass-energy release data from ABB-CE [Ref. 6.1], updated passive (structural) heat sink data, incorporates applicable instrument total loop uncertainties (TLUs), and includes transient containment spray flow modeling not previously used in SONGS containment P-T response analyses. The results of this calculation will be used to update LOCA accident analyses reported in sections 6.2 and 3.11 of the UFSAR.

1.2 Criteria, Codes and Standards

The containment structure is 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 10CFR Part 50 [Ref. 6.3]. 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 the Standard Review Plan, NUREG-0800 [Ref. 6.4, Section 6.2.1.1.A], 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 event.

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.

The containment design pressure is 60 psig and the design temperature for the containment liner plate is 300°F per the containment structure DBD (Ref. 6.5, Section 4.1.1.5.2).

2 RESULTS/CONCLUSIONS & RECOMMENDATIONS

2.1 Results/Conclusions

The Results and Conclusions section is divided into two sub-sections. The first sub-section presents a comparison of the LOCA results for all 9 cases. The second sub-section presents detailed results for the bounding pump discharge leg break, the bounding pump suction leg break and the bounding hot leg break.

2.1.1 Overview of Results for all LOCA Cases Analyzed

Table 2.1.1-1 provides a summary of the analysis results for the 9 LOCA cases run for inclusion in UFSAR Section 6.2. The peak pressures have been rounded up to the next 0.1 psig. Peak temperatures are rounded up to the next degree Fahrenheit. The timing of the peak pressure and temperatures are rounded (up or down) to the nearest second. The integrated energy release to the end of blowdown is reported in millions of Btu with 3 decimal places.

Figures 2.1.1-1 through 2.1.1-3 are plots of containment pressure for the three different break locations comparing the results for the three different single failure cases on each graph. Figures 2.1.1-4 through 2.1.1-6 and 2.1.1-7 through 2.1.1-9 are similar plots comparing the containment vapor temperatures and the containment sump water temperatures, respectively.

The results show that the diesel generator single failure cases (single train operation of safety injection, containment spray and emergency air cooling units) produce more severe containment conditions than do the no diesel generator failure cases (dual safety injection train operation) with either a containment spray train failure or an emergency air cooling unit train failure.

Figure 2.1.1-10 compares the containment pressures for the three break locations with the diesel generator single failure (Cases 1, 4, and 7). The results show the Double Ended Discharge Leg Slot (DEDLS) LOCA (Case 1) yields the highest post-LOCA containment pressure of 45.9 psig, occurring at about 267 seconds (about 4.5 minutes) after the LOCA occurs. The Double-Ended Hot Leg Slot (DEHLS) LOCA (Case 7) yields a peak containment pressure of 45.8 psig at 11 seconds, 0.1 psi lower than that produced by the DEDLS break. The Double-Ended Suction Leg Slot (DESLS) LOCA (Case 4) yields the lowest peak containment pressure of 41.6 psig at 152 seconds, 4.3 psi lower than that produced by the DEDLS break. The calculated peak containment pressure for all cases is well below the containment design pressure of 60 psig, satisfying General Design Criterion (GDC) 16 of 10CFR50, Appendix A. The pressure at one day post-LOCA for all cases is well below 50% of the peak pressure, satisfying GDC 38.

Figure 2.1.1-11 compares the containment vapor temperatures for the same three breaks with the diesel generator single failure. The results show very little difference in short-term peak vapor temperature between the three cases. The DEHLS break produces the highest vapor temperature of 268°F at 12 seconds while the DEDLS break LOCA produces a maximum vapor temperature of 266°F at 264 seconds, and the DESLS break LOCA produces a maximum vapor temperature of

262°F at 41 seconds. The containment vapor temperature for all cases remains below the liner plate design temperature of 300°F. The DEHLS break provides the slowest long-term containment cooldown following the LOCA event.

Figure 2.1.1-12 compares the containment sump water temperatures for the same three breaks with the diesel generator single failure. The results show that the DEHLS break LOCA (Case 7) produces the highest sump water temperature of 261°F during the initial phase of the accident. However, at the time of recirculation, all three cases have similar sump water temperatures of about 210°F. Following the start of sump recirculation, the cold leg breaks provide a higher sump temperature during the long-term containment cooldown, with the pump suction and discharge leg breaks showing virtually identical results.

All three cases of the Double Ended Hot Leg Slot (DEHLS) LOCA produce a peak pressure during the initial RCS blowdown period of 45.8 psig at 11 seconds which is only 0.1 psi less than the peak value for the bounding value for the DEDLS LOCA. Because the peak pressure for the hot leg LOCA occurs during the initial RCS blowdown interval, the short-term peak value is independent of the three single failures assumed for the LOCA analyses. However, the long-term containment cooldown following the hot leg LOCA is single failure dependent.

Section 9 of this calculation contains tables of selected output parameters as a function of time for all 9 cases analyzed. Three tables are provided for the bounding cases (1, 4, & 7). The first (or "A") table contains containment pressure and temperatures. The second (or "B") table contains energy data. The third (or "C") table contains selected heat sink surface temperatures and the condensing heat transfer coefficient. For the non-bounding cases only an "A" table with containment pressures and temperatures is provided.

The COPATTA code runs performed for this calculation provide information on the mass of water vapor in containment and in the reactor vessel at the time sump water recirculation is initiated, as well as the maximum post-recirculation sump water temperature. Rounded bounding values from this containment P-T calculation are:

Parameter	Value	Case
Mass of Water in Containment Vapor Region	53,000 lb_m	7
Mass of Water in Reactor Vessel	190,000 lb_m	1
Maximum Post-Recirculation Sump Water Temperature	215°F	3

This data may be used as input to containment post-LOCA flooding calculation N-4060-030 [Ref. 6.24]. It should be noted that these values are less limiting than the conservative preliminary values provided in Reference 6.25 for use in preparing revision 1 of the flooding calculation.

Table 2.1.1 - 1
Summary of Calculated Containment Peak Pressures and Temperatures

Case Number and Description	Peak Pressure		Peak Vapor Temperature		Peak Sump Temperature		Energy Release to End of Blowdown* (10^6 Btu)
	Value (psig)	Time (sec)	Value (°F)	Time (sec)	Value (°F)	Time (sec)	
Case 1 - DEDLS w/LOP & DG Failure (min SI); 2 ECUs & 1 CS	45.9	267	266	264	231	8	304.179
Case 2 - DEDLS w/LOP & No DG Failure (max SI); 4 ECUs & 1 CS	45.7	217	266	217	231	8	304.179
Case 3 - DEDLS w/LOP & No DG Failure (max SI); 2 ECUs & 2 CS	45.2	210	265	210	231	8	304.179
Case 4 - DESLS w/LOP & DG Failure (min SI); 2 ECUs & 1 CS	41.6	152	262	41	248	22	294.235
Case 5 - DESLS w/LOP & No DG Failure (max SI); 4 ECUs & 1 CS	41.4	143	262	41	248	20	294.235
Case 6 - DESLS w/LOP & No DG Failure (max SI); 2 ECUs & 2 CS	41.2	141	261	36	248	20	294.235
Case 7 - DEHLS w/LOP & DG Failure (min SI); 2 ECUs & 1 CS	45.8	11	268	12	261	290	309.664
Case 8 - DEHLS w/LOP & No DG Failure (max SI); 4 ECUs & 1 CS	45.8	11	268	12	264	175	309.664
Case 9 - DEHLS w/LOP & No DG Failure (max SI); 2 ECUs & 2 CS	45.8	11	268	12	263	165	309.664

* Values from Reference 6.2a

FIGURE 2.1.1-1

DEDLS LOCA @ 102% POWER W/LOP
CONTAINMENT PRESSURE

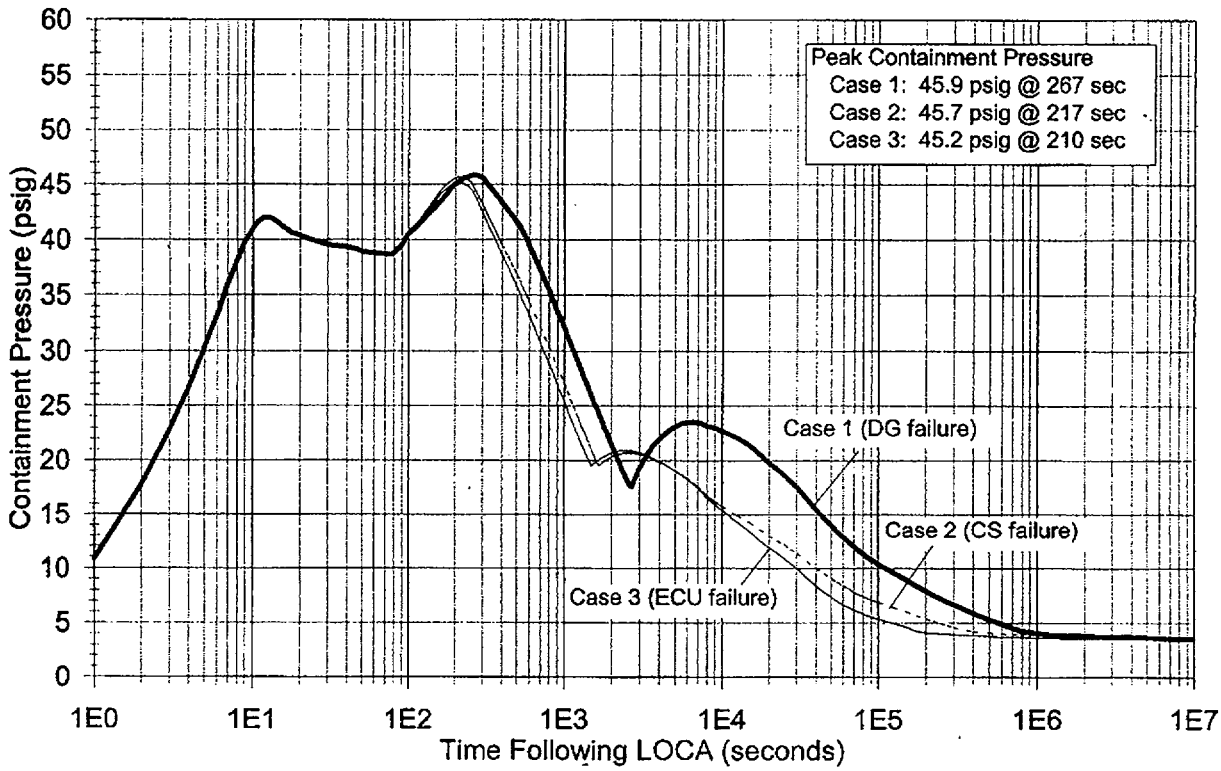


FIGURE 2.1.1-2

DESLS LOCA @ 102% POWER W/LOP
CONTAINMENT PRESSURE

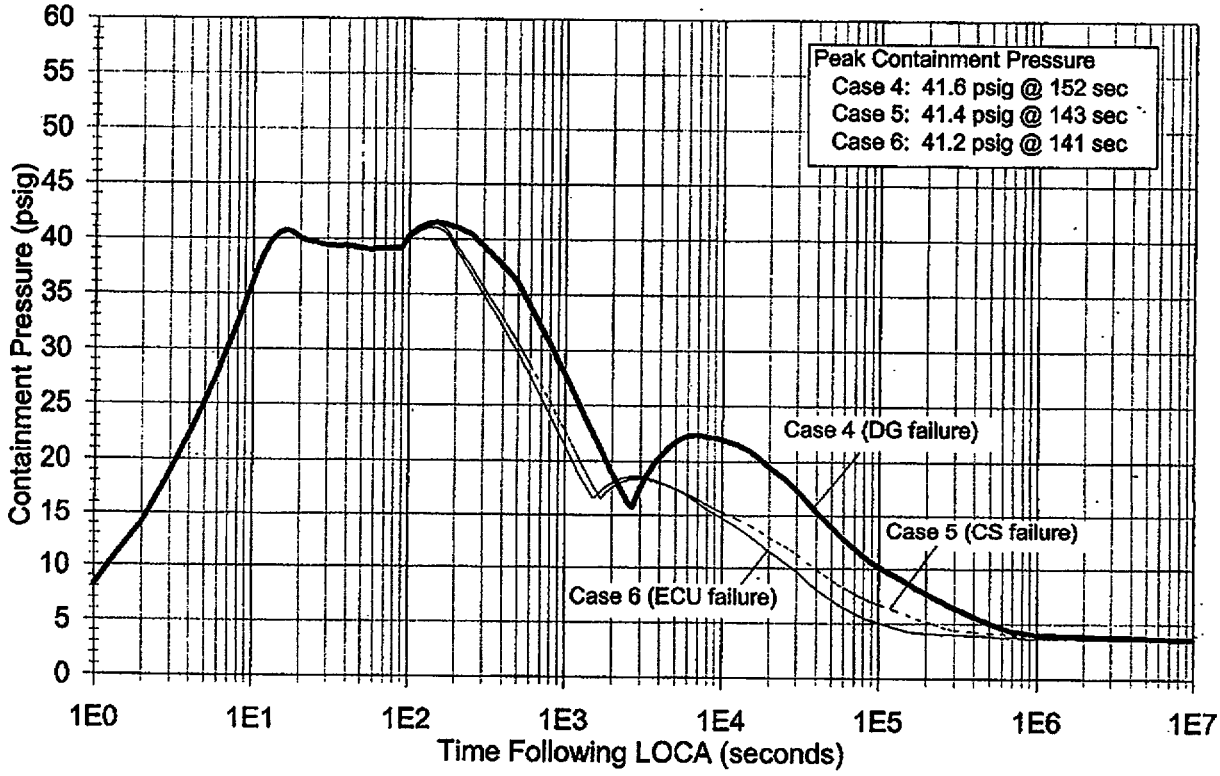


FIGURE 2.1.1-3

DEHLS LOCA @ 102% POWER W/LOP
CONTAINMENT PRESSURE

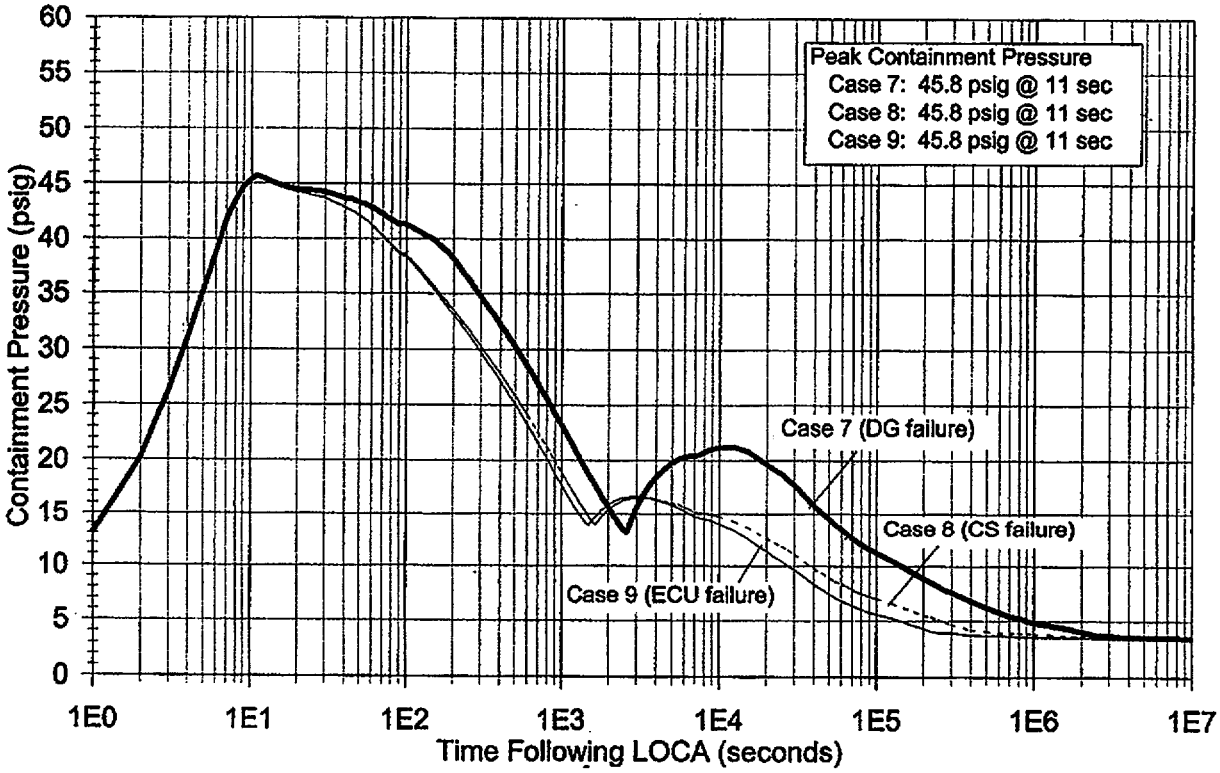


FIGURE 2.1.1-4

DEDLS LOCA @ 102% POWER W/LOP
CONTAINMENT VAPOR TEMPERATURE

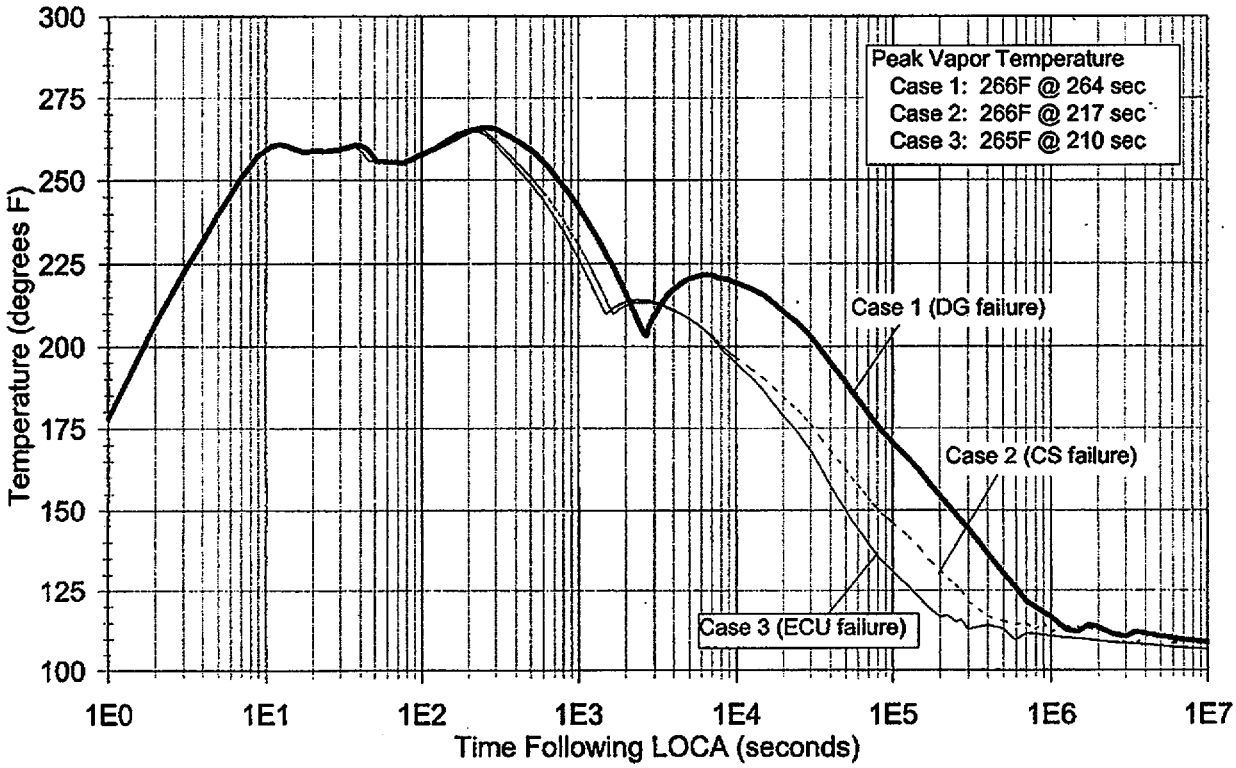


FIGURE 2.1.1-5

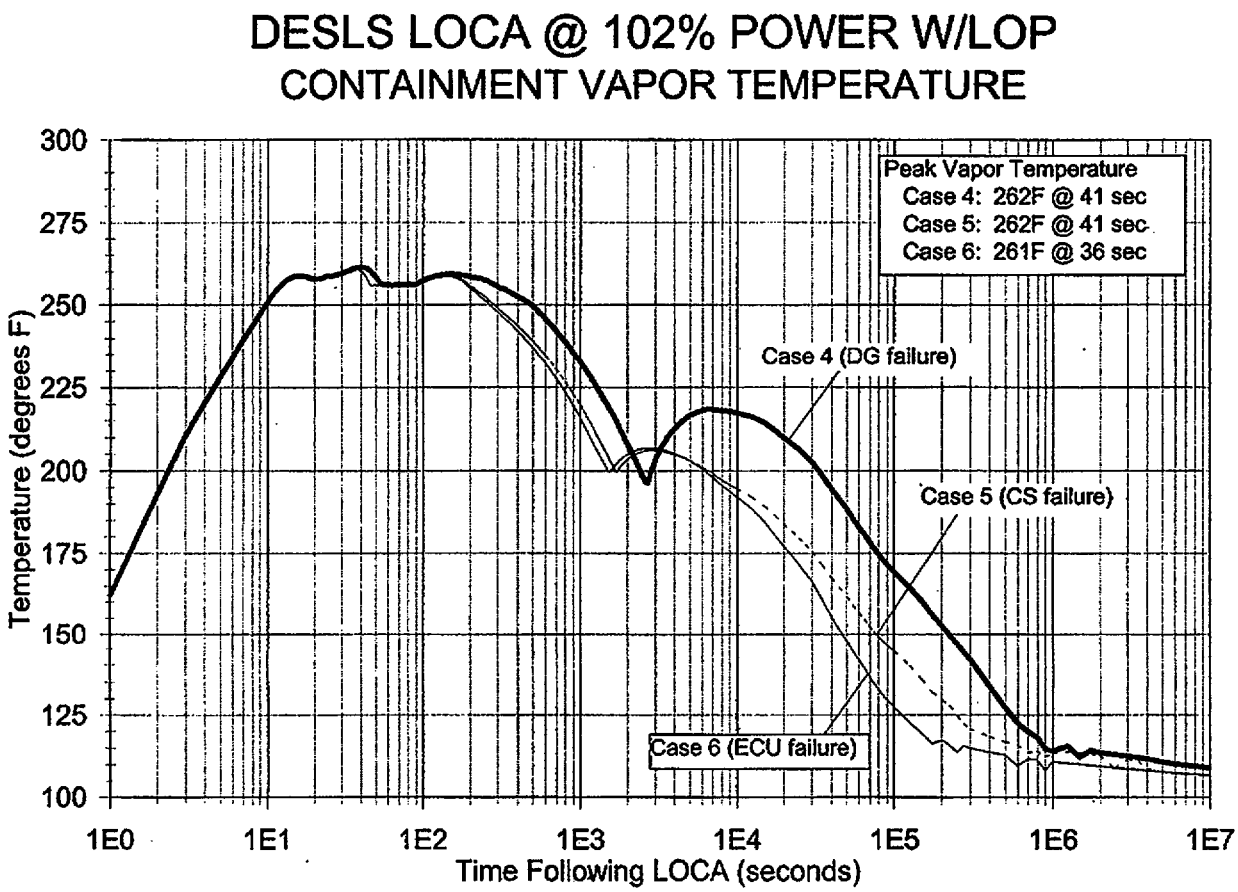

DESLS LOCA @ 102% POWER W/LOP
CONTAINMENT VAPOR TEMPERATURE
Peak Vapor Temperature
Case 4: 262F @ 41 sec
Case 5: 262F @ 41 sec
Case 6: 261F @ 36 sec
Case 4 (DG failure)
Case 5 (CS failure)
Case 6 (ECU failure)
Temperature (degrees F)
300
275
250
225
200
175
150
125
100
1E0
1E1
1E2
1E3
1E4
1E5
1E6
1E7
Time Following LOCA (seconds)

FIGURE 2.1.1-6

DEHLS LOCA @ 102% POWER W/LOP
CONTAINMENT VAPOR TEMPERATURE

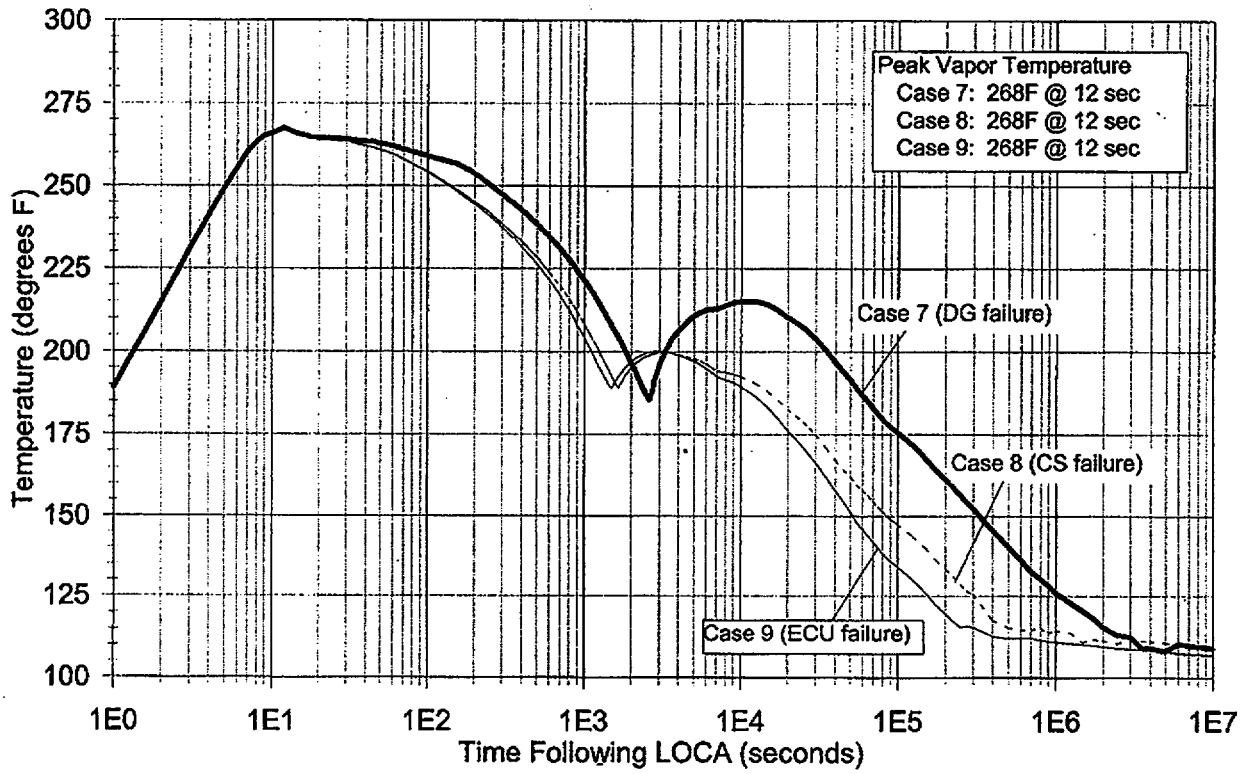


FIGURE 2.1.1-7

DEDLS LOCA @ 102% POWER W/LOP
CONTAINMENT SUMP WATER TEMPERATURE

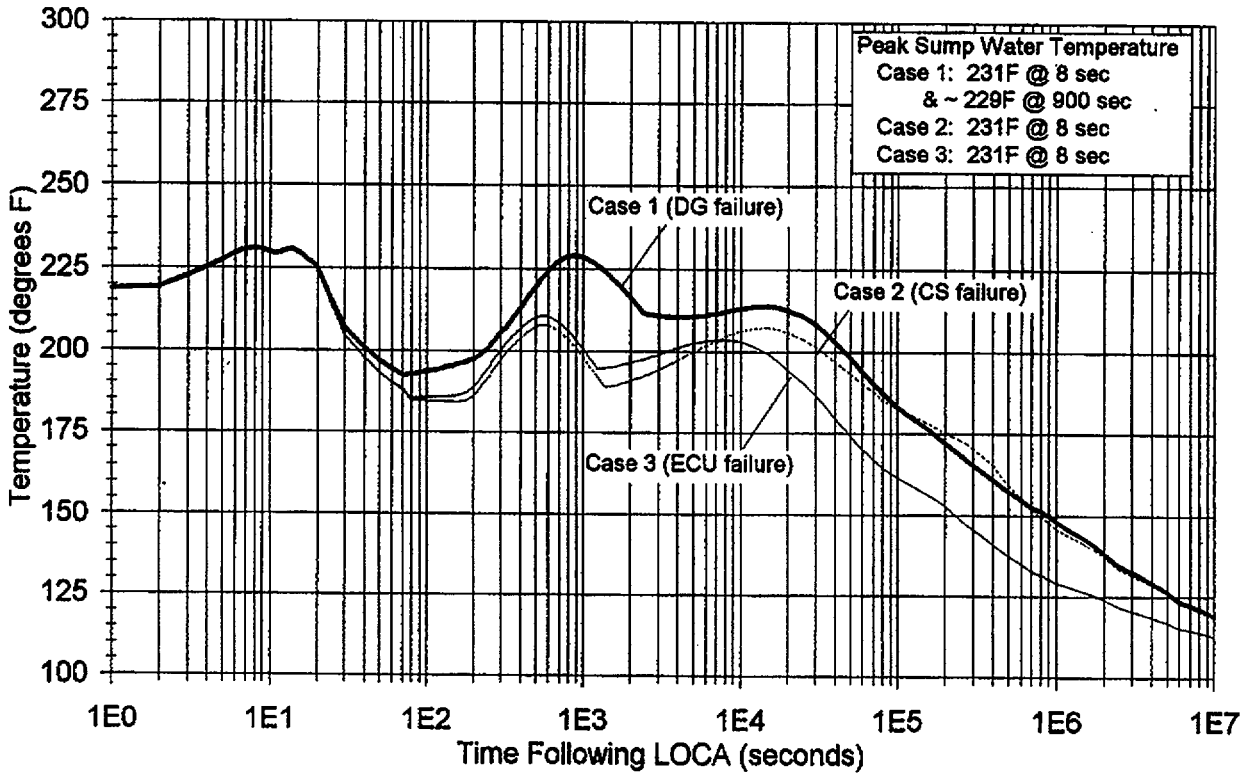


FIGURE 2.1.1-8

DESLS LOCA @ 102% POWER W/LOP
CONTAINMENT SUMP WATER TEMPERATURE

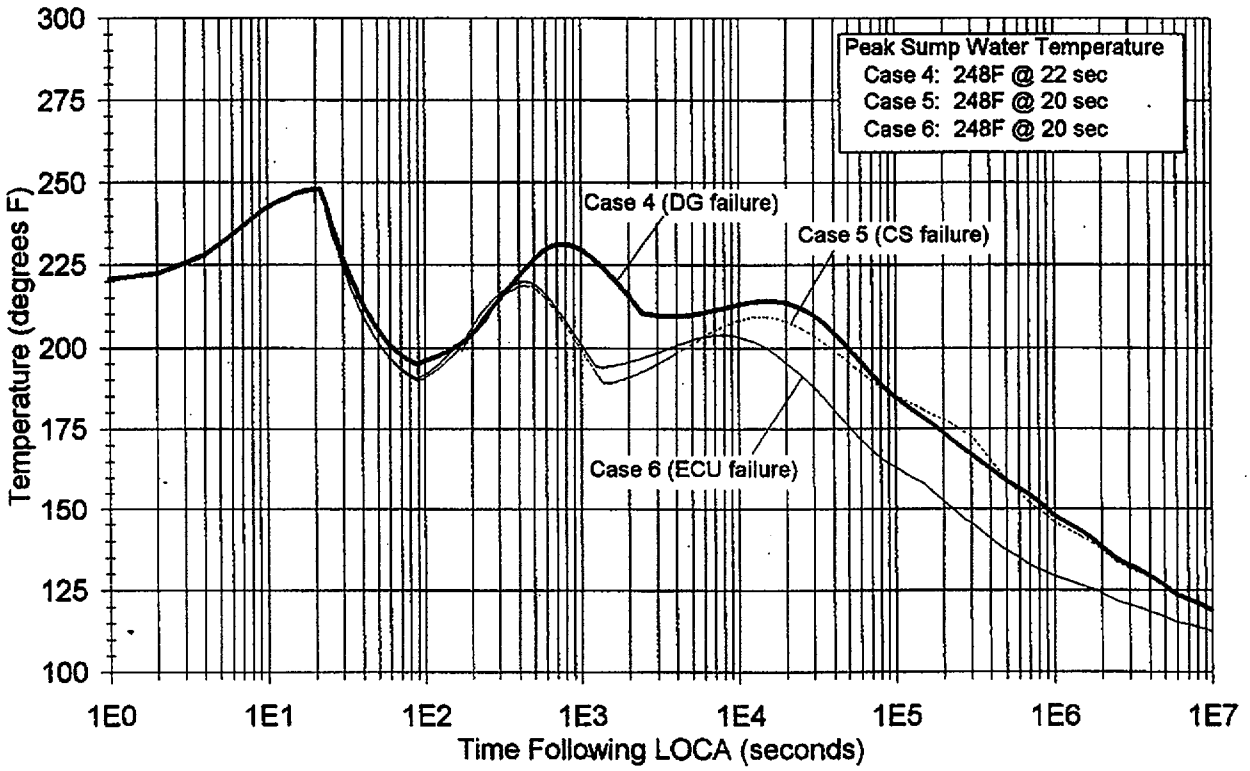


FIGURE 2.1.1-9

DEHLS LOCA @ 102% POWER W/LOP
CONTAINMENT SUMP WATER TEMPERATURE

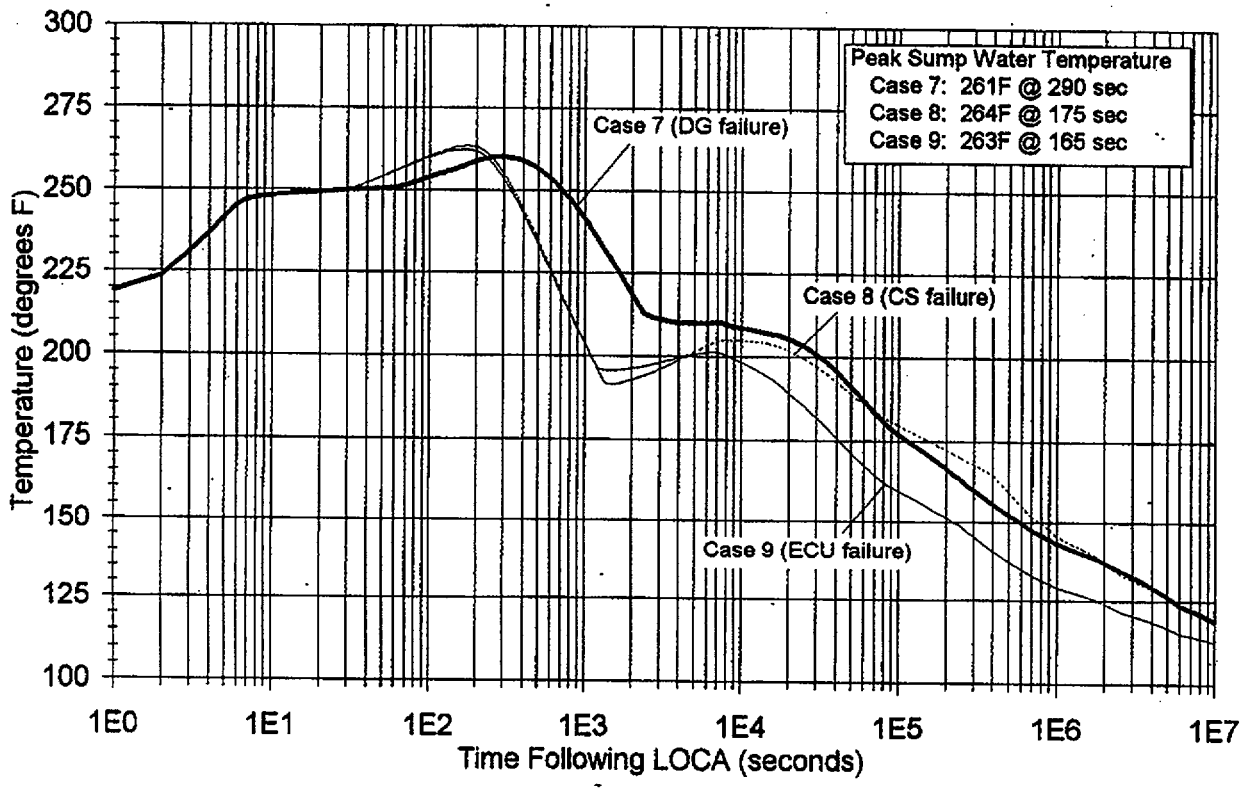


FIGURE 2.1.1-10

COMPARISON OF LOCAS W/LOP & DG FAILURE
CONTAINMENT PRESSURE

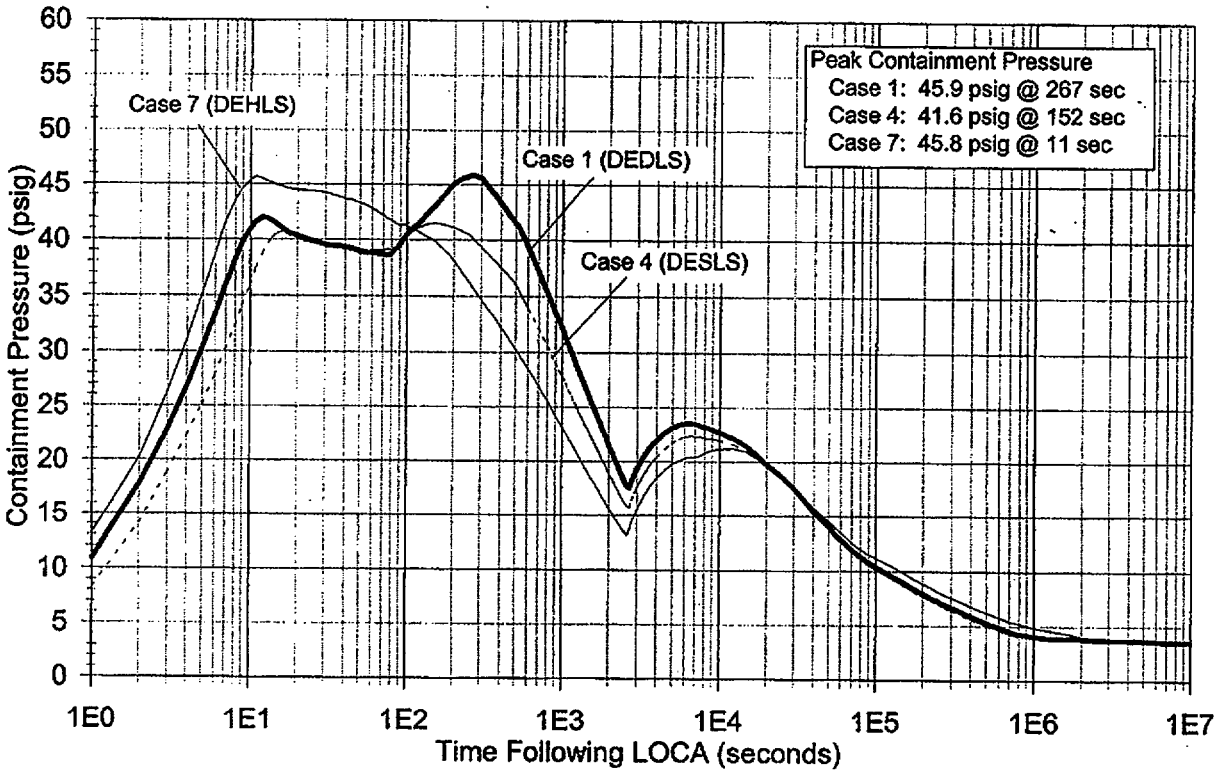


FIGURE 2.1.1-11

COMPARISON OF LOCAS W/LOP & DG FAILURE
CONTAINMENT VAPOR TEMPERATURE

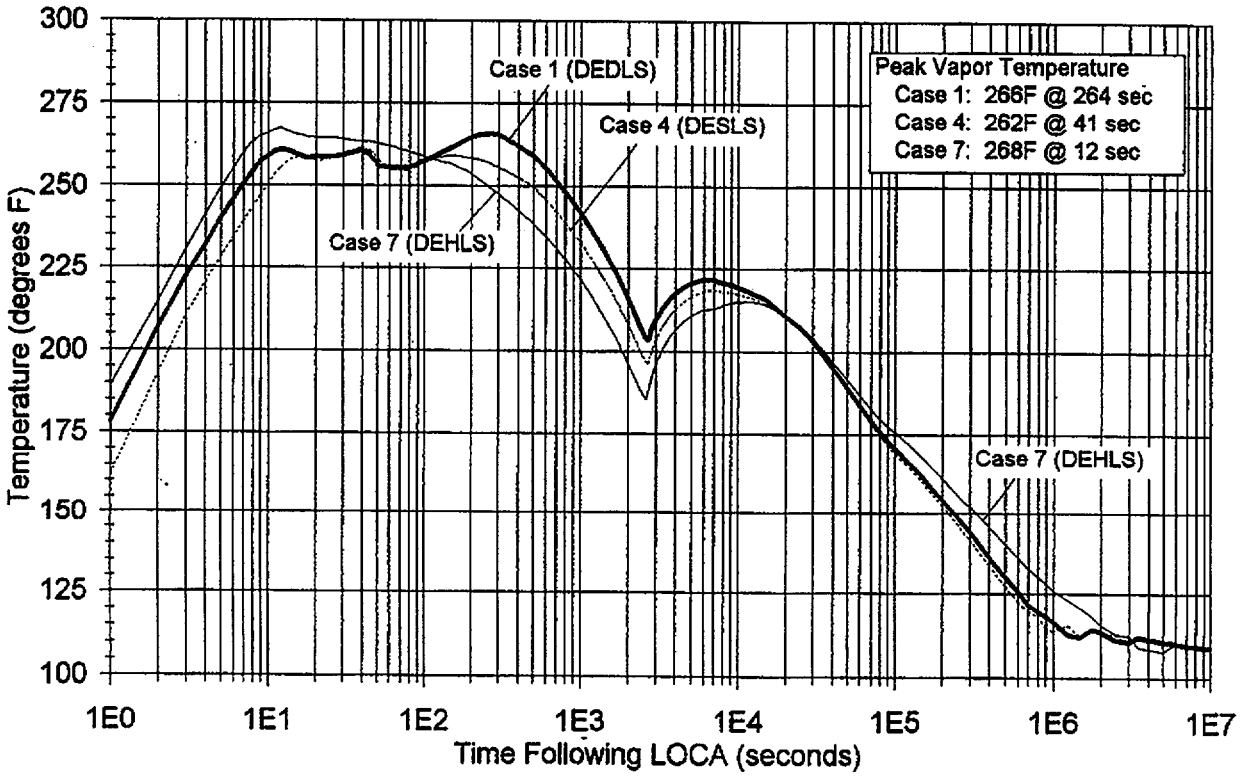
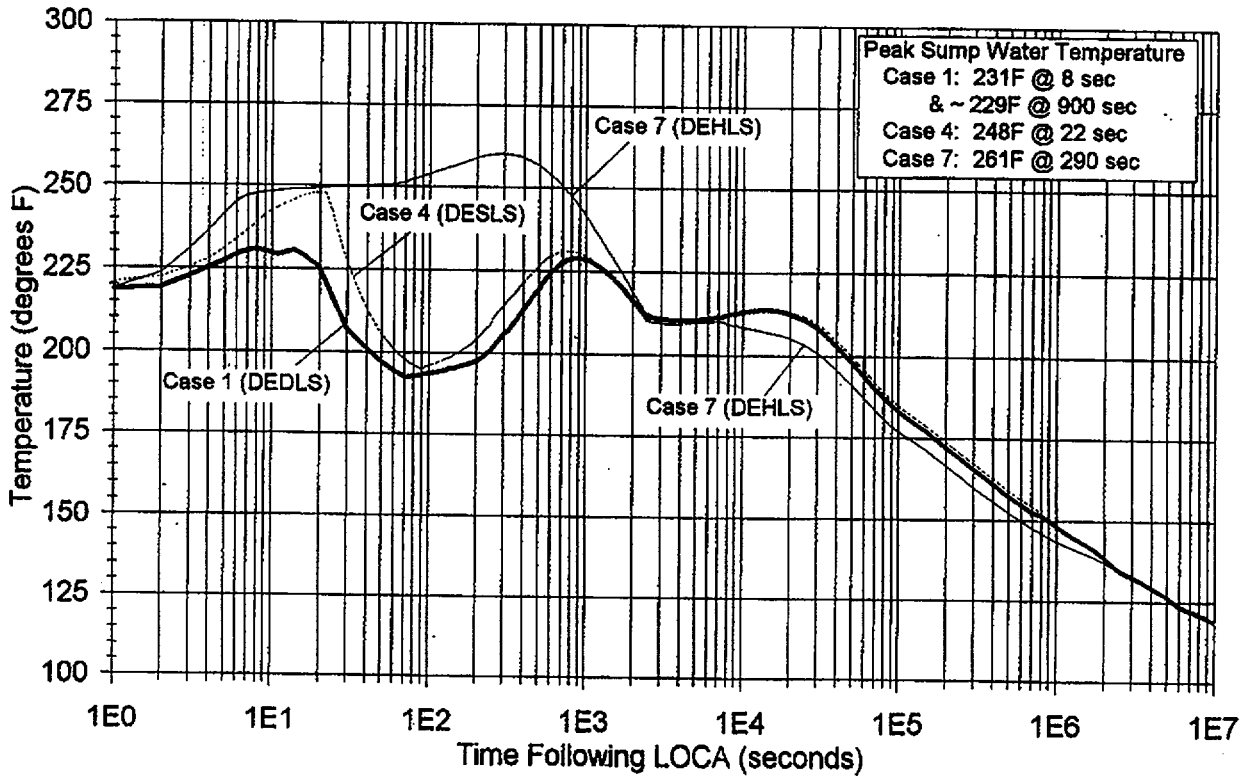


FIGURE 2.1.1-12

COMPARISON OF LOCAS W/LOP & DG FAILURE
CONTAINMENT SUMP WATER TEMPERATURE



2.1.2 Detailed Results for Bounding LOCA Events

The following three subsections present results which are specific for the bounding LOCA case for each of the three break locations. As identified in Section 2.1.1, the diesel generator single failure case is bounding at each break location.

2.1.2.1 Doubled-Ended Pump Discharge Leg Slot Break (DEDLS)

The bounding LOCA event for a large break in the pump discharge line is the DEDLS break LOCA with diesel generator failure (Case 1). For this limiting case:

Figure 2.1.2.1-1 presents the containment gauge pressure as a function of time. Table 9-1A contains the data used to prepare this figure.

Figure 2.1.2.1-2 presents the containment vapor temperature and sump water temperature as a function of time. Table 9-1A contains the data used to prepare this figure.

Figure 2.1.2.1-3 presents the containment air , steam , sump water, reactor vessel water, and total energy as a function of time. The reactor vessel water energy does not appear in the COPATTA calculation until the end of post-reflood, when the vessel boil-off calculations begin. Table 9-1B contains the data used to prepare this figure.

Figure 2.1.2.1-4 presents the energy content of the containment passive (structural) heat sinks, the integrated energy removed from the containment vapor region by the emergency air cooling units (ECUs), the energy transferred from the containment vapor region to the containment sump by the containment sprays, and the energy transferred from the containment by the shutdown heat exchanger used to cool sump water recirculated to the containment spray system all as a function of time. Table 9-1B contains the data used to prepare this figure.

Figure 2.1.2.1-5 presents the condensing heat transfer coefficient used for condensation heat transfer at the passive heat sink surfaces exposed to the containment vapor region as a function of time. Table 9-1C contains the data used to prepare this figure.

Figure 2.1.2.1-6 presents the surface temperature of a representative selection of passive heat sinks as a function of time. The specific heat sinks included in this plot are the containment liner plate (from heat sink 2); the unlined internal concrete walls (from heat sink 10); miscellaneous carbon steel with a thickness </= to 0.5 inches (from heat sink 18); and electrical hardware and other galvanized carbon steel material (from heat sink 19). Table 9-1C contains the data used to prepare this figure.

A chronology of events for the Double-Ended Discharge Leg Slot break LOCA with diesel generator failure is provided in Table 2.1.2.1-1.

FIGURE 2.1.2.1-1

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONTAINMENT PRESSURE

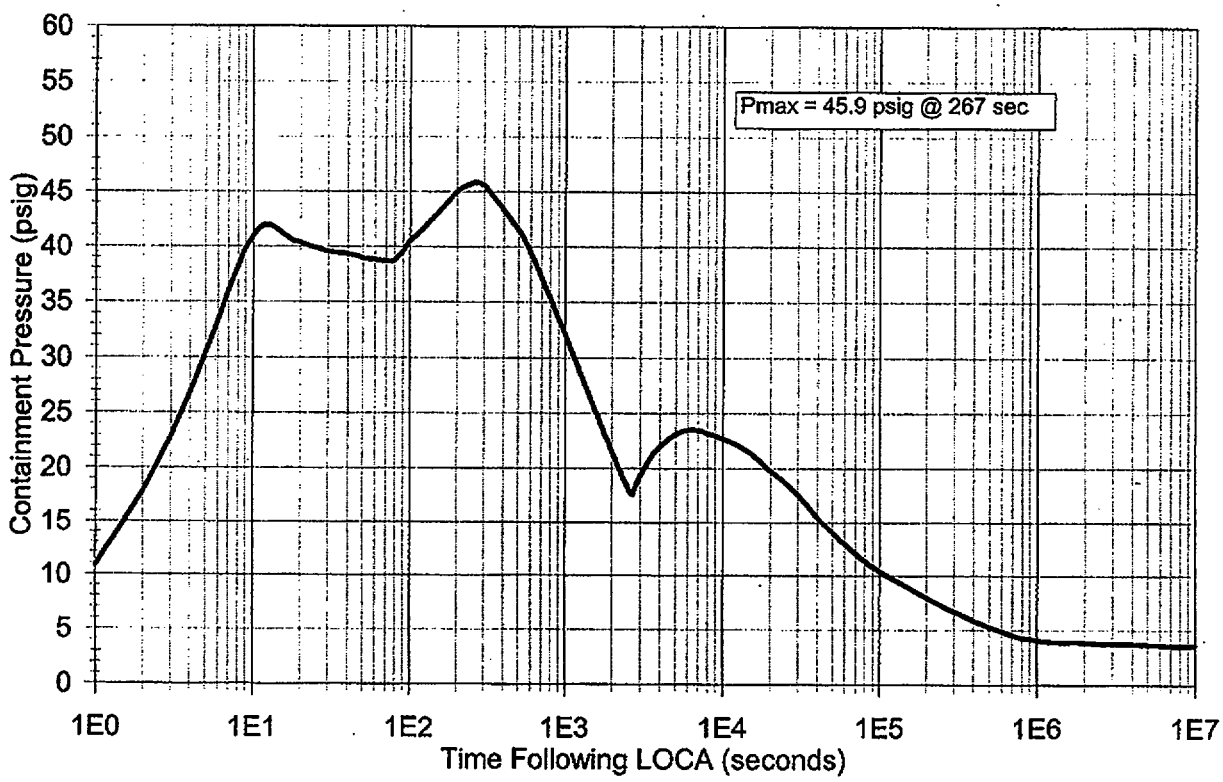


FIGURE 2.1.2.1-2

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONTAINMENT TEMPERATURES

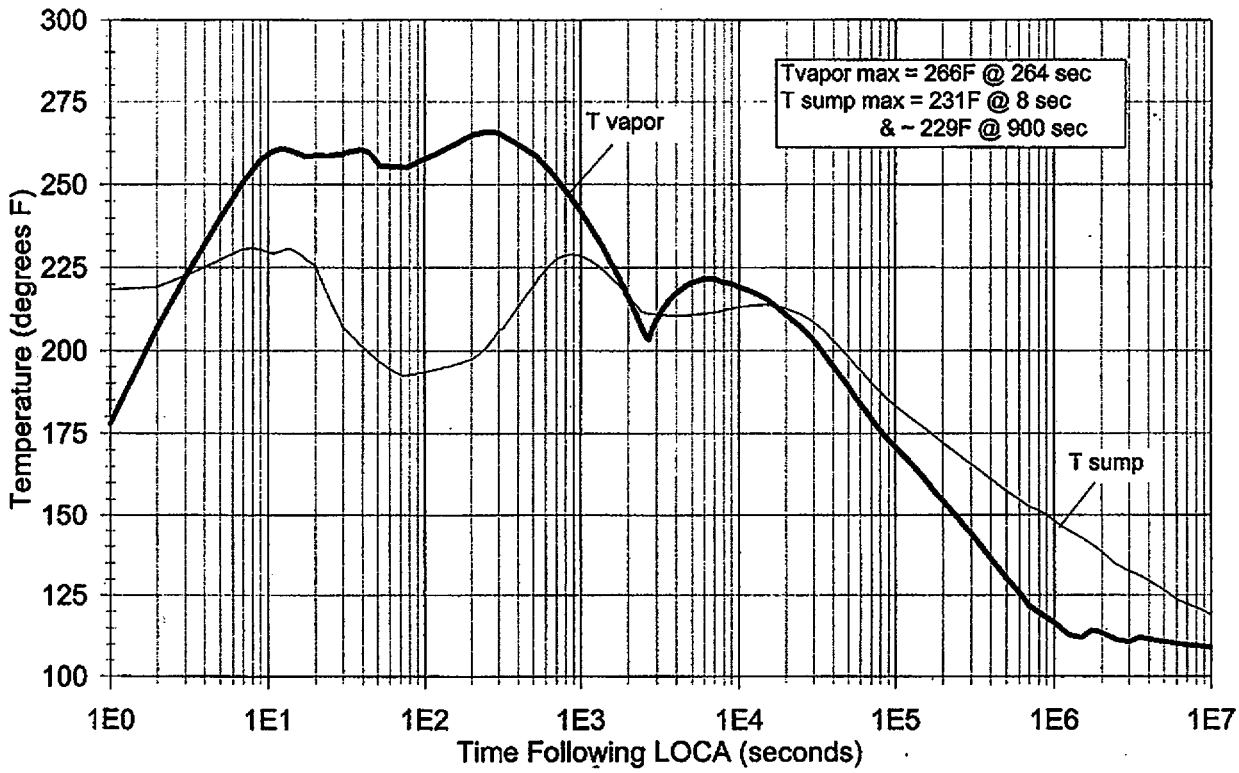


FIGURE 2.1.2.1-3

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

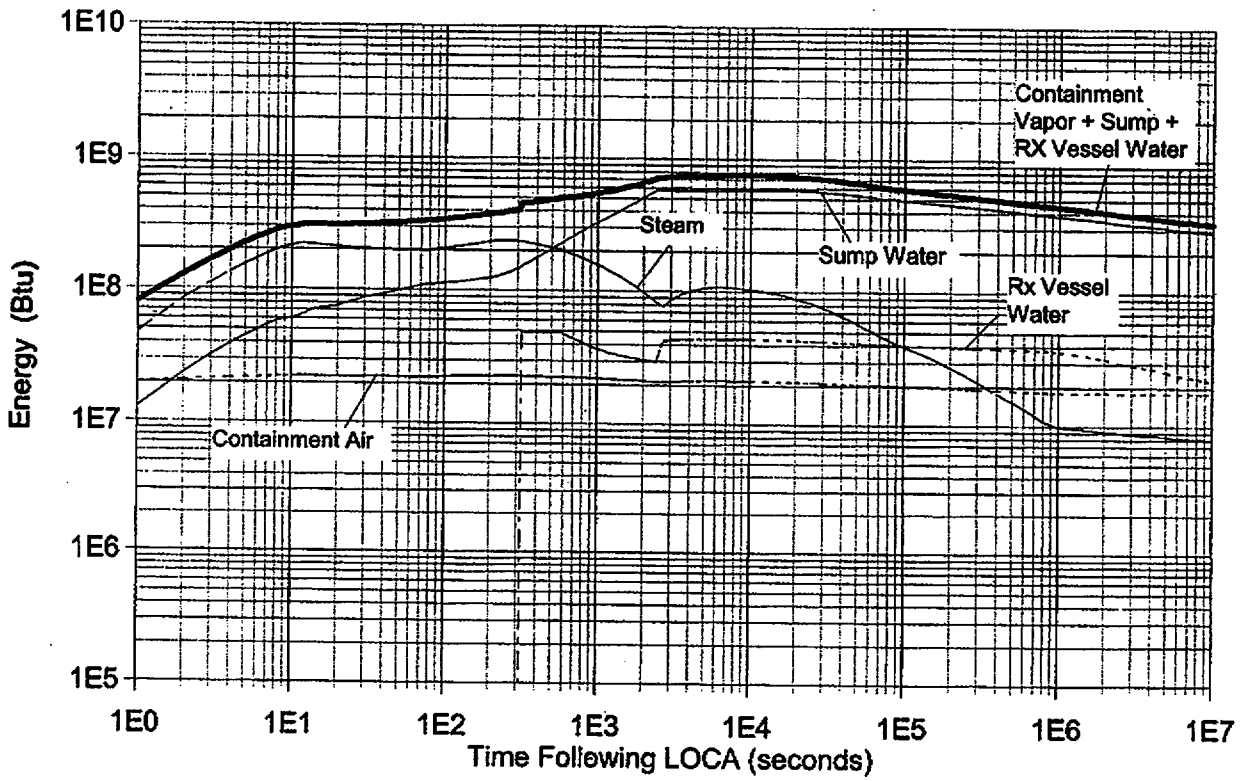


FIGURE 2.1.2.1-4

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

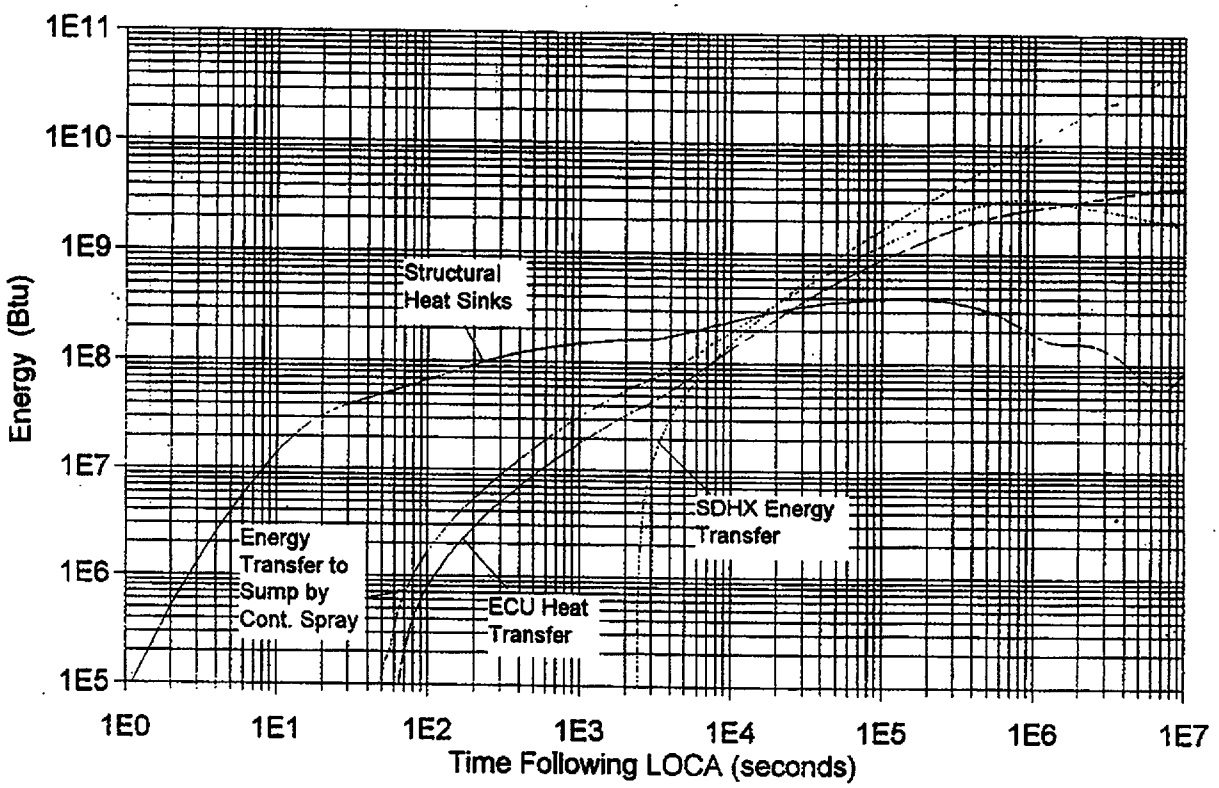


FIGURE 2.1.2.1-5

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
CONDENSING HEAT-TRANSFER COEFFICIENT

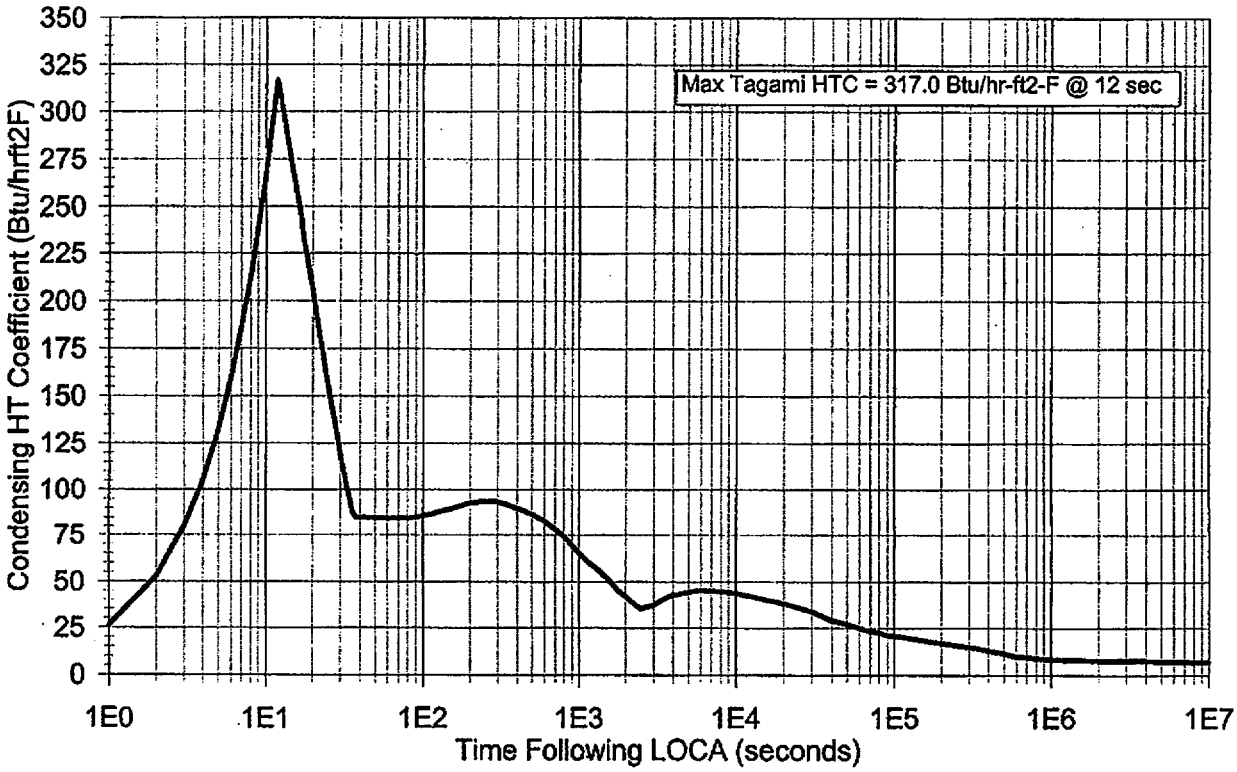


FIGURE 2.1.2.1-6

CASE 1 - DEDLS LOCA W/LOP & DG FAILURE
HEAT SINK SURFACE TEMPERATURES

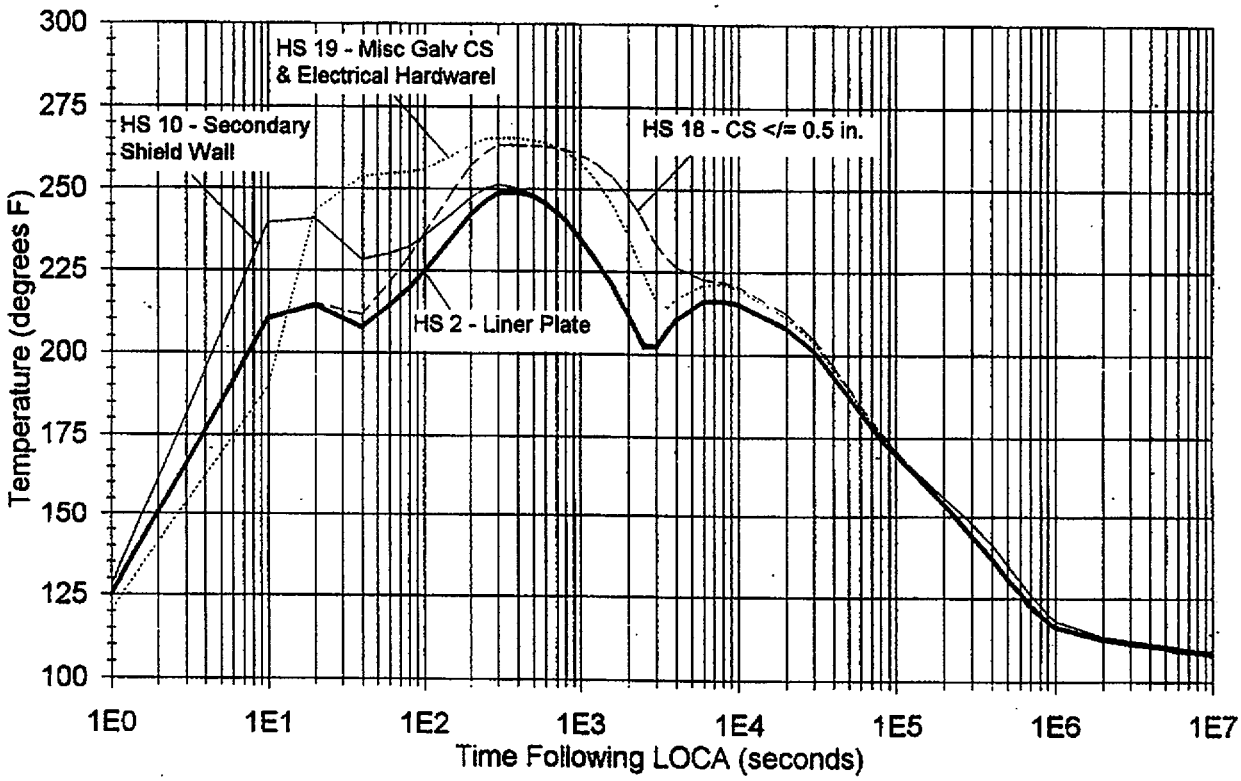


Table 2.1.2.1-1
Chronology of Events for DEDLS Break LOCA
With Diesel Generator Failure
(Case 1)

Time (seconds)	Event
0.0	Break occurs
12	Peak containment pressure during blowdown (42.0 psig)
14.8	End blowdown mass-energy release
14.8	Start pumped safety injection flow
33	Start containment spray injection
60	Containment spray reaches full flow
60	Containment emergency air cooling units in operation
220	End core reflood & start post-reflood
264	Peak containment vapor temperature (266°F)
267	Peak containment pressure (45.9 psig)
310.66	End post-reflood
350	Peak containment liner plate temperature (250°F)
2437	End ECCS injection phase and start ECCS recirculation phase
7200	High pressure safety injection (HPSI) realigned for 50:50 split between hot and cold leg injection
$1x10^7$	End COPATTA analysis

2.1.2.2 Double-Ended Pump Suction Leg Slot Break (DESLS)

The bounding LOCA event for a large break in the pump suction line is the DESLS break LOCA with diesel generator failure (Case 4). For this limiting case:

Figure 2.1.2.2-1 presents the containment gauge pressure as a function of time. Table 9-4A contains the data used to prepare this figure.

Figure 2.1.2.2-2 presents the containment vapor temperature and sump water temperature as a function of time. Table 9-4A contains the data used to prepare this figure.

Figure 2.1.2.2-3 presents the containment air , steam , sump water, reactor vessel water, and total energy as a function of time. The reactor vessel water energy does not appear in the COPATTA calculation until the end of post-reflood, when the vessel boil-off calculations begin. Table 9-4B contains the data used to prepare this figure.

Figure 2.1.2.2-4 presents the energy content of the containment passive (structural) heat sinks, the integrated energy removed from the containment vapor region by the emergency air cooling units (ECUs), the energy transferred from the containment vapor region to the containment sump by the containment sprays, and the energy transferred from the containment by the shutdown heat exchanger used to cool sump water recirculated to the containment spray system all as a function of time. Table 9-4B contains the data used to prepare this figure.

Figure 2.1.2.2-5 presents the condensing heat transfer coefficient used for condensation heat transfer at the passive heat sink surfaces exposed to the containment vapor region as a function of time. Table 9-4C contains the data used to prepare this figure.

Figure 2.1.2.2-6 presents the surface temperature of a representative selection of passive heat sinks as a function of time. The specific heat sinks included in this plot are the containment liner plate (from heat sink 2); the unlined internal concrete walls (from heat sink 10); miscellaneous carbon steel with a thickness </= to 0.5 inches (from heat sink 18); and electrical hardware and other galvanized carbon steel material (from heat sink 19). Table 9-4C contains the data used to prepare this figure.

A chronology of events for the Double-Ended Suction Leg Slot break LOCA with diesel generator failure is provided in Table 2.1.2.2-1.

FIGURE 2.1.2.2-1

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
CONTAINMENT PRESSURE

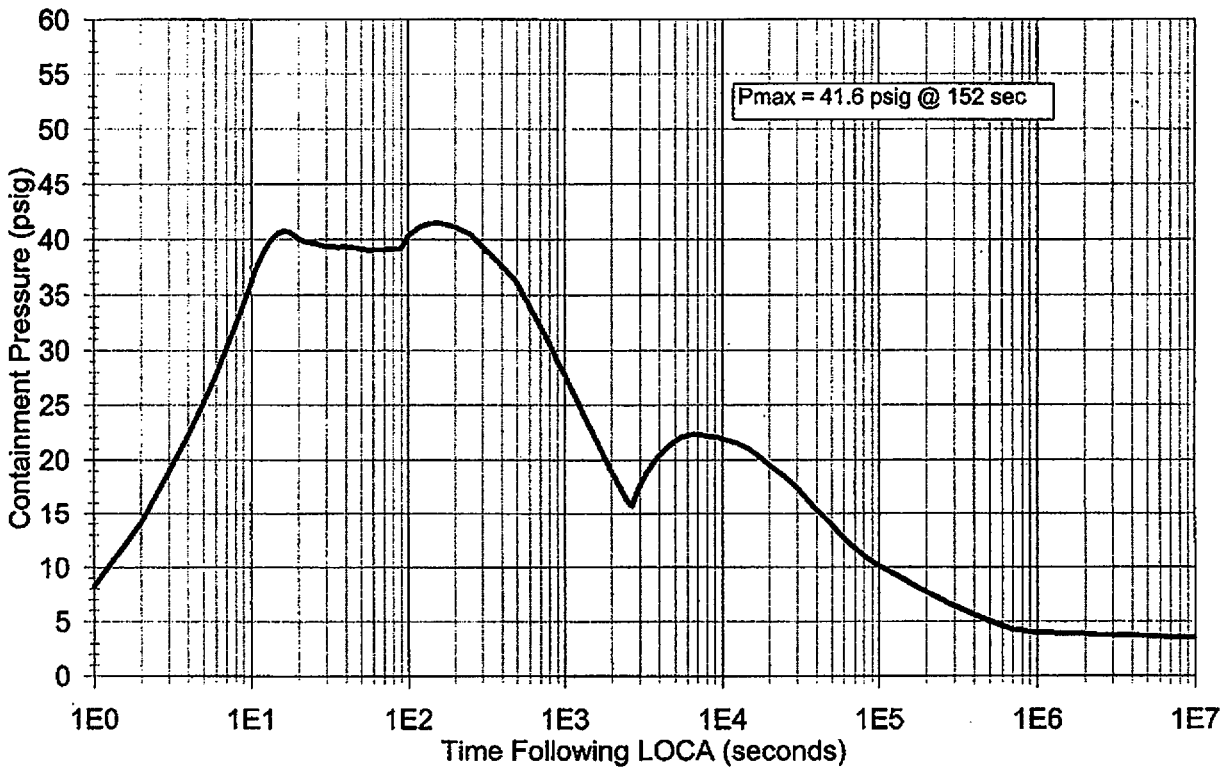


FIGURE 2.1.2.2-2

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
CONTAINMENT TEMPERATURES

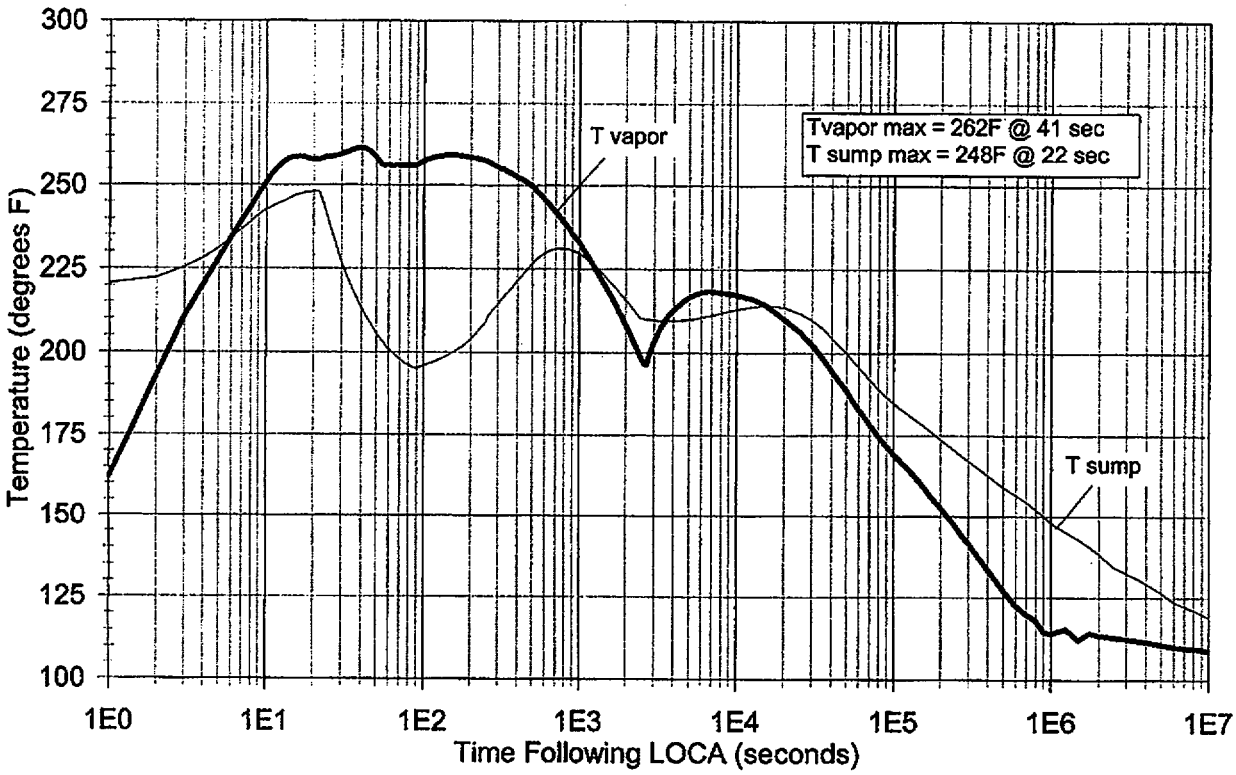


FIGURE 2.1.2.2-3

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

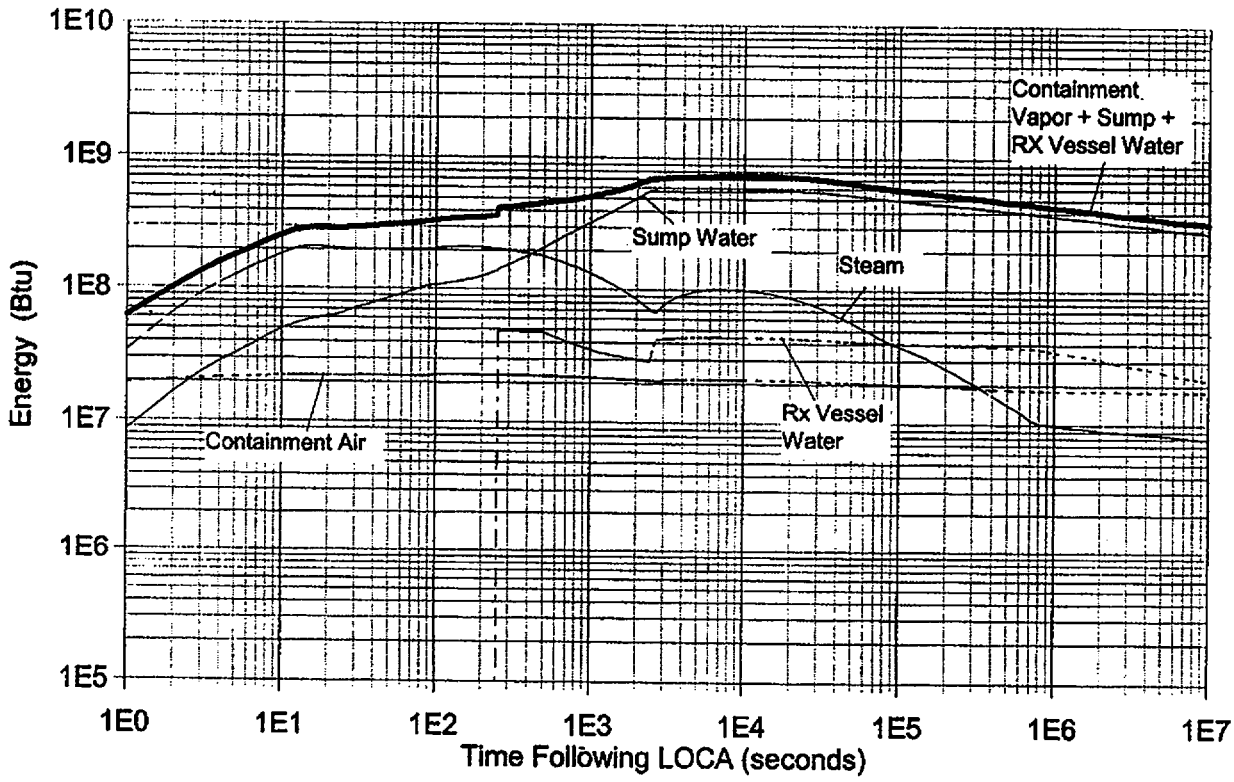


FIGURE 2.1.2.2-4

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

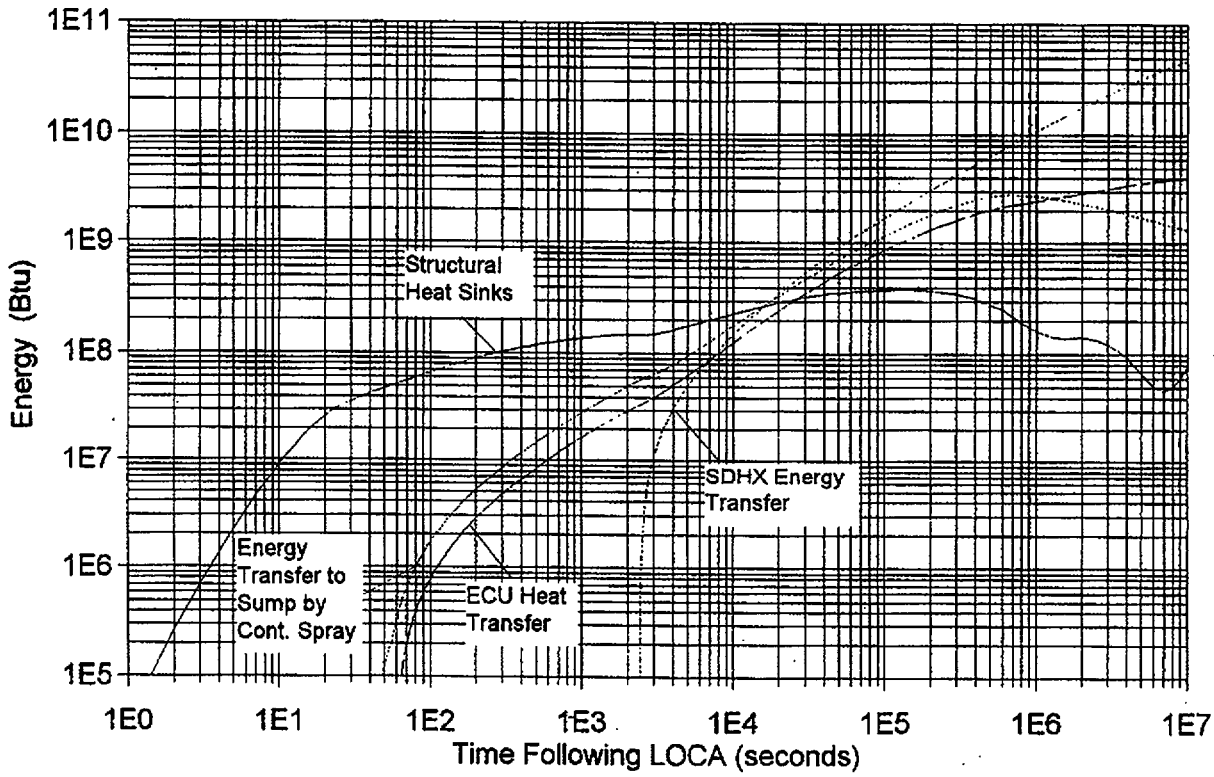


FIGURE 2.1.2.2-5

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
CONDENSING HEAT-TRANSFER COEFFICIENT

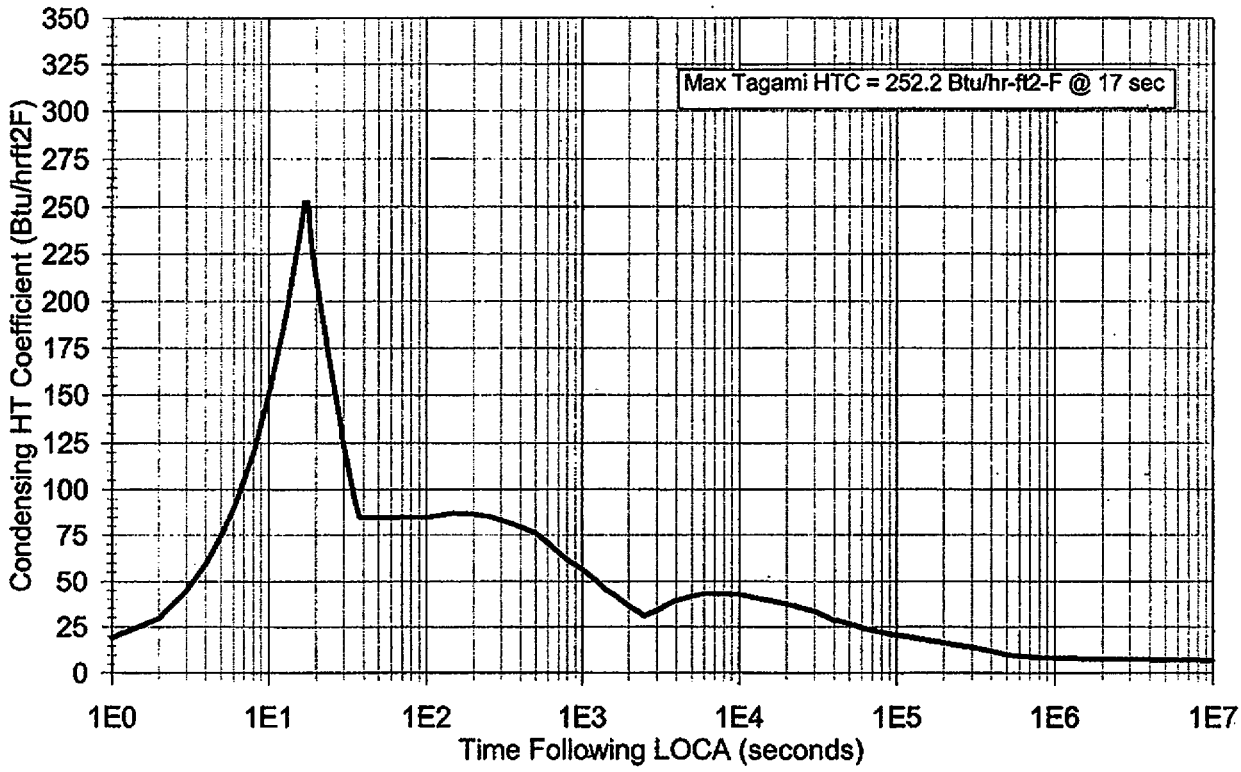


FIGURE 2.1.2.2-6

CASE 4 - DESLS LOCA W/LOP & DG FAILURE
HEAT SINK SURFACE TEMPERATURES

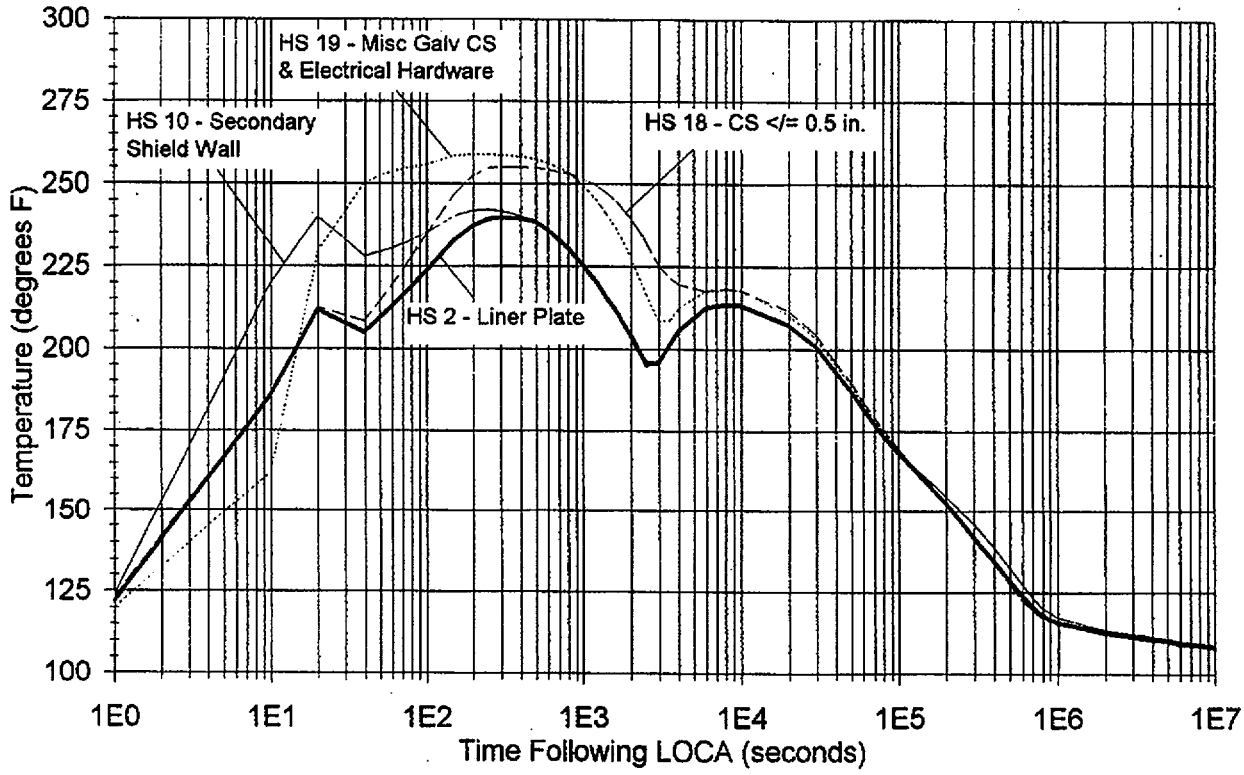


Table 2.1.2.2-1
Chronology of Events for DESLS Break LOCA
With Diesel Generator Failure
(Case 4)

Time (seconds)	Event
0.0	Break occurs
17	Peak containment pressure during blowdown (40.7 psig)
18.4	End blowdown mass-energy release
18.4	Start pumped safety injection flow
33	Start containment spray injection
41	Peak containment vapor temperature (262°F)
60	Containment spray reaches full flow
60	Containment emergency air cooling units in operation
152	Peak containment pressure (41.6 psig)
177.7	End core reflood & start post-reflood
253.51	End post-reflood
300	Peak containment liner plate temperature (240°F)
2437	End ECCS injection phase and start ECCS recirculation phase
7200	High pressure safety injection (HPSI) realigned for 50:50 split between hot and cold leg injection
$1x10^7$	End COPATTA analysis

2.1.2.3 Double-Ended Hot Leg Slot Break (DEHLS)

The bounding LOCA event for a large break in the RCS hot leg is the DEHLS break LOCA with diesel generator failure (Case 7). For this limiting case:

Figure 2.1.2.3-1 presents the containment gauge pressure as a function of time. Table 9-7A contains the data used to prepare this figure.

Figure 2.1.2.3-2 presents the containment vapor temperature and sump water temperature as a function of time. Table 9-7A contains the data used to prepare this figure.

Figure 2.1.2.3-3 presents the containment air, steam, sump water, reactor vessel water, and total energy as a function of time. Since reflood and post-reflood analyses are not provided by ABB-CE for the hot leg LOCA, COPATTA calculations of reactor vessel boil-off start following the end of blowdown at 12.2 seconds, and reactor vessel water energy appears in the output at that time. Table 9-7B contains the data used to prepare this figure.

Figure 2.1.2.3-4 presents the energy content of the containment passive (structural) heat sinks, the integrated energy removed from the containment vapor region by the emergency air cooling units (ECUs), the energy transferred from the containment vapor region to the containment sump by the containment sprays, and the energy transferred from the containment by the shutdown heat exchanger used to cool sump water recirculated to the containment spray system all as a function of time. Table 9-7B contains the data used to prepare this figure.

Figure 2.1.2.3-5 presents the condensing heat transfer coefficient used for condensation heat transfer at the passive heat sink surfaces exposed to the containment vapor region as a function of time. Table 9-7C contains the data used to prepare this figure.

Figure 2.1.2.3-6 presents the surface temperature of a representative selection of passive heat sinks as a function of time. The specific heat sinks included in this plot are the containment liner plate (from heat sink 2); the unlined internal concrete walls (from heat sink 10); miscellaneous carbon steel with a thickness </= to 0.5 inches (from heat sink 18); and electrical hardware and other galvanized carbon steel material (from heat sink 19). Table 9-7C contains the data used to prepare this figure.

A chronology of events for the Double-Ended Hot Leg Slot break LOCA with diesel generator failure is provided in Table 2.1.2.3-1.

FIGURE 2.1.2.3-1

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
CONTAINMENT PRESSURE

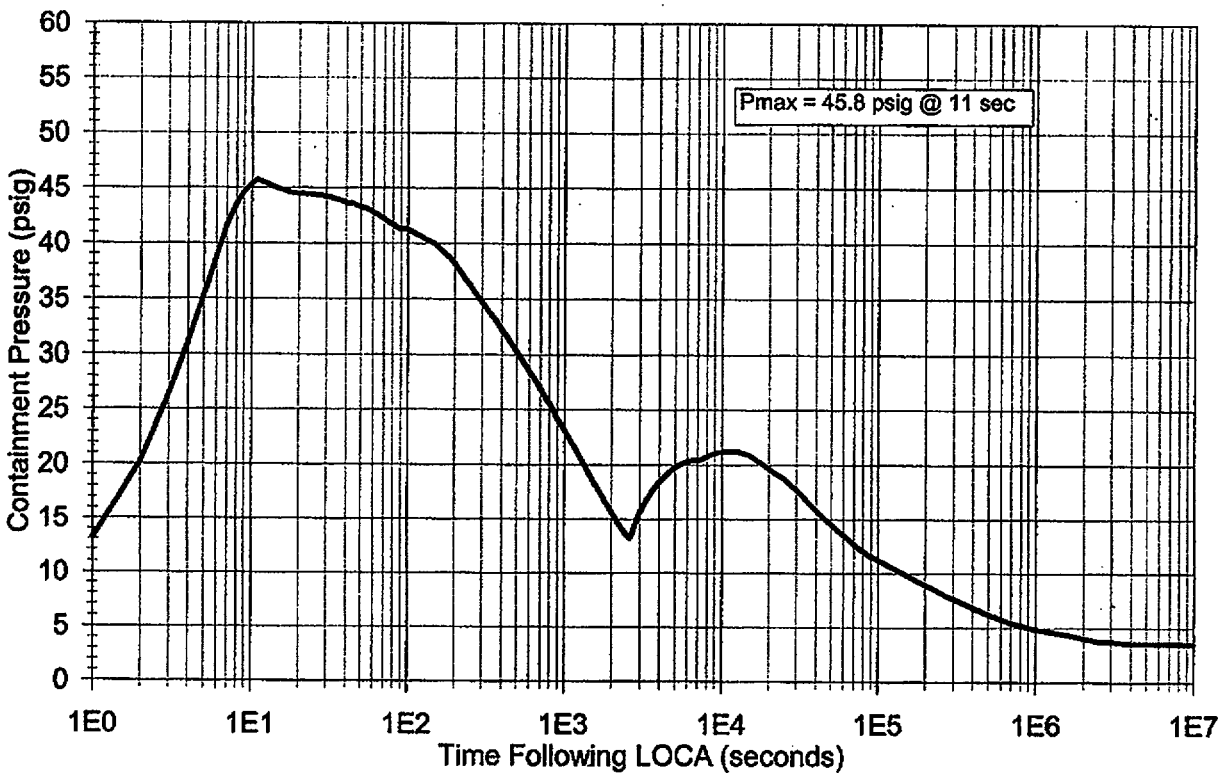


FIGURE 2.1.2.3-2

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
CONTAINMENT TEMPERATURES

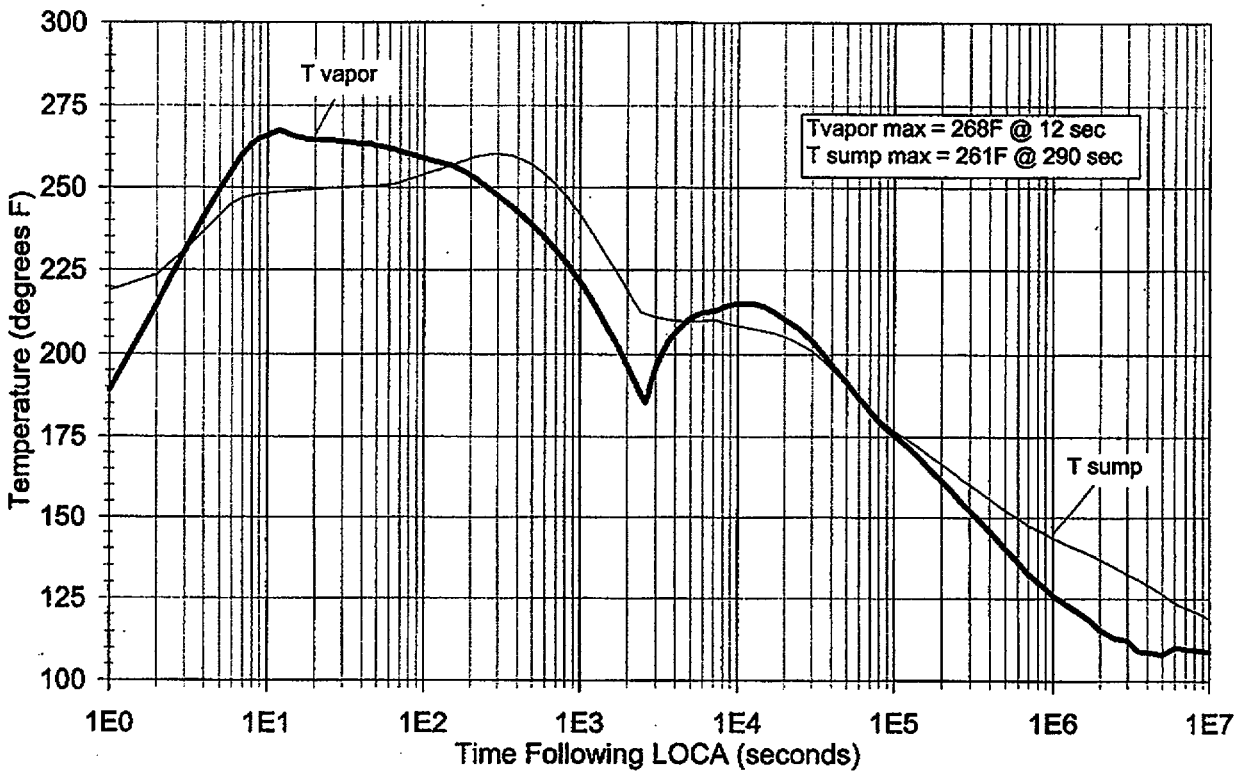


FIGURE 2.1.2.3-3

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

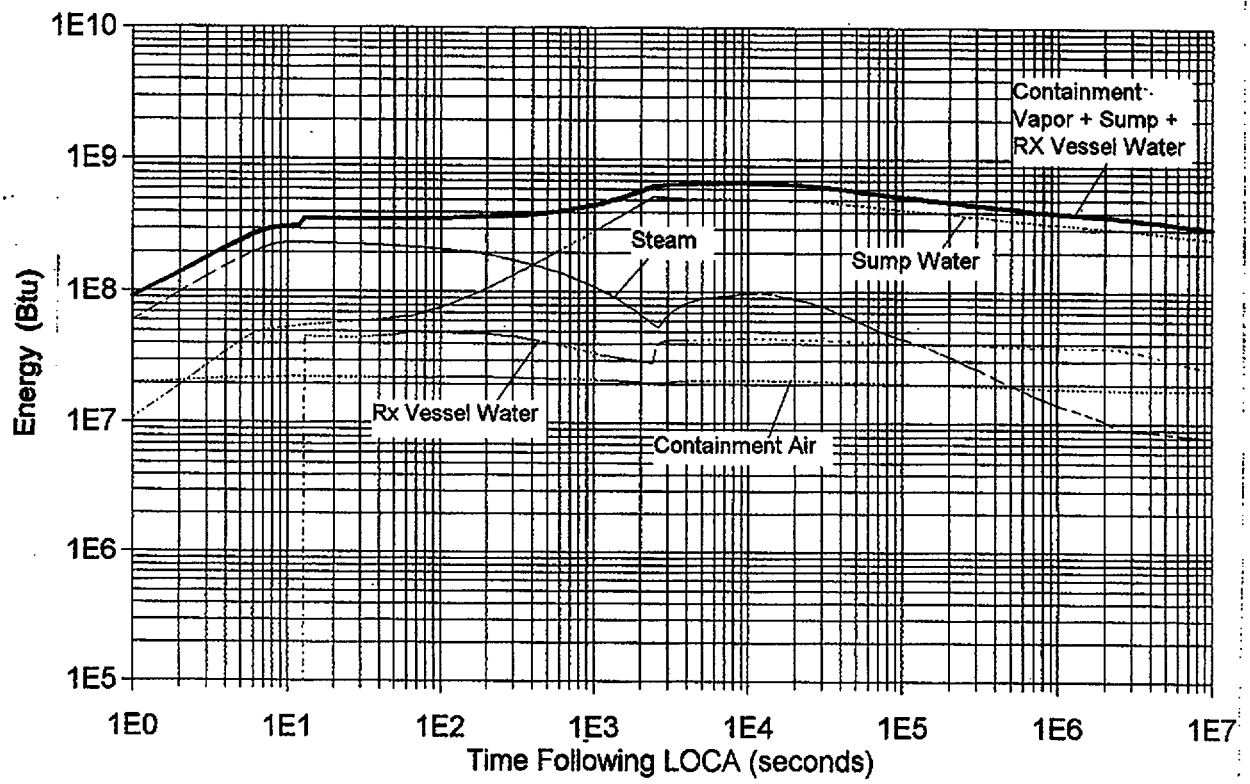


FIGURE 2.1.2.3-4

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
CONTAINMENT ENERGY DISTRIBUTION

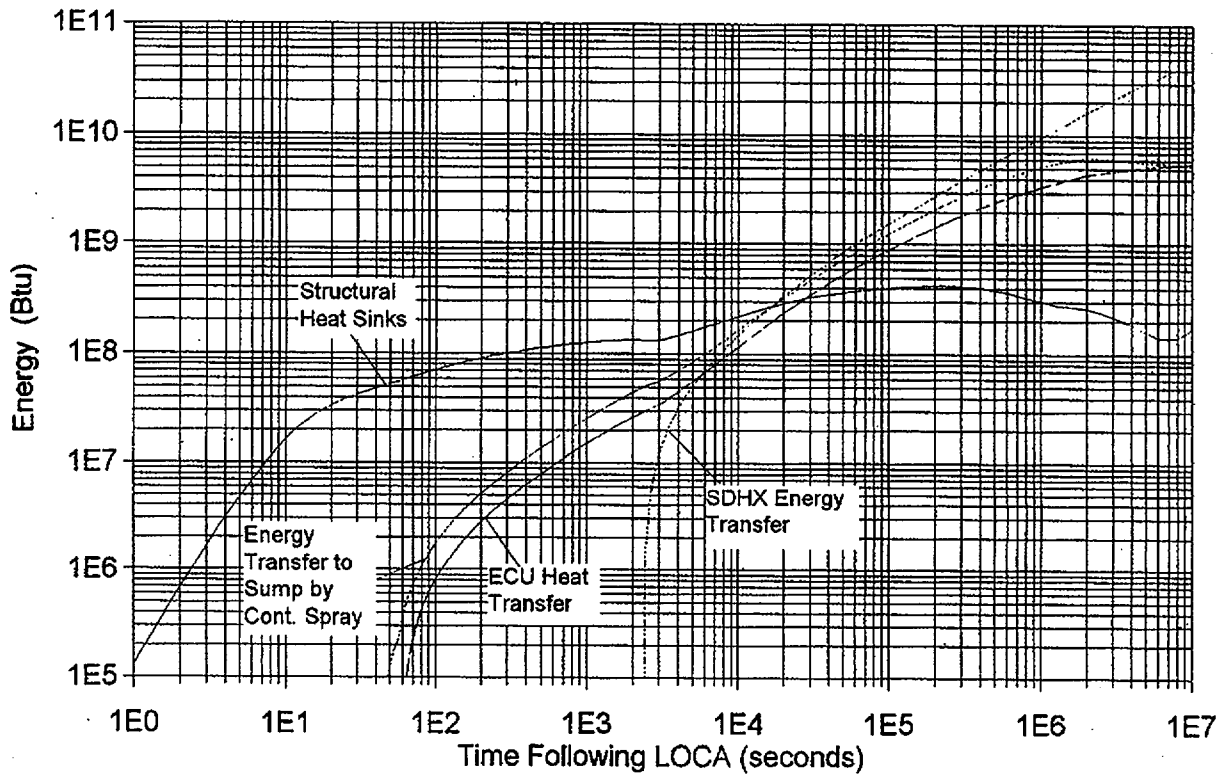


FIGURE 2.1.2.3-5

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
CONDENSING HEAT-TRANSFER COEFFICIENT

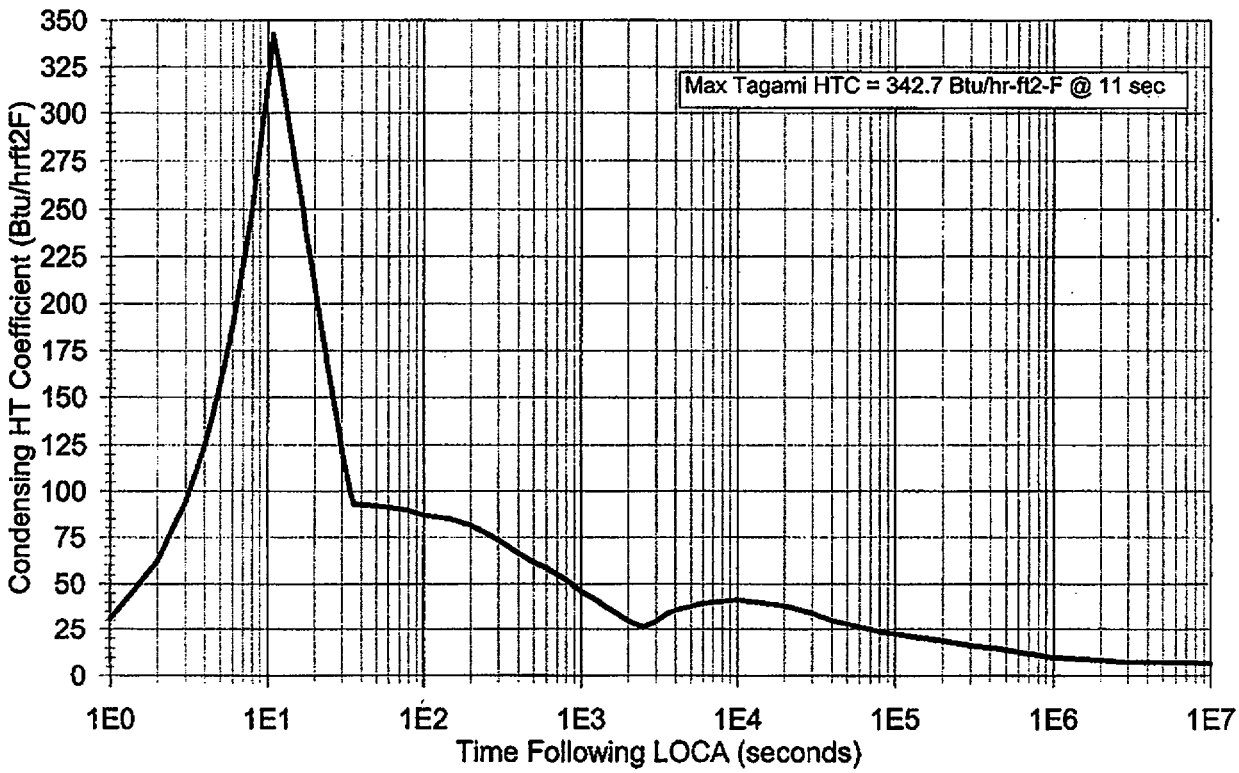


FIGURE 2.1.2.3-6

CASE 7 - DEHLS LOCA W/LOP & DG FAILURE
HEAT SINK SURFACE TEMPERATURES

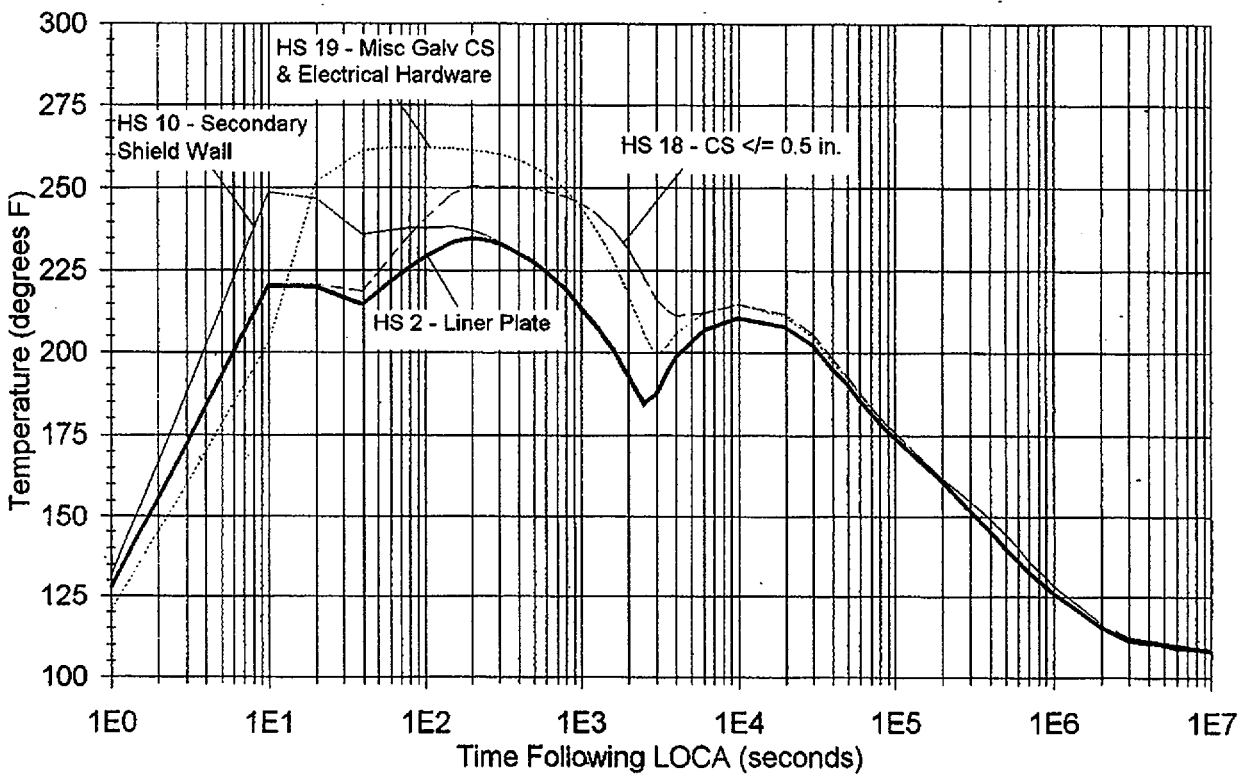


Table 2.1.2.3-1
Chronology of Events for DEHLS Break LOCA
With Diesel Generator Failure
(Case 7)

Time (seconds)	Event
0.0	Break occurs
11	Peak containment pressure during blowdown (45.8 psig)
12	Peak containment vapor temperature (268°F)
12.2	End blowdown mass-energy release
12.2	Start pumped safety injection flow
33	Start containment spray injection
60	Containment spray reaches full flow
60	Containment emergency air cooling units in operation
200	Peak containment liner plate temperature (235°F)
2401	End ECCS injection phase and start ECCS recirculation phase
7200	High pressure safety injection (HPSI) realigned for 50:50 split between hot and cold leg injection
$1x10^7$	End COPATTA analysis

2.1.3 Comparison of Results with Previous Analysis of Record

This subsection provides a comparison of the containment pressure, vapor temperature, and sump water temperature for the bounding case for each break location with the results from the previous analysis of record as contained in Revision 0 of this calculation. The bounding cases in the present analysis are for the single failure of a diesel generator (Cases 1, 4, and 7, for the DEDLS, DESLS, and DEHLS LOCAs, respectively). The bounding LOCA identified in Revision 0 of this calculation is the DESLS LOCA with maximum safety injection and diesel generator failure.

Figure 2.1.3-1 compares the containment pressure for Cases 1, 4, and 7 against the previous AOR. The highest short-term peak pressure in the current analysis is 45.9 psig from the DEDLS LOCA, about 9.2 psig lower than the previous AOR value of 55.1 psig. The reduction in peak post-LOCA pressure is partly due to the use of revised LOCA mass-energy calculation methodology by ABB-CE. The methodology changes were reviewed and approved by the Nuclear Regulatory Commission in 1985, and have previously been used by ABB-CE in SONGS large break LOCA reanalyses for ECCS performance (10CFR50, Appendix K). A second contributor to the reduction in peak pressure is the increase in containment passive heat sink mass and area identified in Reference 6.8. A third factor in the pressure reduction is the increased thermal conductivity used for the epoxy paint in containment implemented as a result of a review of available data documented in Reference 6.14. A fourth reason for the lower peak pressures is the ramped flow modeling for the containment spray system incorporated into the revised calculation, supported by Reference 6.21. The higher long-term containment pressure at the end of the analysis reflects the use of an initial containment pressure of 2.1 psig in the current analysis versus zero psig used in the previous AOR.

Figure 2.1.3-2 compares the containment vapor temperature for Cases 1, 4, and 7 with the previous AOR. The lower short-term vapor temperatures are consistent with the lower containment pressures in the new analysis. The highest peak vapor temperature is 268°F with the DEHLS LOCA and 266°F for the DEDLS LOCA. These values are significantly lower than the 295.4°F cited in the previous AOR for the DESLS LOCA. The absence of the sharp short-term temperature spike at 60 seconds seen in the previous AOR is due to the ramped containment spray flow model incorporated into the new analysis. Containment spray flow begins at a low value at 33 seconds and reaches full flow at 60 seconds. The earlier onset of spray flow, even at low rates, moderates the impact of the superheated steam break flow from the cold leg breaks during the vessel reflood period.

Figure 2.1.3-3 compares the containment sump water temperature for Cases 1, 4, and 7 with the previous AOR. The DEHLS LOCA produces the highest sump water temperatures, 261°F for Case 7, prior to sump water recirculation because all safety injection (SI) water must flow through the reactor vessel to reach the hot leg break location. There is no spillage of low enthalpy SI water with a hot leg break as occurs with the cold leg breaks until the SI system is realigned at about 2 hours to provide 50:50 cold leg/hot leg SI flow. Following recirculation, the long-term sump water temperature for all three break locations and the previous AOR are similar with a maximum post-recirculation value of about 215°F.

FIGURE 2.1.3-1

COMPARISON OF NEW ANALYSES WITH PREVIOUS AOR

CONTAINMENT PRESSURE

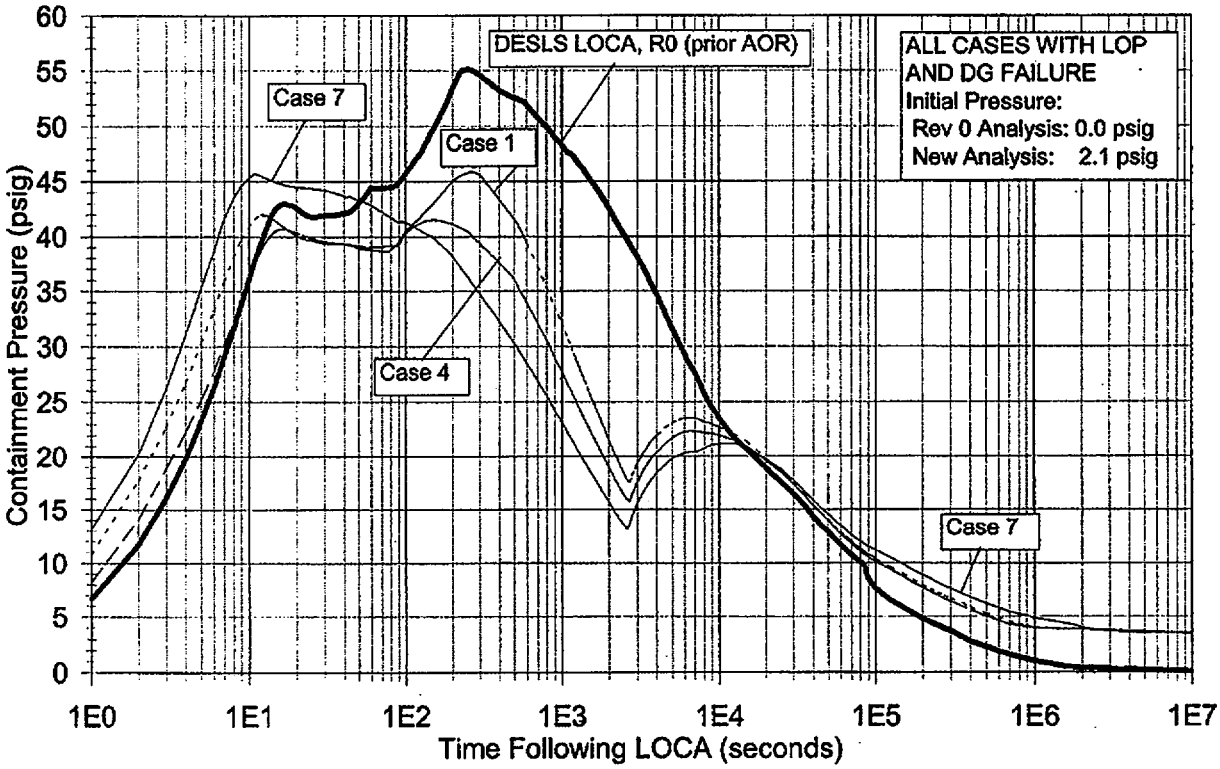


FIGURE 2.1.3-2

COMPARISON OF NEW ANALYSES WITH PREVIOUS AOR

CONTAINMENT VAPOR TEMPERATURE

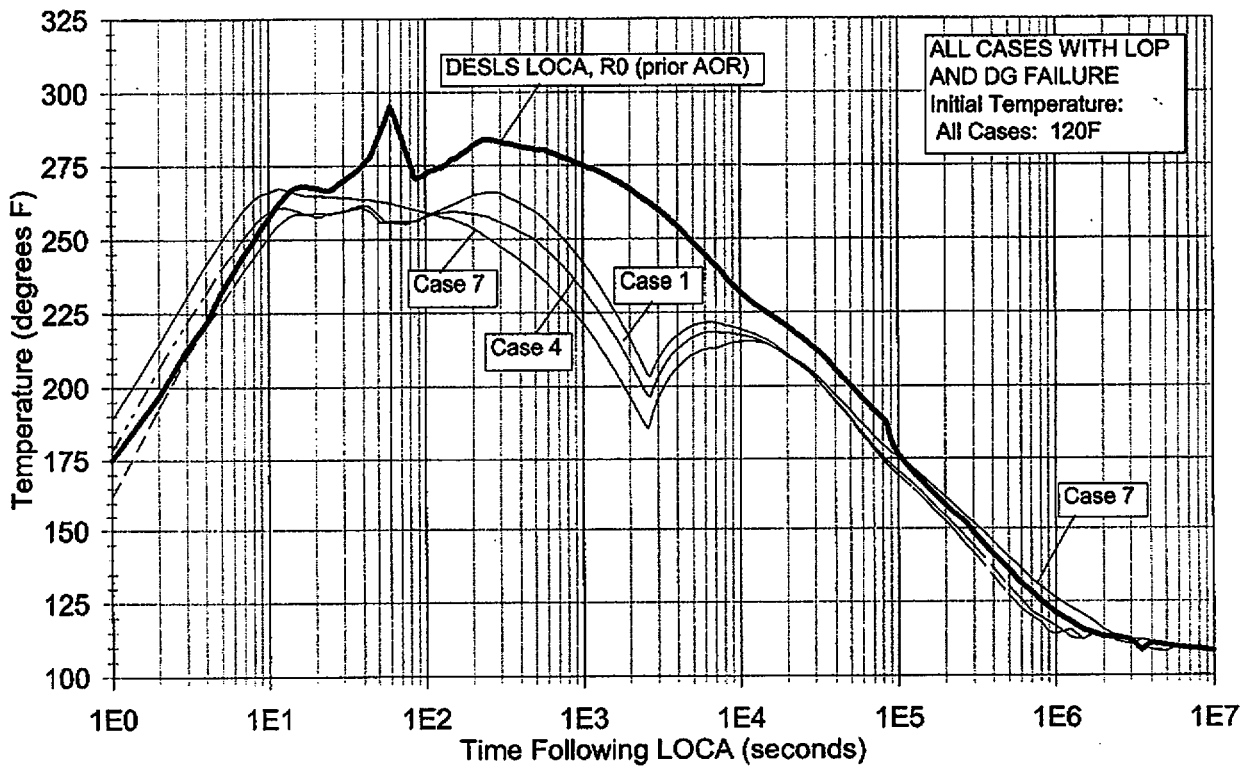
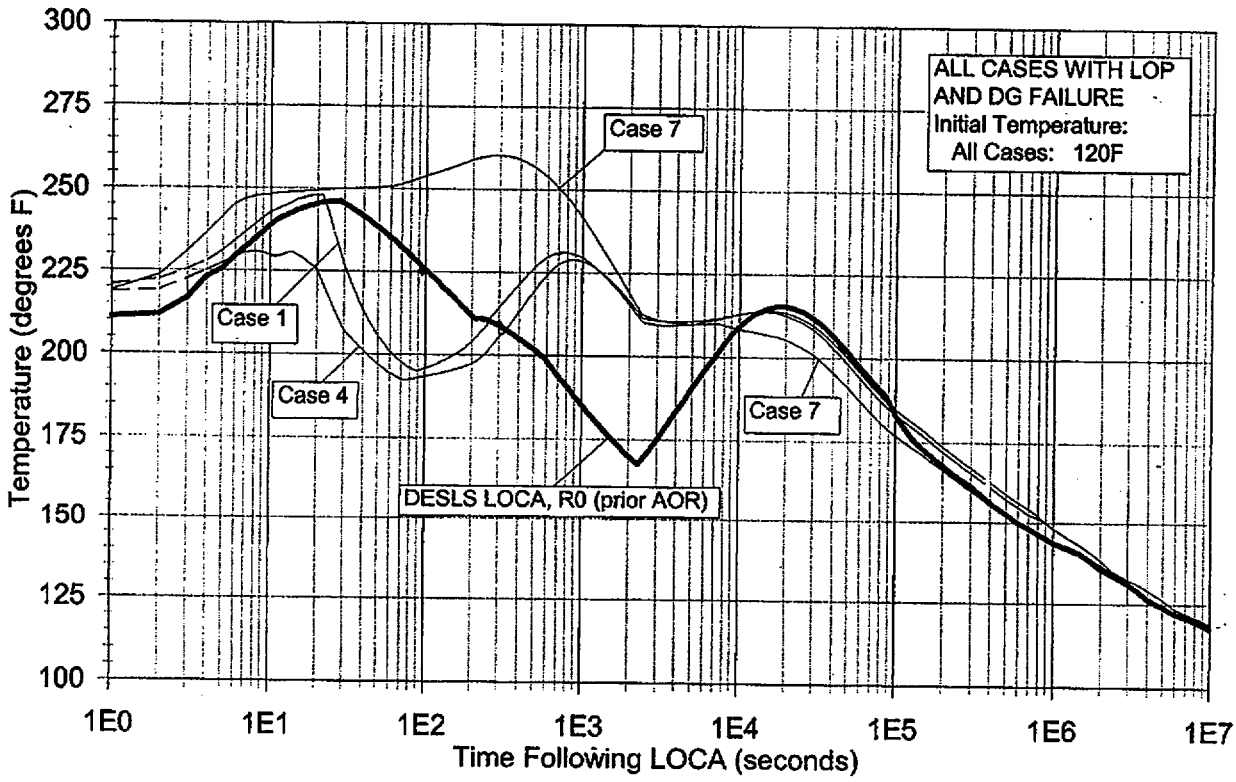


FIGURE 2.1.3-3

COMPARISON OF NEW ANALYSES WITH PREVIOUS AOR

CONTAINMENT SUMP WATER TEMPERATURE



2.2 Recommendations

The following changes/actions are required to be performed as a result of the issue of this calculation. AR991200986 has been generated to track the completion of these actions, listed by responsible group, below:

Licensing

Revise the "Applicable Safety Analyses" of Unit 2 and 3 Station Technical Specification Bases Sections B 3.6.1 and B 3.6.2 to change the cited peak post-LOCA containment pressure (P_a) from 55.1 psig to 45.9 psig.

Revise Section 5.5.2.15 of the Technical Specifications to change the calculated LOCA peak containment pressure (P_a) from 55.1 psig to 45.9 psig.

NEDO, Environmental Qualification

Revise UFSAR Section 3.11 to include the results of the containment LOCA response analysis.

Revise DBD-SO23-TR-EQ to include the results of the containment LOCA response analysis.

NEDO, Civil Engineering

Revise DBD-SO23-TR-ST to include the results of the containment LOCA response analysis.

NFM

Revise UFSAR Section 6.2.1 to include the results of the containment LOCA response analysis.

Revise DBD-SO23-TR-AA , Sections 4.4.5 (Containment Peak Pressure Analysis), 4.4.6 (Long-Term Containment Performance) and 4.4.7 (Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents) to incorporate the results of the containment LOCA response analysis.

Revise calculations N-4059-004, Revision 1 (Post-LOCA Hydrogen Generation) and N-4059-005, Revision 1 (Post-LOCA Hydrogen Generation Without H_2 Control) to incorporate the revised post-LOCA containment vapor temperature profile.

The calculated post-LOCA peak containment pressure in this current revision of the calculation is less than the peak post-LOCA pressure identified in the previous analysis of record, and remains below the peak pressure from the bounding main steam line break identified in calculation N-4080-027, Revision 1 [Ref. 6.14]. Therefore, plant procedures applicable to containment integrated and local leak rate testing, are not impacted, and no revisions to integrated and local leak rate testing procedures are considered necessary as a result of issuance of this revised LOCA containment P-T response calculation.

A copy of this calculation revision will be provided to the Nuclear Training Simulator Group for review and incorporation into simulator training and/or other training modules as appropriate.

3 ASSUMPTIONS

3.1 A loss of off-site electrical power is assumed in accordance with Section 6.2.1.1.A.II.d of the Nuclear Regulatory Commission Standard Review Plan [Ref. 6.4].

3.2 Three different single failure scenarios are included.

One scenario assumes a failure of one diesel generator to start. This failure prevents operation of one train of all engineered safety features (ESF) including one train each of pumped safety injection (SI), containment spray (CS) and emergency air cooling units (ECUs). This single failure is termed "diesel generator failure" and results in minimum pumped safety injection flow (minimum SI) to the reactor coolant system.

The second scenario assumes a failure of one train of containment spray (CS). This scenario assumes both diesel generators operate, allowing both trains of pumped safety injection (SI) and emergency air cooling units (ECUs) to operate. This single failure is termed "single containment spray train failure with max. SI".

The third scenario assumes a failure of one train of emergency air cooling units (ECUs). This scenario assumes both diesel generators operate, allowing both trains of pumped safety injection (SI) and containment spray (CS) to operate. This single failure is termed "single emergency air cooling train failure with max. SI".

3.3 A reactor core operating history of 4 effective full power years (4 EFPY) will be assumed for the purpose of core decay heat calculations to bound 24 month operating cycles.

3.4 This analysis is applicable to both Unit 2 and Unit 3. All references for significant input parameters are either applicable to both units, or, where unit-specific references are cited, differences between units have either been determined to not significantly impact the containment pressure-temperature transient response analysis, or else the more limiting unit-specific parameter is incorporated into the calculation.

4 DESIGN INPUT

4.1 The following initial conditions are used for the LOCA P-T analyses [Refs. 6.6 & 6.7, Sect. IX]:

Containment average vapor temperature	120°F
Containment pressure	16.8 psia
Containment average relative humidity	5%

These values are consistent with applicable technical specification limits, including instrumentation total loop uncertainties (TLUs), where appropriate. A minimum initial relative humidity is appropriate for maximizing containment pressure response. COPATTA Code steam table limitations prevent use of 0% relative humidity. The use of 5% RH is conservative based on the minimum value achievable with the normal containment air coolers using the chilled water cooling system.

4.2 The minimum containment free volume is 2.305×10^6 ft^3 [Ref. 6.8].

4.3 Outside ambient air conditions are modeled as:

Air temperature	100°F
Pressure	14.7 psia
Relative humidity	50%

The outside air temperature is taken from the Unit 2 and 3 RGR [Refs. 6.6 and 6.7, Section IX.016]. A high value is used to conservatively maximize the initial temperature of the concrete containment building. Ambient pressure and relative humidity are typical values for the coastal location. The choice of pressure and relative humidity are actually irrelevant to this analysis, since no containment leakage or air inflow is modeled in this analysis.

4.4 The shutdown cooling heat exchanger is used for cooling recirculated containment spray water. The heat exchanger is a shell and U-tube device with a single pass shell. It is conservatively modeled with 98% of the 7000 ft^2 design heat transfer area and a service overall heat transfer coefficient of 216 Btu/hr ft^2 °F; the SDHX is cooled by component cooling water (CCW) flowing at 3×10^6 lb_m/hr [Ref. 6.10]. The temperature of the CCW flow to the shutdown cooling heat exchanger has a design basis maximum value of 105°F [Ref. 6.11, Section 4.2]. The heat transfer area and CCW flow rate input to the COPATTA Code are doubled for cases where both trains of containment spray are assumed to function.

4.5 Emergency Air Cooling Unit (ECU) operation is conservatively not credited until the containment spray system is fully functioning at 60 seconds post-LOCA. Per Reference 6.12, with loss of power, the ECUs should actually be fully functional 49 seconds post-LOCA. Design basis heat removal capability of each ECU (2 ECUs per train) is determined in calculation M-0072-036 [Ref. 6.13, Table 1] and is also shown in RGR Table IX-2 in References 6.6 & 6.7. Ninety-eight percent of the design basis heat removal capacity of the ECUs is utilized in this calculation to provide arbitrary margin for ECU performance degradation. Once started, ECUs are modeled to operate for the duration of the LOCA analysis (out to 10^7 seconds).

4.6 The reactor vessel volume for containing water below the elevation of the bottom of the primary coolant nozzles is 3259 ft3 [Ref. 6.2d, calculation #9]. The mass of water in the vessel at the time reactor vessel calculations are initialized in COPATTA is also determined in calculation #9 of Reference 6.2d. This water mass is a function of the specific volume of the water at the end of post-reflood for the cold leg breaks or at the end of blowdown for the hot leg breaks. The vessel water masses recommended by ABB-CE in Calculation #9 of Reference 6.2d are as follows:

195830 lbm for all DEDLS and DESLS breaks (Cases 1 thru 6)
172061 lbm for all DEHLS breaks (Cases 7 thru 9)

These values are used as input for the 9 COPATTA cases, as indicated.

4.7 The end of ABB-CE supplied mass and energy break flow data corresponds to the time at which reactor vessel mass and energy balance calculations begin in the COPATTA analyses. These times are identified by ABB-CE in table 21 of Reference 6.2a. For convenience, the times for the cold leg LOCA events (which correspond to the end of post reflood for those breaks) have been rounded off to the nearest whole second.

Case 1	DEDLS w/min SI (DG Failure)	310.66 sec (end of post-reflood) (311 seconds rounded)
Cases 2 & 3	DEDLS w/max SI (no DG Failure)	257.92 sec (end of post-reflood) (258 seconds rounded)
Case 4	DESLS w/min SI (DG Failure)	253.51 sec (end of post-reflood) (254 seconds rounded)
Cases 5 & 6	DESLS w/max SI (no DG Failure)	173.90 sec (end of post-reflood) (174 seconds rounded)
Cases 7, 8&9	DEHLS w/min & max SI (w & w/o DG Failure)	12.20 sec (end of blowdown)

4.8 The containment passive heat sinks (cool structure and components) are identical to those developed and used in the containment P-T response calculation for the design basis main steam line break (MSLB) event documented in calculation N-4080-027, Revision 1 [Ref. 6.14] which includes updated heat sink information from Reference 6.8. The only difference is that the modified Tagami condensing heat transfer coefficient is used during the initial RCS blowdown phase of break flow followed by a short transition to the Uchida condensing coefficient which is used for the balance of the COPATTA run [Ref. 6.15, Theoretical Manual, Appendix C.3].

4.9 Reactor core decay heat used by the COPATTA program following the end of the ABB-CE supplied mass and energy break flow data is calculated according to the method of NRC Branch Technical Position ASB 9-2, "Residual Decay Heat for Light Water Reactors for Long-Term Cooling" [Ref. 6.4]. A Qattro Pro 8 spreadsheet program was used to perform the calculation and a tabular summary of the results are included in Appendix B. Consistent with NFM calculation N-1020-043 [Ref. 6.19], the decay heat calculation includes delayed neutron fissions in addition to the fission product decay heat and the heavy element decay heat included in BTP ASB 9-2. The decay heat was calculated for the reactor operating 4 effective full power years (Assumption 3) and 100% power to facilitate validation of the spreadsheet program by direct comparison with the results in Reference 6.19. The decay heat values were then increased by 1.02 to conform with the requirements for heat sources in NUREG-0800 [Ref. 6.4, Section 6.2.1.3, part II.B.1].

Seventeen of the 25 decay heat data points calculated in the spreadsheet and used for COPATTA input were calculated at same shutdown time as values in the Reference 6.19 calculation. A comparison of the spreadsheet values with the NFM calculation values shows excellent agreement with an average difference of only + 0.08% relative to the Reference 6.19 values. It was necessary to calculate additional values not already in the Reference 19 calculation to provide finer input data during the first 5 hours post LOCA to avoid introducing excessive conservatism in the decay heat term with the linear interpolation routine used by the COPATTA program.

4.10 Pipe break mass and energy release data are provided in Reference 6.2a. Data for 9 cases was taken from Reference 6.2a and incorporated into 9 individual COPATTA cases as identified in the following table:

COPATTA Analysis Case Number	LOCA Case Description: DEDLS = Double-Ended (Pump) Discharge Leg Slot DESLS = Double-Ended (Pump) Suction Leg Slot DEHLS = Double-Ended Hot Leg Slot
1	DEDLS LOCA w/Loss of Power & Diesel Generator Failure
2	DEDLS LOCA w/Loss of Power & Single Containment Spray Train Failure
3	DEDLS LOCA w/Loss of Power & Single Emergency Air Cooling Unit Train Failure
4	DESLS LOCA w/Loss of Power & Diesel Generator Failure
5	DESLS LOCA w/Loss of Power & Single Containment Spray Train Failure
6	DESLS LOCA w/Loss of Power & Single Emergency Air Cooling Unit Train Failure
7	DEHLS LOCA w/Loss of Power & Diesel Generator Failure
8	DEHLS LOCA w/Loss of Power & Single Containment Spray Train Failure
9	DEHLS LOCA w/Loss of Power & Single Emergency Air Cooling Unit Train Failure

The data provided by ABB-CE in Reference 6.2a include:

- Blowdown Phase (for cold and hot leg breaks)
- Reflood and Post-Reflood Phase (for cold leg breaks only)
- Spillage and Condensation Mass and Energy Release (for cold leg breaks only)
- Long-Term Boil-off Phase (for all cases)
- Timing of End of Blowdown, End of Reflood, End of Post-Reflood, and Start of Recirculation (for all cases, as appropriate)
- Additional Information on Direct SI Spillage Modeling (for cold and hot leg breaks)
- Suggested Methodology for Modeling Nitrogen Addition from Empty SI Tanks

The mass and energy flow data provided by ABB-CE is generally in units of lbm/sec and Btu/sec, respectively. COPATTA requires mass and energy flow data to be in units of lbm/hr and Btu/hr, respectively. A Quattro Pro spreadsheet is utilized for unit conversions and data integration to support preparation of the COPATTA input files and comparison of program integrated mass and energy inputs with spreadsheet integrals prepared from the raw data.

4.11 At high temperatures, the zirconium metal present in the fuel cladding may react with the reactor water and release energy. The current LOCA reanalysis will conservatively retain the 1% zirconium metal-water reaction included in the original SONGS 2 & 3 containment P-T response calculations provided in ABB-CE letter S-CE-2604, Appendix I, section 6.2.1.3.8 [Ref.6.20]. The quantity of metal-water reaction energy identified in Reference 6.20 is 1.515E6 Btu based on a core total zirconium mass of 54,645 lb_m, a zirconium molecular weight of 91.22 lb_m/lb-mole, and a reaction energy release of 252,900 Btu/lb-mole and an allowable one per cent reaction. The transmittal letter for Reference 6.20 recommends that the metal-water reaction energy be input to the containment analysis at a uniform rate beginning with the start of the LOCA and ending at the end of reflood. Since the hot leg break does not include a reflood mass and energy release model, the metal-water reaction energy will be input at a uniform rate during the initial RCS blowdown interval to conservatively include this energy during the time the containment peak pressure occurs with the hot leg LOCA event. The mass and energy release data provided in Reference 6.2a does not include metal-water reaction energy releases.

4.12 The containment spray flow rate is modeled as a ramped input from 0 to 1600 gpm per train over a 27-second interval beginning at 33 seconds post-LOCA. The spray timing is predicated on the spray pump being energized with the containment spray block (isolation) valves full open at 30 seconds post LOCA. The ramped spray flow start-up is supported by a containment spray system transient filling analysis in calculation M-0014-009 [Ref. 6.21] which shows that the containment spray ring headers are completely filled within 30 seconds following containment spray pump start and significant spray flow appears at the first spray nozzle group in the lowest ring header within 3 seconds of pump start. The table below shows the spray flow ramp beginning with time of spray pump start as developed for use in Calculation N-4080-027 [Ref. 6.14]:

Time Following Start of Fill Transient (sec)	Single Train Spray Flow (gpm)	Single Train Spray Flow @ 100°F (lb_m/hr)*	Double Train Spray Flow @ 100°F (lb_m/hr)*
0	0	0	0
3	0	0	0
5	100	0.4973E5	0.9946E5
10	245	1.2184E5	2.4368E5
15	530	2.6357E5	5.2714E5
20	615	3.0584E5	6.1168E5
25	675	3.3567E5	6.7134E5
30	1600	7.9567E5	15.9134E5

* mass flow rate (lbm/hr) = (flow in gpm)(1 ft^3/7.48 gal)(60 min/hr)(1 lb_m/0.016130 ft^3) = 497.296 x (flow in gpm)

Calculation N-4080-003, CCN 1 [Ref. 6.12], using bounding times to reach the containment high and high-high pressure analysis set points for the safety injection actuation signal (SIAS) and the containment spray actuation signal (CSAS), indicates that the spray block valves will be fully open within 25 seconds and the containment spray pump will be energized within 25.9 seconds following a design basis LOCA event with loss of power.

The full containment spray flow per train during the injection phase (1600 gpm) is taken from References 6.6 and 6.7 (Section IX.008) and conservatively bounds the minimum plant value of 1606 gpm calculated in Supplement A to calculation M-0014-009 [Ref. 6.21]. The containment spray flow per train during the sump water recirculation phase of the analysis is 1950 gpm [Section IX.008, References 6.7 and 6.8] and this value also bounds the minimum recirculation flow identified in Reference 6.21. The temperature of the water in the refueling water storage tank (RWST) which supplies the containment spray pumps during the injection phase is 100°F per References 6.6 and 6.7 (Section IX.011). As identified in Design Input 4.13, below, a bounding temperature for calculating the mass flow rate of spray water during sump recirculation is 220°F.

A variable containment spray heat transfer efficiency factor, dependent on the containment water vapor to air mass ratio, is included in the COPATTA analysis with the efficiency taken from Figure 2 of Reference 6.17 as recommended by Reference 6.16.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99						
	P. Barbour	3/26/01	M.L. Drucker	3/26/01						

4.13 Pumped safety injection flow for the various cases, both during the injection phase and the recirculation phase are developed in Calculation #2 of Reference 6.2d. The times for recirculation initiation for the various cases are developed in Calculation #3 of Reference 6.2d, and also reported in Table 21 of Reference 6.2a. The values for the various cases are summarized in the following table:

Case	Injection Phase Flow to RCS		Time of Recirculation Initiation (sec)	Recirculation Phase Flow to RCS +		
	Volumetric Flow (gpm) *	Mass Flow (lb_m/sec) **		Volumetric Flow (gpm)	Mass Flow (lb_m/sec)	Mass Flow ++ (lb_m/sec)
1	5676.00	790.25	2437.40	731.0	100.97	97.08
2	8879.4	1238.98	1382.51	1461.9	201.93	194.17
3	8879.4	1238.98	1242.42	1461.9	201.93	194.17
4	5919.6	823.91	2437.25	974.6	134.62	129.44
5	11839.2	1647.81	1375.31	1949.2	269.24	258.89
6	11839.2	1647.81	1235.98	1949.2	269.24	258.89
7	5919.6	823.91	2401.28	974.6	134.62	129.44
8	~~1183.2~~ 11839.2	1647.81	1348.02	1949.2	269.24	258.89
9	11839.2	1647.81	1211.58	1949.2	269.24	258.89

*Pumped SI flow without charging flow
** Pumped SI flow including charging flow
+ Charging pumps off during recirculation
++ Mass flow at 220°F (sp. Vol. = 0.016775 ft^3/lb_m)

The mass flow rates provided by ABB-CE are all calculated for water at 100°F which is the temperature of the water in the RWST used as the source for pumped safety injection prior to sump recirculation. During recirculation, the sump water is warmer than 100°F and the lower density of the warmer water will reduce the mass flow rate of recirculated sump water. Based on preliminary results of this P-T calculation (and confirmed by the final results), an appropriately conservative temperature for recirculated sump water is 220°F. The last column of recirculated mass flow rates are calculated for water at 220°F for use in the COPATTA analysis.

As identified by ABB-CE in Reference 6.2a, only the pump discharge leg LOCA directly spills pumped SI water to the containment sump via the broken pump discharge pipe. Prior to recirculation, the direct pumped SI spillage is included in the Card Series 601 spillage table and the pumped SI flow included in the Card Series 801 table is the net pumped SI flow to the RCS without the spillage flow. After start of recirculation, the direct spillage is included in the SI flow shown in the Card Series 801 table, and a spillage fraction of 0.25 (per ABB-CE) is specified for the pump discharge leg break cases.

4.14 Sump water recirculation for safety injection and containment spray is initiated at the time indicated in the table below. These times are the values from table 21 of Reference 6.2a, rounded off to the nearest whole second.

Case/Description	Sump Recirculation Start Time (seconds)
1 - DEDLS w/DG Failure	2437
2 - DEDLS w/ CS Train Failure	1383
3 - DEDLS w/ECU Train Failure	1242
4 - DESLS w/DG Failure	2437
5 - DESLS w/CS Train Failure	1375
6 - DESLS w/ECU Train Failure	1236
7 - DEHLS w/DG Failure	2401
8 - DEHLS w/CS Train Failure	1348
9 - DEHLS w/ECU Train Failure	1212

4.15 Safety injection tank nitrogen is added to the containment atmosphere over a 10-second interval beginning at 90 seconds post-LOCA. This timing is similar to that recommended by ABB-CE in Table 7 of Reference 6.2d. However, a more conservative calculation of the nitrogen mass release and resultant flow rate is developed in Appendix C and used in this calculation. As shown in Appendix C, the total nitrogen mass release from all 4 SI tanks is 3576 lb_m. This mass release over a 10-second interval yields a mass flow rate of 357.6 lb_m/sec, or 1.2874E6 lb_m/hr. The Card Series 901 table in COPATTA will be used to add the nitrogen. Since the 901 table is designed for air addition to containment, the SI tank nitrogen will be treated by the program as air. Air is about 78% volume nitrogen, 21% volume oxygen and 1% volume argon. Since nitrogen and oxygen have similar molecular weights, and thus also similar to the average molecular weight of air, no significant error will be introduced into the COPATTA analysis by treating the nitrogen mass addition as if it were air.

The temperature of the nitrogen will be conservatively modeled at the initial containment average temperature of 120°F. Nitrogen expansion as the SI tanks are emptied will actually result in cooling of the gas prior to leaving the tank.

5 METHODOLOGY

This calculation uses the Bechtel COPATTA computer program [Ref. 6.15] to model the containment building response to a spectrum of postulated large loss of coolant accidents (LOCAs). This program is a proprietary program of Bechtel Power Corporation, normally used to analyze the containment response to LOCA and main steam line break (MSLB) events. The COPATTA program was used by Bechtel to support the initial design and licensing of SONGS Units 2 and 3, and has continued to be used by SONGS to perform subsequent evaluations, new calculations and calculation revisions. The COPATTA program is installed and validated on the Nuclear Fuels Department RISC 6000 computer system as described in the COPATTA Software Installation Report, Revision 2 [Ref. 6.18].

The COPATTA program calculates pressure and temperature conditions in two separate regions of the containment building: the containment atmosphere (vapor region) and the containment sump (liquid region). These regions are open systems in a thermodynamic sense since the COPATTA code permits mass flow across region boundaries. 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 immediately fall into the liquid region. Non-condensible gas (air) is included in the vapor region. The program models heat transfer to containment structural heat sink materials from the vapor and liquid regions. The performance of containment spray and emergency air cooling unit containment heat removal systems are also modeled.

The mass and energy input into the building from the broken primary coolant line is provided by separate ABB-CE calculations [Refs. 6.2b, 6.2c, and 6.2d] and a summary document [Ref. 6.2a]. This data is input into the COPATTA program as a tabular function of time out through the end of initial RCS blowdown for the hot leg breaks and out through the end of post-reflood for the cold leg breaks. Following the end of this initial ABB-CE supplied break flow data, the reactor vessel is modeled as a third region in containment in equilibrium with the containment total pressure. Using tabular inputs of reactor decay heat, sensible heat extraction rates from the primary system and steam generators and safety injection flows, the COPATTA program calculates long-term mass and energy input into the containment building.

Two minor contributions to the containment pressure-temperature response are also included. These are (1) a 1% zirconium metal water reaction with the energy input to containment prior to the time of calculated peak containment pressure, and (2) safety injection tank nitrogen gas addition to containment following draining of the SI tanks. The SI tank nitrogen only has the potential to impact the peak containment pressure for the cold leg breaks, which occurs after the SI tanks are empty. The peak pressure for the hot leg breaks occurs during the initial RCS blowdown interval, prior to the time the SI tanks are fully drained.

6 REFERENCES

6.1 Letter, G. Singh (ABB-CE) to D. Pilmer (SCE), ST-98-645, "SCE Tcold Program - Transmittal of Final Large Break Containment LOCA Mass & Energy Reports for SONGS 2&3 Tcold Reduction Analysis", (includes Enclosures 1 through 4 listed as References 6.2a, 6.2b, 6.2c, and 6.2d below), 11/4/98

6.2a ABB Inter-Office Correspondence, A. A. Mody to Gurdip Singh, "Transmittal of Final Large Break Containment LOCA Mass & Energy Results for SONGS 2&3 Tcold Reduction Analysis", October 30, 1998 (Enclosure 1 to Ref. 6.1, above)

6.2b ABB Calculation 09/10-ST-98-C-014, Revision 00, "CEFLASH-4A LOCA Blowdown Containment Analysis for SONGS 2&3 Tcold Reduction Program", October 30, 1998 (Enclosure 2 to Ref. 6.1, above)

6.2c ABB Calculation 09/10-ST-98-C-015, Revision 00, "FLOOD3 LOCA Post-Blowdown Containment Analysis for SONGS 2&3 Tcold Reduction Program", October 30, 1998 (Enclosure 3 to Ref. 6.1, above)

6.2d ABB Calculation 09/10-ST-98-C-016, Revision 00, "CONTRANS LOCA Long-Term Containment Analysis for SONGS 2&3 Tcold Reduction Program", October 30, 1998 (Enclosure 4 to Ref. 6.1, above)

6.3 10CFR Part 50, "Domestic Licensing of Production and Utilization Facilities", Revised as of January 1, 1998

6.4 NUREG-0800, "US Nuclear Regulatory Commission Standard Review Plan", Revision 2, July 1981

6.5 DBD-SO23-TR-ST, Revision 0, "Containment Structure Topical Report", 9/25/98

6.6 RGR-U2-C10, Revision 2, "SONGS Unit 2 Cycle 10 Reload Ground Rules", 2/22/99

6.7 RGR-U3-C10, Revision 1, "SONGS Unit 3 Cycle 10 Reload Ground Rules", 2/19/99

6.8 Calculation C-257-01.06.01, Revision 2, including CCN , "Containment Shell Analysis - Containment Passive Heat Sink", 4/30/99

6.9 SONGS Units 2 and 3 UFSAR, Revision 15

6.10 ABB-CE Technical Manual, "Shutdown Cooling Heat Exchanger", SO23-932-15-0 (for Unit 2) and SO23-932-14-0 (for Unit 3)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
1	P. Barbour	12/17/99	J.M. Gilmer	12/17/99					
	P. Barbour	3/26/01	M.I. Drucker	3/26/01					

REV ⇓

6.11 DBD-SO23-400, Revision 6, "Component Cooling Water System Design Basis Document", 1/22/99

6.12 Calculation N-4080-003, Revision 5, including CCN 2, "Containment Spray (CS) and Emergency Cooling Unit (ECU) Actuation Times", 6/10/97

6.13 Calculation M-0072-036, Revision 0, "Containment Emergency Cooler Performance Verification", 1/10/94

6.14 Calculation N-4080-027, Revision 1, "Containment P-T Analysis for Design Basis MSLB". 11/30/99

6.15 Bechtel Standard Computer Program NE100, COPATTA, Version G1-15, "Containment Pressure/Temperature Transient Analysis Code", User and Theoretical Manuals

6.16 Bechtel Nuclear Standard N2.3.2, Revision 0, "Containment Analysis", July, 1975

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

6.18 NE100 (COPATTA) Computer Program Software Installation Report, Revision 2, 8/31/98

6.19 Calculation N-1020-043, Revision 0, "SO23: Single Fuel Assembly Decay Heat", 9/18/91

6.20 Letter, R.W. DeVane (ABB-CE) to J.D. Houchen (Bechtel), S-CE-2604, "FSAR Mass/Energy Release Data for Containment Design, LOCA and MSLB" (Including Appendicies A through J), March 1, 1976 [CDM number C760301G-45-2-4SVT]

6.21 Calculation M-0014-009, Revision 0, including CCN 1, CCN 2, and CCN 3, "Containment Spray Pumps In Service Testing Minimum Requirements", 1/22/99

6.22 ASME Steam Tables, 1967

6.23 Station Emergency Operating Instruction, SO23-12-~~13~~ 3, Revision ~~15~~ 16, "Loss of Coolant Accident", ~~8/12/98~~ 11/24/99

6.24 Calculation N-4060-030, Revision 0, "Containment Flooding Level", 2/11/94

6.25 Memorandum to File, P. Barbour, "Input Data for Containment Flood Level Calculation", dated September 10, 1999

7 NOMENCLATURE

A	area (ft^2 or in^2)
AFW	Auxiliary Feedwater
ALARA	As Low As Reasonably Achievable
AOR	analysis of record
Btu	British thermal unit
CEA	Control Element Assembly
CEDM	Control Element Drive Mechanism
C_p	Heat capacity (or specific heat) at constant pressure (Btu/lb_m-°F)
CS	carbon steel or Containment Spray
CT	Cooling Train
C_v	heat capacity (or specific heat) at constant volume (Btu/lb_m-°F)
D, d	diameter (feet or inches)
DEDLS	Double-Ended (pump) Discharge Leg Slot break LOCA
DEHLS	Double-Ended Hot Leg Slot break LOCA
DESLS	Double-Ended (pump) Suction Leg Slot break LOCA
ECU	Emergency (air) Cooling Unit
EQ	environmental qualification
ESF	engineered safety features
F	degree Fahrenheit
ft	feet
GDC	General Design Criterion (from 10CFR50, Appendix A)
gpm	gallons per minute
hr	hour
H	height (feet)
HELB	high energy line break
HTC	heat transfer coefficient
HVAC	heating, ventilating, (and) air conditioning
in	inches
k_{th}	thermal conductivity (Btu/hr-ft^2/ft of thickness)
lb_f	pound force
lb_m	pound mass
k	specific heat ratio, dimensionless
LOCA	Loss of Coolant Accident
min	minute
MFWIV	Main Feedwater Isolation Valve
MFWLB	Main Feedwater Line Break
MSIS	Main Steam Isolation Signal (or System)
MSIV	Main Steam Isolation Valve
MSLB	Main Steam Line Break
P	pressure (psia)
psia	pound force/square inch, absolute
psig	pound force/square inch, gage

P&ID	piping and instrumentation diagram
P-T	pressure-temperature (transient analysis)
q	energy flow rate (Btu/hr)
RGR	Reload Ground Rules
RWST	Refueling Water Storage Tank
ρ	Greek Rho, density (lb_m/ft^3)
sec	seconds
T or x	Heat Sink material thickness (feet or inches)
TLU	Total Loop Uncertainty (for instrumentation)
V	volume (ft^3)
w or m	mass flow rate (lb_m/sec)

8 CALCULATIONS

This section of the calculation develops the input data for the various LOCA cases analyzed. These cases are:

Case 1 Double-Ended Discharge Leg Slot (DEDLS) LOCA w/LOP & Diesel Generator (DG) Failure
Case 2 DEDLS LOCA w/ LOP & Single Containment Spray Train Failure
Case 3 DEDLS LOCA w/ LOP & Single Emergency Air Cooling Train Failure

Case 4 Double-Ended Suction Leg Slot (DESLS) LOCA w/LOP & DG Failure
Case 5 DESLS LOCA w/ LOP & Single Containment Spray Train Failure
Case 6 DESLS LOCA w/ LOP & Single Emergency Air Cooling Train Failure

Case 7 Double-Ended Hot Leg Slot (DEHLS) LOCA w/LOP & DG Failure
Case 8 DEHLS LOCA w/ LOP & Single Containment Spray Train Failure
Case 9 DEHLS LOCA w/ LOP & Single Emergency Air Cooling Train Failure

Section 8.1 provides the COPATTA variable input data, and Section 8.2 provides the passive heat sink data. Section 8.3 contains the actual COPATTA input data files used for each case.

8.1 COPATTA Variable Input Data

8.1.1 Title Card

The title card is unique to each case of the calculation.

* Case 1 - DEDLS LOCA w/LOP&DG Failure (min SI) N-4080-026R1: 2 ECUs & 1 CS
* Case 2 - DEDLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 4 ECUs & 1 CS
* Case 3 - DEDLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 2 ECUs & 2 CS
* Case 4 - DESLS LOCA w/LOP&DG Failure (min SI) N-4080-026R1: 2 ECUs & 1 CS
* Case 5 - DESLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 4 ECUs & 1 CS
* Case 6 - DESLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 2 ECUs & 2 CS
* Case 7 - DEHLS LOCA w/LOP&DG Failure (min SI) N-4080-026R1: 2 ECUs & 1 CS
* Case 8 - DEHLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 4 ECUs & 1 CS
* Case 9 - DEHLS LOCA w/LOP&NoDG Failure (max SI) N-4080-026R1: 2 ECUs & 2 CS

8.1.2 Card Series 0

This card is identical for all cases.

$LIST POOL=0,2,1,0,1$END

The card contains the following items:

Item 1: Card series identifier = 0

Item 2: IHEAT = 2 — A single heat exchanger for spray only.

Item 3: NOIT = 1 — No iteration for time to blowdown (initial) peak pressure.

Item 4: NPTOP = 0 — Normal set of output data printed at each printout time.

Item 5: LAST = 1 — Single case submission. Sequential change case option is not available.

8.1.3 Card Series 1

This card is identical for all cases except for item 10 (THSDD) which is the time to the initial peak containment pressure near the end of blowdown. This time is used in the Tagami heat transfer coefficient calculations and is determined during preliminary runs not formally included in this calculation.

$LIST POOL=1,10000050,16.8,2.305E6,120,0.05,20,587.5,1,THSDD,0.00,14.7,0.5$END

The card contains the following items:

Item 1: Card series identifier = 1

Item 2: TFNL = 10000050 sec — The run duration time will be 10 million seconds plus 50 seconds. The desired run time is 1E7 seconds. The extra 50 seconds assures a full heat sink printout at the end of the run.

Item 3: PAIR = 16.8 psia — Initial containment pressure (see Design Input 4.1).

Item 4: VOL = 2.305E6 ft^3 — Containment net free volume (see Design Input 4.2).

Item 5: TAIR = 120°F — Containment inital average air temperature (see Design Input 4.1).

Item 6:	HUM = 0.05	Containment initial average relative humidity, 5% expressed as a decimal fraction (see Design Input 4.1).
Item 7:	NSL = 21	Number of heat conducting regions (passive heat sinks) in the problem (see Section 8.1.2).
Item 8:	TBOIL = 587.5°F	Average temperature of primary coolant before the LOCA occurs. This value sets the initial temperature of all heat conducting regions in contact with the coolant. The value cited is not used in this calculation because the COPATTA analysis is not required to calculate heat transfer from the hot RCS components. Energy extraction from the RCS has been modeled by ABB-CE in their mass-energy release calculations. The value cited here is Tcold of 560°F plus one-half the normal full power coolant temperature rise of 55°F (Refs. 6.6 and 6.7, figures III-1 and III-2).
Item 9:	TCHECK = 1	Variable is not used since the option to iterate for peak pressure is disabled
Item 10:	THSDD	This variable is the time to initial (blowdown phase) containment peak pressure when the option to iterate to initial peak pressure is not utilized. It is case dependent and determined by preliminary COPATTA runs, not formally documented in this calculation.
	THSDD = 12 seconds	Time to initial peak pressure for DEDLS LOCAs (Cases 1, 2, & 3)
	THSDD = 17 seconds	Time to initial peak pressure for DESLS LOCAs (Cases 4, 5, & 6)
	THSDD = 11 seconds	Time to initial peak pressure for DEHLS LOCAs (Cases 7, 8, & 9)
Item 11:	EVAP = 0.00	Fraction of heat sink condensate which will be allowed to revaporize (0 to 0.08). This variable is used only for equipment qualification analyses with main steam line breaks.
Item 12:	ENVRNP = 14.7 psia	Outside containment ambient pressure, psia (see Design Input 4.3)
Item 13:	ENVRH = 0.50	Outside containment ambient relative humidity, decimal fraction (see Design Input 4.3).

8.1.4 Card Series 2

This card is identical for all cases except for items 4 (MLEFT) and 8 (PHELP). MLEFT is the mass of water (in pounds) to just fill the reactor vessel up to the bottom of the reactor coolant nozzles at time PHELP. PHELP is the time (in seconds) at which mass and energy balance calculations for the water within the reactor vessel will begin. This is the time at which the mass and energy break flow information given by ABB-CE ends. Modeling of reactor core decay heat, primary & secondary system sensible heat extraction and safety injection flow will begin at this time, as required.

```
$LIST POOL=2,0,0,MLEFT,3259,0,120,PHELP $END
```

The card contains the following items:

Item 1:	Card Series Identifier = 2	
Item 2:	MWATR = 0 lb_m	Mass of water added to containment as a step input at time zero
Item 3:	UTOT = 0 Btu	Energy associated with the water added by item 2, above
Item 4:	MLEFT = 1.95830E5 lb_m MLEFT = 1.72061E5 lb_m	Cases 1 thru 6 (see Design Input 4.6) Cases 7 thru 9 (see Design Input 4.6)
Item 5:	REVOL = 3259 ft^3	RCS volume below the reactor coolant nozzles (see Design Input 4.6)
Item 6:	HAB = 0 Btu/hr ft^2	Total heat transfer rate between the surface of the containment sump water and containment vapor region.
Item 7:	TCONT = 2	Used only if the temperature boundary control for either the right or left boundary of a heat sink shown on Card 1XX400 equals zero. No heat sinks in this calculation specify zero as a surface temperature boundary condition; therefore, any positive value may be entered for TCONT.
Item 8:	PHELP = 311 seconds PHELP = 258 seconds PHELP = 254 seconds PHELP = 174 seconds PHELP = 12.2 seconds	Case 1 (see Design Input 4.7) Cases 2 & 3 (see Design Input 4.7) Case 4 (see Design Input 4.7) Cases 5 & 6 (see Design Input 4.7) Cases 7, 8 & 9 (see Design Input 4.7)

8.1.5 Card Series 3

This card provides for modeling HVAC systems adding outside air to containment or removing air/steam from containment as a function of time. This option is not used in this calculation; therefore, zero entries are provided for items 3 - 6 and 8 - 11..

$LIST POOL=3,0,0,0,0,0,2E7,0,0,0,0 $END

This card contains the following items:

Item 1: Card Series Number = 3

Item 2: Time, seconds

Item 3: Volume addition rate, ft^3/min

Item 4: Temperature of volume added, °F

Item 5: Relative humidity of volume added, decimal fraction

Item 6: Volume removal rate ft^3/min

Items 7-11 2nd set of input data, items 2-6, etc.

Minimum of 2 sets of values; maximum of 25 sets of values

8.1.6 Card Series 4

This card provides for the modeling of heat exchangers for long-term cooling of containment spray water following the onset of sump water recirculation. All items in the card are the same for all cases except for HEX(1) and HEX(4). Card series 4 also allows for a step-function startup of the containment spray (CS) system a finite time following the containment reaching a containment spray actuation pressure setpoint. This CS start option is not used in this calculation; instead, card series 801 is used to initiate spray in this calculation.

$LIST POOL=4,1,6860,216,105,3.0E6,0,0,0,0,0,0,0 $END

This card contains the following items:

Item 1: Card Series Identifier = 4

Item 2: IHEX = 1 Type of primary heat exchanger. Type 1 is a shell and U-tube heat exchanger with a single pass shell which represents the Shutdown HX used for recirculated CS

water cooling (see Input Data 4.4).

Item 3: HEX(1) — Primary HX surface area (see Design Input 4.4).

HEX(1) = 6860 ft^2 — All cases with only one CS train operating (Cases 1,2,4,5,7 & 8).

HEX(1) = 13720 ft^2 — All cases with two CS trains operating (Cases 3, 6 & 9).

Item 4: HEX(2) = 216 Btu/hr ft^2 °F — Overall primary HX heat transfer coefficient (see Design Input 4.4).

Item 5: HEX(3) = 105°F — Primary heat exchanger coolant inlet temperature. This is the design maximum component cooling water temperature (see Design Input 4.4)

Item 6: HEX(4) — Primary HX cooling water flow rate (see Design Input 4.4).

HEX(4) = 3.0E6 lb_m/hr — All cases with only one CS train operating (Cases 1,2,4,5,7 & 8).

HEX(4) = 6.0E6 lb_m/hr — All cases with two CS trains operating (Cases 3, 6 & 9).

Items 7 - 11 IHIX & HIX(1) thru HIX(4) — Secondary HX parameters analogous to Items 2 thru 6. Not used (input zeros).

Item 12: CS Actuation pressure setpoint, psia — Not used (input zero).

Item 13: Instrumentation and equipment delay time, sec — Not used (input zero).

8.1.7 Card Series 5

This card provides information on the number of emergency air cooling units (ECUs) operating, the start and stop times for the ECUs, and also allows for ECU start up at a specified containment pressure plus a specified delay time. All items in this card series are identical for each case except for the number of ECUs operating. Each emergency air cooling train contains two ECUs.

```
$LIST POOL=5,N,60,2E7,0,0 $END
```

This card contains the following items:

Item 1: Card Series Identifier = 5

Item 2:	N	Number of ECUs operating
	N = 2	For all cases with DG failure and all cases with No DG failure but with single ECU train failure.
	N = 4	For all cases with No DG failure but with single CS train failure
Item 3:	ECU start time = 60 sec	ECU start time (see Design Input 4.5).
Item 4:	ECU stop time = 2E7 sec	ECU stop time. A large value is used to asure the ECUs continue running for the duration of the analysis.
Item 5:	ECU Actuation pressure Setpoint, psia	Not used (input zero).
Item 6;:	Instrumentation and Equipment delay time, sec	Not used (input zero).

8.1.8 Card Series 6

This card series provides for the instantaneous release of a specified amount of energy at any one time during the problem. All energy input to the LOCA problem is added through the blowdown tables (Card Series 301 and 501), the decay heat and metal-water reaction/sensible heat addition tables (Card Series 101 and 201), or the spillage table (Card Series 601). Consequently the card series 6 entries are all zeros.

```
$LIST POOL=6,0,0,0 $END
```

This card contains the following items:

Item 1:	Card Series Identifier = 6	
Item 2:	TPULSE = 0 sec	The time at which the impulse of energy is released.
Item 3:	IPULSE = 0	An indicator designating the location of the energy release.
Item 4:	UPULSE = 0 Btu	The amount of energy released at the specified time and location.

8.1.9 Card Series Leak

This is a namelist input set which allows modeling of containment atmosphere leakage. This

option is not used for the LOCA analysis and only a simple entry of NOPEN=0 is required.

$LEAK NOPEN=0 $END

8.1.10 Card Series 101

This card series is used to provide reactor core decay heat as a tabular function of time for use in long-term LOCA calculations. This data is used in conjunction with information provided in card series 401 and 701 to direct the energy either into the reactor vessel water or into the containment vapor region. The reactor core decay heat table includes up to 25 sets of the following data entered in columnar form:

Time (seconds)
Decay Heat Generation (Btu/hr)

Information from this table is used in the COPATTA program only following the end of the post-reflood mass energy release data for the cold leg LOCAs, or following the end of the initial RCS blowdown data for the hot leg LOCA provided in Card Series 301. Core decay heat energy is already included in the break flow data supplied by ABB-CE out through the end of post-reflood for the cold leg breaks and out through the initial RCS blowdown data for the hot leg break.

As described in Design Input 4.9, the reactor core decay heat is calculated according to NRC Branch Technical Position ASB 9-2. Four effective full power years of reactor operation at 102% power are assumed. Calculation of the decay heat values at specific shutdown times is provided in Appendix B. All of the decay heat power is added to the reactor vessel water by using a scaling factor of 1.0 in Card Series 401 and a scaling factor of zero in Card Series 701.

The Card Series 101 input table is as follows:

```
$LIST POOL=101,
        1.0E+01,  1.40669E+09,
        2.0E+01,  9.95691E+08,
        3.0E+01,  7.85072E+08,
        6.0E+01,  5.75572E+08,
       1.00E+02,  5.08637E+08,
       2.00E+02,  4.30510E+08,
       4.00E+02,  3.58179E+08,
      1.000E+03,  2.72813E+08,
      1.800E+03,  2.35686E+08,
      2.700E+03,  2.07082E+08,
      3.600E+03,  1.87376E+08,
      7.200E+03,  1.50229E+08,
     1.8000E+04,  1.18335E+08,
     3.6000E+04,  9.41483E+07,
     5.4000E+04,  8.21067E+07,
     7.2000E+04,  7.53054E+07,
     8.6400E+04,  7.16199E+07,
    1.72800E+05,  5.88206E+07,
```

```
 2.59200E+05,  5.08008E+07,
 4.32000E+05,  4.10087E+07,
 6.91200E+05,  3.37355E+07,
1.036800E+06,  2.89365E+07,
2.592000E+06,  1.96478E+07,
6.048000E+06,  1.24410E+07,
1.0368000E+07,  9.14378E+06 $END
```

8.1.11 Card Series 201

Card Series 201 is used to input metal-water reaction energy or other energy inputs (other than decay heat) as a function of time in a LOCA analysis. This data is also used in conjunction with card series 401 and 701 to direct the energy terms either into the reactor vessel water or into the containment vapor region. This card series is limited to 25 sets of energy input data in the following columnar form:

Time (seconds)
Energy Release Rate (Btu/hr)

This card series will be used to input a Zirconium metal-water reaction energy release as described in Design Input 4.10. The amount of metal-water energy added is 1.515E6 Btu. The energy is added entirely to the vapor region and at a uniform rate from time zero to the end of reflood for the cold leg breaks and during the initial RCS blowdown period for the hot leg breaks. The resultant metal-water reaction energy input as a function of time is shown in the table below:

Zirconium Metal-Water Reaction Energy Input

LOCA Case Description	Metal-Water Reaction Energy (Btu)	Energy Input Time Interval* (seconds)	Energy Input Rate (Btu/hr)
Case 1: DEDLS w/DG Failure	1.515E6	0 to 220.0	2.47909E7
Case 2: DEDLS w/CS Train Failure	1.515E6	0 to 191.0	2.85550E7
Case 3: DEDLS w/ECU Train Failure	1.515E6	0 to 191.0	2.85550E7
Case 4: DESLS w/DG Failure	1.515E6	0 to 177.7	3.06922E7
Case 5: DESLS w/CS Train Failure	1.515E6	0 to 140.6	3.87909E7
Case 6: DESLS w/ECU Train Failure	1.515E6	0 to 140.6	3.87909E7
Case 7: DEHLS w/ DG Failure	1.515E6	0 to 12.2	4.47049E8
Case 8: DEHLS w/ CS Train Failure	1.515E6	0 to 12.2	4.47049E8
Case 9: DEHLS w/ ECU Train Failure	1.515E6	0 to 12.2	4.47049E8

* Time intervals from Table 21 of Reference 6.2a

In addition to providing the metal-water reaction energy input to containment, Card Series 201 is also used to provide the long-term sensible heat transfer from the RCS hot components to containment as supplied by ABB-CE in Tables 12 through 20 of Reference 6.2a. This energy term consists of sensible heat and steam generator heat for the 6 cold leg breaks beginning at the end of post-reflood. The time for the initial sensible heat entry in the table has been rounded to be consistent with the time specified for the initiation of reactor vessel calculations (PHELP in Card Series 2, Section 8.1.4 and Design Input 4.7) Sensible heat transfer from the RCS alone, beginning at the end of initial RCS blowdown, is applicable to the three hot leg breaks, where a mechanism for rapid steam generator energy extraction does not exist. Sensible heat from the RCS is modeled as an energy addition to the reactor vessel water where it is combined with decay heat energy to produce steam. Sensible heat associated with the steam generator in a loop with a failed cold leg is modeled as a direct energy addition to the containment vapor region since this energy is transferred to steam originating in the reactor vessel as the steam flows through the SG to the break location.

The RCS/SG sensible heat input begins after the metal-water energy input occurs. Three entries are needed to describe the metal-water reaction energy input, leaving twenty-two entries remaining for the sensible heat input in the Card Series 201 table. The sensible heat input values are selected from the detailed output data provided by ABB-CE in Reference 6.2a such that the general shape of the sensible heat input parameter is retained. The Card Series 201 tabular input listings for each LOCA case are provided below, including the metal-water reaction for the specific case at the beginning of the input table. The ABB-CE sensible heat data are provided only out to about 3.25E6 seconds. The sensible heat rate is then conservatively held constant at the last value provided by ABB-CE out to the end of the run at 1E7 seconds. This action has no significant impact on the long term cooldown of containment since the sensible heat term is very small and more than 3 orders of magnitude smaller than the decay heat term at the end of the run.

The Card Series 201 input tables for each LOCA case are provided below:

Case 1, DEDLS LOCA w/DG Failure

```
$LIST POOL=201,        0,    2.47909E7,
               2.20E2,    2.47909E7,
               2.20E2,            0,
               3.11E2,            0,
               3.11E2,    3.42417E8,
               5.13E2,    3.38630E8,
               6.13E2,    1.42818E7,
              1.013E3,    1.14450E7,
              4.226E3,    6.08605E6,
             1.0026E4,    3.57160E6,
             1.9626E4,    2.46029E6,
             4.2260E4,    1.50213E6,
             8.8260E4,    7.62653E5,
             9.4260E4,    5.71655E5,
```

```
                1.9826E5,    2.23797E5,
                2.9626E5,    1.29554E5,
                5.3565E5,    8.81150E4,
               1.03065E6,    2.28200E4,
               1.27565E6,    1.05506E4,
               1.52565E6,    1.00088E4,
               2.01565E6,    5.34510E3,
               2.75565E6,    4.83980E3,
               3.00565E6,    5.16344E3,
               3.25065E6,    2.81562E3,
               1.00001E7,    2.81562E3 $END
```

Case 2, DEDLS LOCA w/CS Train Failure

```
$LIST POOL=201,       0,    2.85550E7,
                  1.91E2,    2.85550E7,
                  1.91E2,            0,
                  2.58E2,            0,
                  2.58E2,    3.53688E8,
                 4.929E2,    3.44505E8,
                 4.979E2,    2.28144E7,
                 2.116E3,    1.21308E7,
                 4.916E3,    7.68744E6,
                1.0116E4,    4.52556E6,
                3.9160E4,    1.76203E6,
                8.9160E4,    7.61407E5,
                9.5160E4,    5.91714E5,
                1.0116E5,    5.70175E5,
                2.9716E5,    1.05156E5,
                5.3790E5,    7.57767E4,
                7.8790E5,    2.31177E4,
               1.03290E6,    1.76747E4,
               1.52790E6,    5.52391E3,
               2.01790E6,    4.83905E3,
               2.26790E6,    1.08000E3,
               2.75790E6,    4.08218E3,
               3.00790E6,    1.18800E3,
               3.25290E6,    2.85090E3,
               1.00001E7,    2.85090E3 $END
```

Case 3, DEDLS LOCA w/ECU Train Failure

```
$LIST POOL=201,       0,    2.85550E7,
                  1.91E2,    2.85550E7,
                  1.91E2,            0,
                  2.58E2,            0,
                  2.58E2,    3.56133E8,
                 4.929E2,    3.46912E8,
                 4.979E2,    2.60551E7,
                 1.258E3,    1.76703E7,
                 4.916E3,    7.69090E6,
                1.5116E4,    3.62903E6,
                4.9160E4,    1.46373E6,
                1.0116E5,    5.95098E5,
                2.9716E5,    1.02950E5,
                5.3790E5,    6.63568E4,
               1.03290E6,    9.78757E3,
               1.27790E6,    9.13788E3,
```

```
                1.52790E6,     5.19844E3,
                1.77290E6,     4.94600E3,
                2.01790E6,     1.44000E3,
                2.26790E6,     4.72950E3,
                2.51290E6,     1.18800E3,
                2.75790E6,     1.15200E3,
                3.00790E6,     2.88000E2,
                3.25290E6,     5.04000E2,
                1.00001E7,     5.04000E2 $END
```

Case 4, DESLS LOCA w/DG Failure

```
$LIST POOL=201,       0,     3.06922E7,
                1.777E2,     3.06922E7,
                1.777E2,             0,
                 2.54E2,             0,
                 2.54E2,     3.62923E8,
                4.885E2,     3.56620E8,
                4.935E2,     2.65569E7,
                1.069E3,     1.75726E7,
                2.938E3,     1.19027E7,
               1.0138E4,     6.30022E6,
               1.9738E4,     4.29145E6,
               4.9380E4,     2.10432E6,
               8.9380E4,     1.09725E6,
               9.5380E4,     8.71042E5,
               1.9938E5,     2.87980E5,
               2.9738E5,     1.48094E5,
               5.3845E5,     9.53694E4,
               7.8845E5,     4.12270E4,
              1.27845E6,     1.05503E4,
              1.52845E6,     1.00445E4,
              1.77345E6,     5.99346E3,
              2.01845E6,     5.34499E3,
              2.75845E6,     4.87570E3,
              3.25345E6,     2.85157E3,
              1.00001E7,     2.85157E3 $END
```

Case 5, DESLS LOCA w/CS Train Failure

```
$LIST POOL=201,       0,     3.87909E7,
               1.406E2,     3.87909E7,
               1.406E2,             0,
                1.74E2,             0,
                1.74E2,     3.81434E8,
               4.139E2,     3.65547E8,
               4.189E2,     3.52358E7,
               9.770E2,     2.27916E7,
               1.977E3,     1.81719E7,
               4.954E3,     1.16832E7,
              1.5154E4,     5.87462E6,
              3.9540E4,     2.83363E6,
              9.5540E4,     9.40802E5,
              1.9954E5,     2.67259E5,
              2.9754E5,     1.23300E5,
              5.3885E5,     7.57768E4,
              7.8885E5,     2.27573E4,
             1.03385E6,     1.76382E4,
```

```
                1.52885E6,    5.52380E3,
                2.01885E6,    4.87494E3,
                2.26885E6,    1.11600E3,
                2.51385E6,    4.04629E3,
                3.00885E6,    4.65786E3,
                3.25385E6,    2.45484E3,
                1.00001E7,    2.45484E3 $END
```

Case 6, DESLS LOCA w/ECU Train Failure

```
$LIST POOL=201,       0,    3.87909E7,
                  1.406E2,    3.87909E7,
                  1.406E2,            0,
                   1.74E2,            0,
                   1.74E2,    3.84045E8,
                  4.139E2,    3.67844E8,
                  4.189E2,    3.85443E7,
                  1.577E3,    2.15289E7,
                  4.954E3,    1.17494E7,
                 1.5154E4,    6.00188E6,
                 3.9540E4,    2.86224E6,
                 9.5540E4,    9.65041E5,
                 1.9954E5,    2.64549E5,
                 2.9754E5,    1.21078E5,
                 5.3885E5,    6.67163E4,
                1.03385E6,    9.78736E3,
                1.27885E6,    9.13763E3,
                1.52885E6,    5.19833E3,
                1.77385E6,    4.94590E3,
                2.26885E6,    7.20000E2,
                2.51385E6,    1.18800E3,
                2.75885E6,    4.68000E2,
                3.00885E6,    7.20000E2,
                3.25385E6,    5.04000E2,
                1.00001E7,    5.04000E2 $END
```

Case 7, DEHLS LOCA w/DG Failure

```
$LIST POOL=201,       0,    4.47049E8,
                  1.22E1,    4.47049E8,
                  1.22E1,    2.86825E9,
                  2.22E1,    2.86461E9,
                  3.22E1,    1.00942E9,
                  4.72E1,    9.33001E8,
                  5.72E1,    6.33103E8,
                 1.472E2,    6.23452E8,
                 1.522E2,    2.98048E8,
                 1.872E2,    2.95063E8,
                 1.922E2,    1.72512E7,
                 3.972E2,    7.53696E6,
                 9.430E2,    3.14460E6,
                 1.243E3,    3.19536E6,
                 5.086E3,    1.28664E6,
                1.4086E4,    3.16800E5,
                3.2860E4,    2.04120E5,
                5.2860E4,    1.02600E5,
                8.8860E4,    5.97600E4,
```

```
                1.9886E5,    1.90800E4,
                2.9686E5,    1.18800E4,
                7.8715E5,    6.84000E3,
               1.27715E6,    1.80000E3,
               3.25215E6,    5.40000E2,
               1.00001E7,    5.40000E2 $END
```

Case 8, DEHLS LOCA w/CS Train Failure

```
$LIST POOL=201,       0,    4.47049E8,
                  1.22E1,    4.47049E8,
                  1.22E1,    2.86821E9,
                  2.22E1,    2.86457E9,
                  3.22E1,    1.00934E9,
                  4.72E1,    9.32915E8,
                  5.72E2,    6.43320E8,
                 1.472E2,    6.24506E8,
                 1.522E2,    2.99808E8,
                 1.872E2,    2.96762E8,
                 1.922E2,    1.97496E7,
                 3.972E2,    9.76536E6,
                 9.430E2,    4.90644E6,
                 1.443E3,    4.79052E6,
                 5.086E3,    1.65564E6,
                1.4086E4,    3.17160E5,
                3.2860E4,    1.54080E5,
                4.2860E4,    9.39600E4,
                8.8860E4,    3.85200E4,
                1.9886E5,    1.22400E4,
                2.9686E5,    8.28000E3,
                7.8715E5,    4.68000E3,
               1.03215E6,    1.72800E3,
               3.25215E6,    3.96000E2,
               1.00001E7,    3.96000E2 $END
```

Case 9, DEHLS LOCA w/ECU Train Failure

```
$LIST POOL=201,       0,    4.47049E8,
                  1.22E1,    4.47049E8,
                  1.22E1,    2.86821E9,
                  2.22E1,    2.86457E9,
                  3.22E1,    1.00934E9,
                  4.72E1,    9.32915E8,
                  5.72E1,    6.32999E8,
                 1.472E2,    6.25338E8,
                 1.522E2,    3.01187E8,
                 1.872E2,    2.98102E8,
                 1.922E2,    2.16936E7,
                 3.972E2,    1.13782E7,
                 9.430E2,    5.96124E6,
                 1.243E3,    6.17976E6,
                 5.086E3,    1.52172E6,
                1.4086E4,    3.38760E5,
                3.2860E4,    1.58760E5,
                4.2860E4,    9.21600E4,
                8.8860E4,    3.38400E4,
                1.9886E5,    1.11600E4,
```

```
 2.9686E5,    7.20000E3,
 7.8715E5,    3.96000E3,
1.03215E6,    1.40400E3,
3.25215E6,    2.88000E2,
1.00001E7,    2.88000E2 $END
```

8.1.12 Card Series 301

Card Series 301 is a tabular input of pipe break mass and energy input into containment as a function of time. The basic data is supplied by ABB-CE in Reference 6.2a as identified in Design Input 4.10. The portion of the mass-energy release data incorporated into Card Series 301 is the initial RCS blowdown followed by the reflood and post-reflood mass-energy release data from ABB-CE. The vendor data includes mass flow rate in lb_m/sec and break flow enthalpy in Btu/lb_m, both as a function of time in seconds. The COPATTA input table requires the mass flow rate to be in units of lb_m/hr; therefore, the mass flow rates from Reference 6.2a have been multiplied by 3600 seconds/hour to provide the correct data for the COPATTA analysis. The break flow data from the ABB-CE calculation was entered from an output table diskette provided by ABB-CE with their calculation.

The Card Series 301 tables for the 9 LOCA cases are provided below:

Case 1, DEDLS LOCA w/DG Failure

Cases 1, 2, and 3 all have the same mass-energy release flow during initial RCS blowdown (0 to 14.7998 seconds). The timing of the final post-reflood mass-energy data point is rounded from 310.7seconds in the ABB-supplied table to 311 seconds to correspond to the rounded time for initializing COPATTA reactor vessel calculations (Design Input 4.7 and Section 8.1.4).

```
$LIST POOL=301,          0,          0,      0,
              0.0103421,  2.75463e+08,  554.43,
              0.0203421,  2.72956e+08,  553.61,
              0.0303421,  2.74063e+08,  553.27,
              0.0403421,  2.76931e+08,  553.31,
              0.0503421,  2.97586e+08,  553.46,
              0.0603421,  2.84049e+08,  553.54,
              0.0703421,  2.78919e+08,  553.48,
              0.0803421,  2.86323e+08,  553.41,
              0.0901884,  3.45168e+08,  554.02,
              0.100686,   4.12405e+08,  554.03,
              0.150686,   4.36972e+08,  556.16,
              0.200686,   4.22471e+08,  556.85,
              0.250686,   4.20134e+08,  557.26,
              0.300686,   4.17128e+08,  557.32,
              0.350686,   4.07365e+08,  557.23,
              0.400686,   4.10645e+08,  557.16,
              0.450686,   4.05922e+08,  557.09,
              0.499686,   4.04438e+08,  557.03,
              1.00069,    3.73813e+08,  558.71,
              1.50069,    3.01578e+08,  569.10,
              2.00069,    2.62691e+08,  576.37,
              2.50069,    2.16451e+08,  577.37,
              3.00069,    1.97648e+08,  579.33,
```

```
4.00131,    1.66789e+08,  619.63,
5.00044,    1.24285e+08,  679.25,
6.00044,    1.18203e+08,  661.96,
7.00044,    9.53597e+07,  694.06,
8.00044,    7.54916e+07,  744.56,
9.00044,    3.60446e+07, 1016.36,
10.0021,    2.91492e+07,  959.57,
11.0021,    4.28504e+07,  656.17,
12.0021,    4.37940e+07,  475.01,
12.5021,    3.79980e+07,  419.00,
13.0017,    3.43031e+07,  373.20,
13.5008,    3.75977e+07,  345.15,
14.0008,    1.25310e+07,  336.27,
14.2008,    9.74693e+06,  334.46,
14.4008,    6.42028e+06,  336.95,
14.6008,    2.18261e+06,  362.69,
14.7998,    0.00000e+00,  362.69,
14.810,     0.00000e+00, 1301.13,
14.900,     3.77532e+05, 1301.13,
19.200,     2.20187e+06, 1288.31,
20.700,     2.61400e+06, 1282.75,
20.710,     1.30700e+06, 1282.75,
23.400,     1.31195e+06, 1277.20,
27.600,     1.30934e+06, 1273.24,
31.700,     1.30277e+06, 1271.18,
35.900,     1.29503e+06, 1269.52,
40.100,     1.28695e+06, 1268.00,
44.300,     1.27876e+06, 1266.50,
48.400,     1.27078e+06, 1265.05,
52.600,     1.26266e+06, 1263.51,
56.800,     1.25451e+06, 1262.01,
61.000,     1.24634e+06, 1260.50,
65.100,     1.23833e+06, 1259.03,
69.300,     1.23007e+06, 1257.53,
73.500,     1.22175e+06, 1256.07,
77.590,     1.21360e+06, 1254.63,
77.600,     2.42719e+06, 1254.63,
87.100,     2.27790e+06, 1252.93,
96.600,     2.14567e+06, 1251.54,
106.100,    2.03411e+06, 1250.13,
115.600,    1.94281e+06, 1248.63,
125.100,    1.86890e+06, 1247.04,
134.600,    1.80990e+06, 1245.31,
144.100,    1.76328e+06, 1243.41,
153.600,    1.72616e+06, 1241.57,
163.100,    1.69808e+06, 1239.42,
172.600,    1.67656e+06, 1237.12,
182.100,    1.66018e+06, 1234.73,
191.600,    1.58706e+06, 1180.54,
201.100,    1.42006e+06, 1180.55,
210.600,    1.27188e+06, 1180.53,
220.000,    1.14152e+06, 1180.55,
220.100,    1.11528e+06, 1193.29,
220.800,    1.14768e+06, 1170.67,
222.300,    1.11585e+06, 1183.78,
224.600,    1.11928e+06, 1177.60,
227.600,    1.09476e+06, 1182.83,
231.400,    1.08230e+06, 1175.69,
235.900,    1.04847e+06, 1183.76,
241.200,    1.02051e+06, 1177.77,
```

```
          247.200,    9.79736e+05, 1182.43,
          254.000,    9.38851e+05, 1179.20,
          261.600,    8.84830e+05, 1181.36,
          269.900,    7.30166e+05, 1179.80,
          279.000,    6.66313e+05, 1181.76,
          288.800,    5.57809e+05, 1180.06,
          299.400,    4.96379e+05, 1180.81,
          311.000,    4.20296e+05, 1179.93,
          311.010,           0.00, 1179.93,
      1.00001e+07,           0.00,    0.00 $END
```

Case 2, DEDLS LOCA w/CS Train Failure

```
$LIST POOL=301,          0,           0,      0,
          0.0103421,  2.75463e+08,  554.43,
          0.0203421,  2.72956e+08,  553.61,
          0.0303421,  2.74063e+08,  553.27,
          0.0403421,  2.76931e+08,  553.31,
          0.0503421,  2.97586e+08,  553.46,
          0.0603421,  2.84049e+08,  553.54,
          0.0703421,  2.78919e+08,  553.48,
          0.0803421,  2.86323e+08,  553.41,
          0.0901884,  3.45168e+08,  554.02,
          0.100686,   4.12405e+08,  554.03,
          0.150686,   4.36972e+08,  556.16,
          0.200686,   4.22471e+08,  556.85,
          0.250686,   4.20134e+08,  557.26,
          0.300686,   4.17128e+08,  557.32,
          0.350686,   4.07365e+08,  557.23,
          0.400686,   4.10645e+08,  557.16,
          0.450686,   4.05922e+08,  557.09,
          0.499686,   4.04438e+08,  557.03,
          1.00069,    3.73813e+08,  558.71,
          1.50069,    3.01578e+08,  569.10,
          2.00069,    2.62691e+08,  576.37,
          2.50069,    2.16451e+08,  577.37,
          3.00069,    1.97648e+08,  579.33,
          4.00131,    1.66789e+08,  619.63,
          5.00044,    1.24285e+08,  679.25,
          6.00044,    1.18203e+08,  661.96,
          7.00044,    9.53597e+07,  694.06,
          8.00044,    7.54916e+07,  744.56,
          9.00044,    3.60446e+07, 1016.36,
          10.0021,    2.91492e+07,  959.57,
          11.0021,    4.28504e+07,  656.17,
          12.0021,    4.37940e+07,  475.01,
          12.5021,    3.79980e+07,  419.00,
          13.0017,    3.43031e+07,  373.20,
          13.5008,    3.75977e+07,  345.15,
          14.0008,    1.25310e+07,  336.27,
          14.2008,    9.74693e+06,  334.46,
          14.4008,    6.42028e+06,  336.95,
          14.6008,    2.18261e+06,  362.69,
          14.7998,    0.00000e+00,  362.69,
          14.810,     0.00000e+00, 1301.15,
          14.900,     3.84804e+05, 1301.15,
          19.200,     2.27808e+06, 1287.75,
          20.700,     2.61515e+06, 1282.34,
          20.710,     1.30757e+06, 1282.34,
```

```
      23.400,    1.31211e+06, 1276.97,
      27.600,    1.30921e+06, 1273.17,
      31.800,    1.30241e+06, 1271.09,
      35.900,    1.29483e+06, 1269.47,
      40.100,    1.28673e+06, 1267.96,
      44.300,    1.27854e+06, 1266.46,
      48.500,    1.27039e+06, 1264.96,
      52.700,    1.26225e+06, 1263.44,
      56.900,    1.25411e+06, 1261.92,
      61.000,    1.24614e+06, 1260.44,
      65.200,    1.23791e+06, 1258.94,
      69.400,    1.22965e+06, 1257.46,
      73.600,    1.22134e+06, 1255.98,
      77.690,    1.21316e+06, 1254.58,
      77.700,    2.42633e+06, 1254.58,
      85.300,    2.39594e+06, 1251.95,
      92.900,    2.36552e+06, 1249.28,
     100.400,    2.33536e+06, 1246.69,
     108.000,    2.30461e+06, 1244.06,
     115.500,    2.27387e+06, 1241.55,
     123.100,    2.24237e+06, 1239.05,
     130.600,    2.21026e+06, 1236.81,
     138.200,    2.17850e+06, 1234.29,
     145.700,    2.14686e+06, 1231.86,
     153.300,    2.11432e+06, 1229.66,
     160.800,    1.98961e+06, 1180.52,
     168.400,    1.81735e+06, 1180.54,
     175.900,    1.66489e+06, 1180.53,
     183.500,    1.52780e+06, 1180.52,
     191.000,    1.40112e+06, 1180.55,
     191.100,    1.40671e+06, 1179.25,
     191.600,    1.36652e+06, 1182.93,
     192.700,    1.38259e+06, 1179.00,
     194.400,    1.35362e+06, 1182.18,
     196.600,    1.34309E+06, 1177.02,
     199.400,    1.30238E+06, 1182.93,
     202.800,    1.27903e+06, 1176.32,
     206.700,    1.23832e+06, 1183.02,
     211.100,    1.01260e+06, 1178.71,
     216.100,    1.00484e+06, 1183.92,
     221.700,    8.47980e+05, 1178.45,
     227.900,    7.95247e+05, 1182.09,
     234.600,    6.75108e+05, 1180.29,
     241.800,    6.07892e+05, 1179.81,
     249.600,    5.10221e+05, 1181.35,
     258.000,    4.40352e+05, 1179.17,
     258.010,           0.00, 1179.19,
  1.00001e+07,          0.00,    0.00 $END
```

Case 3, DEDLS LOCA w/ECU Train Failure

This table is identical to Case 2. Since both cases have no SI train failure, the reflood/post-reflood mass-energy releases are the same.

```
$LIST POOL=301,          0,          0,      0,
           0.0103421, 2.75463e+08, 554.43,
           0.0203421, 2.72956e+08, 553.61,
           0.0303421, 2.74063e+08, 553.27,
```

```
0.0403421,  2.76931e+08,  553.31,
0.0503421,  2.97586e+08,  553.46,
0.0603421,  2.84049e+08,  553.54,
0.0703421,  2.78919e+08,  553.48,
0.0803421,  2.86323e+08,  553.41,
0.0901884,  3.45168e+08,  554.02,
0.100686,   4.12405e+08,  554.03,
0.150686,   4.36972e+08,  556.16,
0.200686,   4.22471e+08,  556.85,
0.250686,   4.20134e+08,  557.26,
0.300686,   4.17128e+08,  557.32,
0.350686,   4.07365e+08,  557.23,
0.400686,   4.10645e+08,  557.16,
0.450686,   4.05922e+08,  557.09,
0.499686,   4.04438e+08,  557.03,
1.00069,    3.73813e+08,  558.71,
1.50069,    3.01578e+08,  569.10,
2.00069,    2.62691e+08,  576.37,
2.50069,    2.16451e+08,  577.37,
3.00069,    1.97648e+08,  579.33,
4.00131,    1.66789e+08,  619.63,
5.00044,    1.24285e+08,  679.25,
6.00044,    1.18203e+08,  661.96,
7.00044,    9.53597e+07,  694.06,
8.00044,    7.54916e+07,  744.56,
9.00044,    3.60446e+07, 1016.36,
10.0021,    2.91492e+07,  959.57,
11.0021,    4.28504e+07,  656.17,
12.0021,    4.37940e+07,  475.01,
12.5021,    3.79980e+07,  419.00,
13.0017,    3.43031e+07,  373.20,
13.5008,    3.75977e+07,  345.15,
14.0008,    1.25310e+07,  336.27,
14.2008,    9.74693e+06,  334.46,
14.4008,    6.42028e+06,  336.95,
14.6008,    2.18261e+06,  362.69,
14.7998,    0.00000e+00,  362.69,
14.810,     0.00000e+00, 1301.15,
14.900,     3.84804e+05, 1301.15,
19.200,     2.27808e+06, 1287.75,
20.700,     2.61515e+06, 1282.34,
20.710,     1.30757e+06, 1282.34,
23.400,     1.31211e+06, 1276.97,
27.600,     1.30921e+06, 1273.17,
31.800,     1.30241e+06, 1271.09,
35.900,     1.29483e+06, 1269.47,
40.100,     1.28673e+06, 1267.96,
44.300,     1.27854e+06, 1266.46,
48.500,     1.27039e+06, 1264.96,
52.700,     1.26225e+06, 1263.44,
56.900,     1.25411e+06, 1261.92,
61.000,     1.24614e+06, 1260.44,
65.200,     1.23791e+06, 1258.94,
69.400,     1.22965e+06, 1257.46,
73.600,     1.22134e+06, 1255.98,
77.690,     1.21316e+06, 1254.58,
77.700,     2.42633e+06, 1254.58,
85.300,     2.39594e+06, 1251.95,
92.900,     2.36552e+06, 1249.28,
100.400,    2.33536e+06, 1246.69,
```

```
        108.000,    2.30461e+06, 1244.06,
        115.500,    2.27387e+06, 1241.55,
        123.100,    2.24237e+06, 1239.05,
        130.600,    2.21026e+06, 1236.81,
        138.200,    2.17850e+06, 1234.29,
        145.700,    2.14686e+06, 1231.86,
        153.300,    2.11432e+06, 1229.66,
        160.800,    1.98961e+06, 1180.52,
        168.400,    1.81735e+06, 1180.54,
        175.900,    1.66489e+06, 1180.53,
        183.500,    1.52780e+06, 1180.52,
        191.000,    1.40112e+06, 1180.55,
        191.100,    1.40671e+06, 1179.25,
        191.600,    1.36652e+06, 1182.93,
        192.700,    1.38259e+06, 1179.00,
        194.400,    1.35362e+06, 1182.18,
        196.600,    1.34309E+06, 1177.02,
        199.400,    1.30238E+06, 1182.93,
        202.800,    1.27903e+06, 1176.32,
        206.700,    1.23832e+06, 1183.02,
        211.100,    1.01260e+06, 1178.71,
        216.100,    1.00484e+06, 1183.92,
        221.700,    8.47980e+05, 1178.45,
        227.900,    7.95247e+05, 1182.09,
        234.600,    6.75108e+05, 1180.29,
        241.800,    6.07892e+05, 1179.81,
        249.600,    5.10221e+05, 1181.35,
        258.000,    4.40352e+05, 1179.17,
        258.010,           0.00, 1179.19,
    1.00001e+07,           0.00,    0.00 $END
```

Case 4, DESLS LOCA w/DG Failure

Cases 4, 5, and 6 all have the same mass-energy release flow during initial RCS blowdown (0 to 18.4100 seconds). The timing of the final post-reflood mass-energy data point is rounded from 253.60seconds in the ABB-supplied table to 254 seconds to correspond to the rounded time for initializing COPATTA reactor vessel calculations (Design Input 4.7 and Section 8.1.4).

```
$LIST POOL=301,        0,          0,      0,
            0.0101591,   2.76290e+08,  555.06,
            0.0201591,   2.71945e+08,  554.21,
            0.0301591,   2.70278e+08,  553.61,
            0.0401591,   2.70214e+08,  553.37,
            0.0501591,   2.70331e+08,  553.40,
            0.0601591,   2.69700e+08,  553.53,
            0.0701591,   2.68210e+08,  553.69,
            0.0800991,   2.66522e+08,  553.89,
            0.0900991,   2.65138e+08,  554.08,
            0.100099,    2.64412e+08,  554.30,
            0.150099,    2.68953e+08,  555.89,
            0.200099,    2.70322e+08,  557.21,
            0.250099,    2.74895e+08,  558.27,
            0.300099,    2.74942e+08,  559.11,
            0.350099,    2.77154e+08,  559.92,
            0.400099,    2.76002e+08,  560.74,
            0.450099,    2.76795e+08,  561.52,
            0.500099,    2.75253e+08,  562.39,
```

```
 1.00010,   2.66197e+08,  571.16,
 1.50010,   2.49140e+08,  576.47,
 2.00010,   2.31010e+08,  579.68,
 2.50010,   2.05488e+08,  586.33,
 3.00010,   1.62033e+08,  609.52,
 4.00082,   1.23496e+08,  629.33,
 5.00082,   1.12250e+08,  638.75,
 6.00082,   1.00938e+08,  654.69,
 7.00082,   9.31147e+07,  658.07,
 8.00082,   8.74523e+07,  656.30,
 9.00082,   8.14244e+07,  662.20,
10.00080,   6.57601e+07,  719.48,
11.00080,   5.60322e+07,  756.46,
12.00440,   4.40165e+07,  800.42,
12.99970,   3.39326e+07,  730.84,
14.00430,   3.10272e+07,  674.77,
15.00430,   2.51280e+07,  656.55,
16.00190,   1.54538e+07,  706.73,
16.49970,   1.35041e+07,  704.97,
17.00020,   9.76676e+06,  769.16,
17.50240,   8.85420e+06,  741.36,
18.00060,   1.05321e+07,  570.22,
18.19980,   9.92243e+06,  575.85,
18.40250,   9.02380e+06,  597.71,
18.41000,   0.00000e+00,  597.71,
18.410,     0.00000e+00,  1293.42,
18.500,     4.90032e+05,  1293.42,
23.300,     3.39775e+06,  1271.47,
23.310,     1.69888e+06,  1271.47,
23.500,     1.70039e+06,  1270.51,
28.300,     1.71092e+06,  1257.38,
33.100,     1.70050e+06,  1251.98,
37.900,     1.68505e+06,  1248.37,
42.700,     1.66831e+06,  1245.23,
47.500,     1.65119e+06,  1242.22,
52.300,     1.63397e+06,  1239.27,
57.200,     1.61644e+06,  1236.26,
62.000,     1.59932e+06,  1233.30,
66.800,     1.58168e+06,  1230.27,
71.600,     1.56492e+06,  1227.18,
76.400,     1.54818e+06,  1224.10,
81.200,     1.53131e+06,  1221.42,
86.000,     1.41716e+06,  1204.75,
90.790,     1.31929e+06,  1205.88,
90.800,     2.63858e+06,  1205.88,
96.600,     2.42701e+06,  1205.78,
102.400,    2.20039e+06,  1206.28,
108.200,    1.99714e+06,  1206.92,
114.000,    1.81476e+06,  1207.66,
119.800,    1.65154e+06,  1208.54,
125.600,    1.50408e+06,  1209.50,
131.400,    1.36901e+06,  1210.63,
137.200,    1.25104e+06,  1211.73,
143.000,    1.14649e+06,  1212.86,
148.800,    1.05343e+06,  1214.07,
154.600,    9.70272e+05,  1215.27,
160.400,    8.95968e+05,  1216.49,
166.200,    8.29404e+05,  1217.72,
172.000,    7.69644e+05,  1218.91,
177.700,    7.16832e+05,  1220.12,
```

```
        177.800,    6.83525e+05,  1263.17,
        178.400,    7.32496e+05,  1180.38,
        179.600,    6.91780e+05,  1243.35,
        181.500,    7.21699e+05,  1202.55,
        184.100,    6.94955e+05,  1233.07,
        187.200,    6.98598e+05,  1216.97,
        191.000,    6.72955e+05,  1230.21,
        195.400,    6.60683e+05,  1221.25,
        200.500,    6.29539e+05,  1230.03,
        206.200,    6.08357e+05,  1224.98,
        212.500,    5.78120e+05,  1229.50,
        219.400,    5.53010e+05,  1229.93,
        227.000,    5.24149e+05,  1230.89,
        235.200,    4.98780e+05,  1229.88,
        244.100,    4.71776e+05,  1234.16,
        254.000,    4.47548e+05,  1230.83,
        254.010,           0.00,  1230.83,
      1.00001e+07,         0.00,     0.00 $END
```

Case 5, DESLS LOCA w/CS Train Failure

```
$LIST POOL=301,        0,          0,      0,
          0.0101591,   2.76290e+08,  555.06,
          0.0201591,   2.71945e+08,  554.21,
          0.0301591,   2.70278e+08,  553.61,
          0.0401591,   2.70214e+08,  553.37,
          0.0501591,   2.70331e+08,  553.40,
          0.0601591,   2.69700e+08,  553.53,
          0.0701591,   2.68210e+08,  553.69,
          0.0800991,   2.66522e+08,  553.89,
          0.0900991,   2.65138e+08,  554.08,
          0.100099,    2.64412e+08,  554.30,
          0.150099,    2.68953e+08,  555.89,
          0.200099,    2.70322e+08,  557.21,
          0.250099,    2.74895e+08,  558.27,
          0.300099,    2.74942e+08,  559.11,
          0.350099,    2.77154e+08,  559.92,
          0.400099,    2.76002e+08,  560.74,
          0.450099,    2.76795e+08,  561.52,
          0.500099,    2.75253e+08,  562.39,
          1.00010,     2.66197e+08,  571.16,
          1.50010,     2.49140e+08,  576.47,
          2.00010,     2.31010e+08,  579.68,
          2.50010,     2.05488e+08,  586.33,
          3.00010,     1.62033e+08,  609.52,
          4.00082,     1.23496e+08,  629.33,
          5.00082,     1.12250e+08,  638.75,
          6.00082,     1.00938e+08,  654.69,
          7.00082,     9.31147e+07,  658.07,
          8.00082,     8.74523e+07,  656.30,
          9.00082,     8.14244e+07,  662.20,
         10.00080,     6.57601e+07,  719.48,
         11.00080,     5.60322e+07,  756.46,
         12.00440,     4.40165e+07,  800.42,
         12.99970,     3.39326e+07,  730.84,
         14.00430,     3.10272e+07,  674.77,
         15.00430,     2.51280e+07,  656.55,
         16.00190,     1.54538e+07,  706.73,
         16.49970,     1.35041e+07,  704.97,
```

```
17.00020,     9.76676e+06,  769.16,
17.50240,     8.85420e+06,  741.36,
18.00060,     1.05321e+07,  570.22,
18.19980,     9.92243e+06,  575.85,
18.40250,     9.02380e+06,  597.71,
18.41000,     0.00000e+00,  597.71,
18.410,       0.00000e+00,  1293.36,
18.500,       5.02776e+05,  1293.36,
22.300,       3.37244e+06,  1276.23,
22.310,       1.68622e+06,  1276.23,
23.500,       1.70127e+06,  1269.89,
28.300,       1.71070e+06,  1257.17,
33.100,       1.70003e+06,  1251.87,
37.900,       1.68451e+06,  1248.29,
42.700,       1.66775e+06,  1245.15,
47.600,       1.65028e+06,  1242.09,
52.400,       1.63305e+06,  1239.13,
57.200,       1.61588e+06,  1236.19,
62.000,       1.59876e+06,  1233.22,
66.800,       1.58112e+06,  1230.19,
71.700,       1.56400e+06,  1227.05,
76.500,       1.54726e+06,  1223.97,
81.300,       1.53040e+06,  1221.30,
86.100,       1.41255e+06,  1204.79,
90.890,       1.31501e+06,  1205.91,
90.900,       2.63002e+06,  1205.91,
94.300,       2.50132e+06,  1206.73,
97.600,       2.38468e+06,  1207.48,
100.900,      2.27333e+06,  1208.21,
104.200,      2.16666e+06,  1208.91,
107.500,      2.06431e+06,  1209.60,
110.800,      1.96614e+06,  1210.29,
114.100,      1.87189e+06,  1210.99,
117.500,      1.77876e+06,  1211.72,
120.800,      1.69204e+06,  1212.44,
124.100,      1.60877e+06,  1213.19,
127.400,      1.52719e+06,  1214.04,
130.700,      1.44742e+06,  1214.87,
134.000,      1.37081e+06,  1215.79,
137.300,      1.29730e+06,  1216.73,
140.600,      1.22666e+06,  1217.73,
140.700,      1.22307e+06,  1205.88,
140.900,      1.19081e+06,  1240.48,
141.500,      1.16737e+06,  1203.69,
142.300,      1.15462e+06,  1238.36,
143.400,      1.13060e+06,  1212.05,
144.800,      1.10273e+06,  1233.74,
146.500,      1.07058e+06,  1217.03,
148.400,      1.03638e+06,  1232.87,
150.600,      9.90454e+05,  1222.65,
153.100,      1.18497e+06,  1207.69,
155.900,      4.23662e+05,  1230.10,
159.000,      1.05582e+06,  1209.04,
162.300,      6.98101e+05,  1236.23,
165.900,      7.91903e+05,  1228.68,
169.800,      4.46864e+05,  1189.66,
174.000,      5.47423e+05,  1227.23,
174.010,            0.00,  1227.23,
1.00001e+07,        0.00,     0.00 $END
```

Case 6, DESLS LOCA w/ECU Train Failure

This table is identical to Case 5. Since both cases have no SI train failure, the reflood/post-reflood mass-energy releases are the same.

```
$LIST POOL=301,        0,          0,       0,
              0.0101591,  2.76290e+08,  555.06,
              0.0201591,  2.71945e+08,  554.21,
              0.0301591,  2.70278e+08,  553.61,
              0.0401591,  2.70214e+08,  553.37,
              0.0501591,  2.70331e+08,  553.40,
              0.0601591,  2.69700e+08,  553.53,
              0.0701591,  2.68210e+08,  553.69,
              0.0800991,  2.66522e+08,  553.89,
              0.0900991,  2.65138e+08,  554.08,
              0.100099,   2.64412e+08,  554.30,
              0.150099,   2.68953e+08,  555.89,
              0.200099,   2.70322e+08,  557.21,
              0.250099,   2.74895e+08,  558.27,
              0.300099,   2.74942e+08,  559.11,
              0.350099,   2.77154e+08,  559.92,
              0.400099,   2.76002e+08,  560.74,
              0.450099,   2.76795e+08,  561.52,
              0.500099,   2.75253e+08,  562.39,
              1.00010,    2.66197e+08,  571.16,
              1.50010,    2.49140e+08,  576.47,
              2.00010,    2.31010e+08,  579.68,
              2.50010,    2.05488e+08,  586.33,
              3.00010,    1.62033e+08,  609.52,
              4.00082,    1.23496e+08,  629.33,
              5.00082,    1.12250e+08,  638.75,
              6.00082,    1.00938e+08,  654.69,
              7.00082,    9.31147e+07,  658.07,
              8.00082,    8.74523e+07,  656.30,
              9.00082,    8.14244e+07,  662.20,
             10.00080,    6.57601e+07,  719.48,
             11.00080,    5.60322e+07,  756.46,
             12.00440,    4.40165e+07,  800.42,
             12.99970,    3.39326e+07,  730.84,
             14.00430,    3.10272e+07,  674.77,
             15.00430,    2.51280e+07,  656.55,
             16.00190,    1.54538e+07,  706.73,
             16.49970,    1.35041e+07,  704.97,
             17.00020,    9.76676e+06,  769.16,
             17.50240,    8.85420e+06,  741.36,
             18.00060,    1.05321e+07,  570.22,
             18.19980,    9.92243e+06,  575.85,
             18.40250,    9.02380e+06,  597.71,
             18.41000,    0.00000e+00,  597.71,
             18.410,      0.00000e+00,  1293.36,
             18.500,      5.02776e+05,  1293.36,
             22.300,      3.37244e+06,  1276.23,
             22.310,      1.68622e+06,  1276.23,
             23.500,      1.70127e+06,  1269.89,
             28.300,      1.71070e+06,  1257.17,
             33.100,      1.70003e+06,  1251.87,
             37.900,      1.68451e+06,  1248.29,
             42.700,      1.66775e+06,  1245.15,
```

```
    47.600,    1.65028e+06,  1242.09,
    52.400,    1.63305e+06,  1239.13,
    57.200,    1.61588e+06,  1236.19,
    62.000,    1.59876e+06,  1233.22,
    66.800,    1.58112e+06,  1230.19,
    71.700,    1.56400e+06,  1227.05,
    76.500,    1.54726e+06,  1223.97,
    81.300,    1.53040e+06,  1221.30,
    86.100,    1.41255e+06,  1204.79,
    90.890,    1.31501e+06,  1205.91,
    90.900,    2.63002e+06,  1205.91,
    94.300,    2.50132e+06,  1206.73,
    97.600,    2.38468e+06,  1207.48,
   100.900,    2.27333e+06,  1208.21,
   104.200,    2.16666e+06,  1208.91,
   107.500,    2.06431e+06,  1209.60,
   110.800,    1.96614e+06,  1210.29,
   114.100,    1.87189e+06,  1210.99,
   117.500,    1.77876e+06,  1211.72,
   120.800,    1.69204e+06,  1212.44,
   124.100,    1.60877e+06,  1213.19,
   127.400,    1.52719e+06,  1214.04,
   130.700,    1.44742e+06,  1214.87,
   134.000,    1.37081e+06,  1215.79,
   137.300,    1.29730e+06,  1216.73,
   140.600,    1.22666e+06,  1217.73,
   140.700,    1.22307e+06,  1205.88,
   140.900,    1.19081e+06,  1240.48,
   141.500,    1.16737e+06,  1203.69,
   142.300,    1.15462e+06,  1238.36,
   143.400,    1.13060e+06,  1212.05,
   144.800,    1.10273e+06,  1233.74,
   146.500,    1.07058e+06,  1217.03,
   148.400,    1.03638e+06,  1232.87,
   150.600,    9.90454e+05,  1222.65,
   153.100,    1.18497e+06,  1207.69,
   155.900,    4.23662e+05,  1230.10,
   159.000,    1.05582e+06,  1209.04,
   162.300,    6.98101e+05,  1236.23,
   165.900,    7.91903e+05,  1228.68,
   169.800,    4.46864e+05,  1189.66,
   174.000,    5.47423e+05,  1227.23,
   174.010,          0.00,  1227.23,
 1.00001e+07,        0.00,     0.00 $END
```

Case 7, DEHLS LOCA w/DG Failure

Cases 7, 8, and 9 all have the same mass-energy release flow during initial RCS blowdown (0 to 12.2000 seconds). In the case of the hot leg breaks, all steam from the reactor vessel boil-off flows directly to containment without being forced to flow through a steam generator. With no mechanism for the break flow to rapidly extract energy from a steam generator, no reflood/post-reflood mass-energy release data is provided by ABB-CE. At the end of initial RCS blowdown, the COPATTA program begins to calculate the break flow using energy inputs from the decay heat and sensible heat tables (Card Series 101 and 201, together with safety injection flows from Card Series 801.

```
$LIST POOL=301,        0,            0,        0,
              0.0103421,  6.27354e+08,  643.05,
              0.0202421,  6.02244e+08,  640.94,
              0.0307891,  6.08616e+08,  642.24,
              0.0401493,  5.48352e+08,  641.28,
              0.0499552,  4.76899e+08,  638.15,
              0.0599552,  4.95108e+08,  637.33,
              0.0699552,  5.28664e+08,  640.99,
              0.0799552,  5.06801e+08,  640.93,
              0.0899552,  4.99086e+08,  639.35,
              0.0999552,  5.29254e+08,  640.78,
              0.149955,   5.09058e+08,  641.86,
              0.199955,   4.72468e+08,  641.13,
              0.249955,   4.53560e+08,  640.96,
              0.299955,   4.26856e+08,  639.77,
              0.349955,   4.19393e+08,  638.70,
              0.399955,   4.06228e+08,  637.33,
              0.449955,   3.93149e+08,  636.55,
              0.499955,   3.85862e+08,  635.72,
              0.999955,   2.88242e+08,  645.34,
              1.49996,    2.64587e+08,  630.78,
              1.99996,    2.66148e+08,  611.46,
              2.49996,    2.46600e+08,  611.91,
              2.99996,    2.20959e+08,  628.09,
              4.00168,    1.88085e+08,  635.67,
              5.00168,    1.62186e+08,  642.94,
              6.00168,    1.26314e+08,  668.96,
              7.00322,    6.26681e+07,  933.15,
              8.00322,    4.88578e+07,  923.82,
              9.00322,    2.30701e+07, 1111.97,
             10.0024,     2.41007e+07,  981.82,
             10.2024,     2.23662e+07, 1006.48,
             10.4024,     2.02257e+07, 1021.58,
             10.6024,     1.73485e+07, 1034.34,
             10.8024,     1.23247e+07, 1100.95,
             11.0024,     7.76318e+06, 1207.09,
             11.1999,     5.11481e+06, 1225.42,
             11.4035,     4.37044e+06, 1233.57,
             11.6035,     3.80862e+06, 1226.16,
             11.8035,     3.16153e+06, 1228.38,
             12.0019,     2.49742e+06, 1229.31,
             12.2000,           0.00, 1229.31,
         1.00001e+07,           0.00,    0.00 $END
```

Case 8, DEHLS LOCA w/CS Train Failure

This table is identical to Case 7.

```
$LIST POOL=301,        0,            0,        0,
              0.0103421,  6.27354e+08,  643.05,
              0.0202421,  6.02244e+08,  640.94,
              0.0307891,  6.08616e+08,  642.24,
              0.0401493,  5.48352e+08,  641.28,
              0.0499552,  4.76899e+08,  638.15,
              0.0599552,  4.95108e+08,  637.33,
              0.0699552,  5.28664e+08,  640.99,
              0.0799552,  5.06801e+08,  640.93,
              0.0899552,  4.99086e+08,  639.35,
```

```
                0.0999552,  5.29254e+08,  640.78,
                0.149955,   5.09058e+08,  641.86,
                0.199955,   4.72468e+08,  641.13,
                0.249955,   4.53560e+08,  640.96,
                0.299955,   4.26856e+08,  639.77,
                0.349955,   4.19393e+08,  638.70,
                0.399955,   4.06228e+08,  637.33,
                0.449955,   3.93149e+08,  636.55,
                0.499955,   3.85862e+08,  635.72,
                0.999955,   2.88242e+08,  645.34,
                1.49996,    2.64587e+08,  630.78,
                1.99996,    2.66148e+08,  611.46,
                2.49996,    2.46600e+08,  611.91,
                2.99996,    2.20959e+08,  628.09,
                4.00168,    1.88085e+08,  635.67,
                5.00168,    1.62186e+08,  642.94,
                6.00168,    1.26314e+08,  668.96,
                7.00322,    6.26681e+07,  933.15,
                8.00322,    4.88578e+07,  923.82,
                9.00322,    2.30701e+07, 1111.97,
               10.0024,     2.41007e+07,  981.82,
               10.2024,     2.23662e+07, 1006.48,
               10.4024,     2.02257e+07, 1021.58,
               10.6024,     1.73485e+07, 1034.34,
               10.8024,     1.23247e+07, 1100.95,
               11.0024,     7.76318e+06, 1207.09,
               11.1999,     5.11481e+06, 1225.42,
               11.4035,     4.37044e+06, 1233.57,
               11.6035,     3.80862e+06, 1226.16,
               11.8035,     3.16153e+06, 1228.38,
               12.0019,     2.49742e+06, 1229.31,
               12.2000,            0.00, 1229.31,
           1.00001e+07,            0.00,    0.00 $END
```

Case 9, DEHLS LOCA w/ECU Train Failure

This table is identical to Case 7.

```
$LIST POOL=301,        0,           0,       0,
                0.0103421,  6.27354e+08,  643.05,
                0.0202421,  6.02244e+08,  640.94,
                0.0307891,  6.08616e+08,  642.24,
                0.0401493,  5.48352e+08,  641.28,
                0.0499552,  4.76899e+08,  638.15,
                0.0599552,  4.95108e+08,  637.33,
                0.0699552,  5.28664e+08,  640.99,
                0.0799552,  5.06801e+08,  640.93,
                0.0899552,  4.99086e+08,  639.35,
                0.0999552,  5.29254e+08,  640.78,
                0.149955,   5.09058e+08,  641.86,
                0.199955,   4.72468e+08,  641.13,
                0.249955,   4.53560e+08,  640.96,
                0.299955,   4.26856e+08,  639.77,
                0.349955,   4.19393e+08,  638.70,
                0.399955,   4.06228e+08,  637.33,
                0.449955,   3.93149e+08,  636.55,
                0.499955,   3.85862e+08,  635.72,
                0.999955,   2.88242e+08,  645.34,
```

```
     1.49996,    2.64587e+08,  630.78,
     1.99996,    2.66148e+08,  611.46,
     2.49996,    2.46600e+08,  611.91,
     2.99996,    2.20959e+08,  628.09,
     4.00168,    1.88085e+08,  635.67,
     5.00168,    1.62186e+08,  642.94,
     6.00168,    1.26314e+08,  668.96,
     7.00322,    6.26681e+07,  933.15,
     8.00322,    4.88578e+07,  923.82,
     9.00322,    2.30701e+07, 1111.97,
    10.0024,     2.41007e+07,  981.82,
    10.2024,     2.23662e+07, 1006.48,
    10.4024,     2.02257e+07, 1021.58,
    10.6024,     1.73485e+07, 1034.34,
    10.8024,     1.23247e+07, 1100.95,
    11.0024,     7.76318e+06, 1207.09,
    11.1999,     5.11481e+06, 1225.42,
    11.4035,     4.37044e+06, 1233.57,
    11.6035,     3.80862e+06, 1226.16,
    11.8035,     3.16153e+06, 1228.38,
    12.0019,     2.49742e+06, 1229.31,
    12.2000,            0.00, 1229.31,
1.00001e+07,            0.00,    0.00 $END
```

8.1.13 Card Series 401

Card Series 401 is a table that is used to apportion energy into the reactor vessel water from the core decay heat table (card series 101) and any energy in the metal-water reaction /sensible heat addition table (card series 201). The card series 401 table consists of decay heat multiplier and metal-water reaction multiplier versus time in seconds. A minimum of two data sets are required and a maximum of 20 data sets are permitted. The data are entered in the following order:

Time (seconds)
Decay Power Multiplier (dimensionless)
Metal-Water Reaction/Sensible Heat Multiplier (dimensionless)

The decay heat is all added to the reactor vessel water (Section 8.1.10, Card Series 101). All the metal-water reaction energy is added to the containment vapor region (Section 8.1.11, Card Series 201); therefore the multiplier in the 401 table is zero out through the end of the metal-water reaction energy interval. The fraction of the sensible heat addition which is input to the reactor vessel water is a variable function of time as determined by the ratio of the sensible heat from the RCS to the sum of the sensible heat from the RCS plus the sensible heat from the steam generator in the broken cold leg loop. These fractions are calculated in the Quattro Pro spreadsheets used to manipulate the data provided by ABB-CE for insertion into the COPATTA input file. In the case of the hot leg LOCA, all sensible heat is input into the reactor vessel water.

The Card Series 401 tabular input listing for each LOCA case is provided below, including the metal-water reaction for the specific case at the beginning of the input table.

Case 1, DEDLS LOCA w/DG Failure

```
$LIST POOL=401,      0,     0,      0,
              3.11E2,     0,      0,
              3.11E2,     1,  0.984,
              5.13E2,     1,  0.986,
              6.13E2,     1,  0.816,
             1.013E3,     1,  0.775,
             4.226E3,     1,  0.547,
            1.0026E4,     1,  0.322,
            1.9626E4,     1,  0.237,
            8.8260E4,     1,  0.232,
            9.4260E4,     1,  0.040,
            1.9826E5,     1,  0.309,
            5.3565E5,     1,  0.588,
           1.03065E6,     1,  0.207,
           1.27565E6,     1,  0.314,
           1.52565E6,     1,  0.277,
           2.01565E6,     1,  0.323,
           3.00565E6,     1,  0.300,
           3.25065E6,     1,  0.358,
           1.00001E7,     1,  0.358 $END
```

Case 2, DEDLS LOCA w/CS Train Failure

```
$LIST POOL=401,      0,     0,      0,
            2.58E2,     0,      0,
            2.58E2,     1,  0.974,
           4.929E2,     1,  0.976,
           4.979E2,     1,  0.804,
           2.116E3,     1,  0.632,
           4.916E3,     1,  0.476,
          1.0116E4,     1,  0.258,
          3.9160E4,     1,  0.154,
          8.9160E4,     1,  0.185,
          9.5160E4,     1,  0.013,
          1.0116E5,     1,  0.073,
          2.9716E5,     1,  0.483,
          5.3790E5,     1,  0.618,
          7.8790E5,     1,  0.374,
         1.03290E6,     1,  0.181,
         1.52790E6,     1,  0.345,
         2.01790E6,     1,  0.253,
         3.25290E6,     1,  0.366,
         1.00001E7,     1,  0.366 $END
```

Case 3, DEDLS LOCA w/ECU Train Failure

```
$LIST POOL=401,      0,     0,  0,
            2.58E2,     0,  0,
            2.58E2,     1,  0.974,
           4.929E2,     1,  0.975,
           4.979E2,     1,  0.819,
           1.258E3,     1,  0.721,
           4.916E3,     1,  0.440,
          1.5116E4,     1,  0.194,
          4.9160E4,     1,  0.148,
          1.0116E5,     1,  0.082,
          2.9716E5,     1,  0.472,
          5.3790E5,     1,  0.673,
         1.03290E6,     1,  0.261,
         1.27790E6,     1,  0.209,
         1.52790E6,     1,  0.305,
         1.77290E6,     1,  0.269,
         2.01790E6,     1,  1.0,
         2.26790E6,     1,  0.236,
         2.51290E6,     1,  1.0,
         1.00001E7,     1,  1.0 $END
```

Case 4, DESLS LOCA w/DG Failure

```
$LIST POOL=401,      0,     0,      0,
            2.54E2,     0,      0,
            2.54E2,     1,  0.921,
           4.885E2,     1,  0.930,
           4.935E2,     1,  0.494,
           1.069E3,     1,  0.400,
           2.938E3,     1,  0.303,
          1.0138E4,     1,  0.164,
          1.9738E4,     1,  0.132,
```

```
                4.9380E4,    1,   0.136,
                8.9380E4,    1,   0.163,
                9.5380E4,    1,   0.010,
                1.9938E5,    1,   0.241,
                2.9738E5,    1,   0.387,
                5.3845E5,    1,   0.544,
                7.8845E5,    1,   0.297,
               1.27845E6,    1,   0.314,
               1.77345E6,    1,   0.396,
               3.25345E6,    1,   0.366,
               1.00001E7,    1,   0.366 $END
```

Case 5, DESLS LOCA w/CS Train Failure

```
$LIST POOL=401,      0,     0,     0,
                  1.74E2,    0,     0,
                  1.74E2,    1,     0.906,
                 4.139E2,    1,     0.917,
                 4.189E2,    1,     0.520,
                 9.770E2,    1,     0.386,
                 1.977E3,    1,     0.369,
                 4.954E3,    1,     0.277,
                1.5154E4,    1,     0.110,
                3.9540E4,    1,     0.096,
                9.5540E4,    1,     0.007,
                1.9954E5,    1,     0.218,
                2.9754E5,    1,     0.412,
                5.3885E5,    1,     0.618,
                7.8885E5,    1,     0.364,
               1.03385E6,    1,     0.180,
               1.52885E6,    1,     0.345,
               2.01885E6,    1,     0.258,
               3.25385E6,    1,     0.264,
               1.00001E7,    1,     0.264 $END
```

Case 6, DESLS LOCA w/ECU Train Failure

```
$LIST POOL=401,      0,     0,     0,
                  1.74E2,    0,     0,
                  1.74E2,    1,     0.905,
                 4.139E2,    1,     0.917,
                 4.189E2,    1,     0.552,
                 1.577E3,    1,     0.408,
                 4.954E3,    1,     0.256,
                1.5154E4,    1,     0.114,
                3.9540E4,    1,     0.096,
                9.5540E4,    1,     0.014,
                1.9954E5,    1,     0.211,
                2.9754E5,    1,     0.401,
                5.3885E5,    1,     0.674,
               1.03385E6,    1,     0.261,
               1.27885E6,    1,     0.209,
               1.52885E6,    1,     0.305,
               1.77385E6,    1,     0.269,
               2.26885E6,    1,     1.0,
               3.25385E6,    1,     1.0,
               1.00001E7,    1,     1.0 $END
```

Case 7, DEHLS LOCA w/DG Failure

```
$LIST POOL=401,      0,      0,      0,
             1.22E1,      0,      0,
             1.22E1,      1,      1,
          1.00001E7,      1,      1 $END
```

Case 8, DEHLS LOCA w/CS Train Failure

```
$LIST POOL=401,      0,      0,      0,
             1.22E1,      0,      0,
             1.22E1,      1,      1,
          1.00001E7,      1,      1 $END
```

Case 9, DEHLS LOCA w/ECU Train Failure

```
$LIST POOL=401,      0,      0,      0,
             1.22E1,      0,      0,
             1.22E1,      1,      1,
          1.00001E7,      1,      1 $END
```

8.1.14 Card Series 501

Card Series 501 is a data input table which can be used to provide additional mass and energy break flow into containment following the end of the series 301 mass-energy table. This table is normally used to extend the mass-energy input if the vendor-supplied data exceeds the capacity of the 301 series table. Card Series 501 may include up to 200 sets of break mass-energy release data in the following format:

Time (seconds)
Water or Steam Addition Rate (lb_m/hr)
Energy Addition Rate (Btu/hr)

Card Series 501 is not needed for the LOCA analysis since Card Series 301 has enough space for all break flow data. Therefore, Card Series 501 is included in the data file as:

```
$LIST POOL=501,      0,      0,      0,
          1.00001E7,      0,      0 $END
```

8.1.15 Card Series 601

This card series is used to add water and/or energy directly to the containment sump as a tabular function of time. The table is normally used to model spillage of safety injection water and hot condensate specified by the NSSS vendor in their mass and energy release calculation from cold leg breaks during a LOCA event.

The Card Series 601 table includes up to 80 sets of the following data:

Time (seconds)
Water Addition Rate (lb_m/hr)
Energy Addition Rate (Btu/hr)

As determined by ABB-CE in the mass-energy release analyses summarized in Reference 6.2a, the spillage flow for the three break locations is as follows:

Pump Discharge Leg:
- one of four SI tanks (from time 0 to 30 seconds post-LOCA)
- reflood and post-reflood spillage and condensation (from end of blowdown to end of post-reflood)
- SI pump flow directly to containment sump (from end of blowdown to start of sump water recirculation)

Pump Suction Leg:
- reflood and post-reflood spillage and condensation (from end of blowdown to end of post-reflood)

Hot Leg:
- No specifically identified spillage

The Quattro Pro spreadsheets used to manipulate the data provided by ABB-CE for insertion into the COPATTA input file were also used to combine the spillage terms for the DEDLS LOCA. Spillage tables for all 9 LOCA cases are provided below:

Case 1, DEDLS LOCA w/DG Failure

```
$LIST POOL=601,      0.00,    1.29388E7,    1.16203E9,
                    14.81,    1.29388E7,    1.16203E9,
                    14.81,    1.30599E7,    1.17027E9,
                    15.00,    1.33098E7,    1.23842E9,
                    15.50,    1.34253E7,    1.26993E9,
                    16.00,    1.34633E7,    1.28027E9,
                    16.50,    1.35312E7,    1.29881E9,
                    17.00,    1.36864E7,    1.34112E9,
                    18.00,    1.39285E7,    1.40715E9,
                    19.00,    1.41250E7,    1.46073E9,
                    20.00,    1.42965E7,    1.50753E9,
                    20.70,    3.83107E7,    3.63378E9,
                    22.70,    3.67122E7,    3.49392E9,
                    25.70,    3.47342E7,    3.31987E9,
                    30.00,    3.25346E7,    3.12520E9,
                    30.00,    1.95958E7,    1.96317E9,
```

```
                    30.70,     1.92378E7,     1.93148E9,
                    35.70,     1.72636E7,     1.75607E9,
                    40.70,     1.56645E7,     1.61357E9,
                    45.70,     1.43246E7,     1.49386E9,
                    50.70,     1.31732E7,     1.39075E9,
                    60.70,     1.12672E7,     1.21943E9,
                    70.70,     9.72313E6,     1.07993E9,
                    77.70,     1.33456E6,     3.39165E8,
                    78.70,     1.21176E5,     8.23997E6,
                   199.90,     1.21176E5,     8.23997E6,
                   200.00,     5.34204E5,     1.20834E8,
                   220.10,     8.70696E5,     2.12560E8,
                   240.10,     1.59858E6,     4.10979E8,
                   260.10,     1.82275E6,     4.72083E8,
                   280.10,     2.09941E6,     5.47502E8,
                   300.10,     2.20370E6,     5.75931E8,
                   320.10,     2.26271E6,     5.92016E8,
                   320.11,     1.21176E5,     8.23997E6,
                     2437,     1.21176E5,     8.23997E6,
                     2437,             0,             0,
                1.00001E7,             0,             0 $END
```

Case 2, DEDLS LOCA w/CS Train Failure

```
$LIST POOL=601,      0.00,     1.29388E7,     1.16203E9,
                    14.81,     1.29388E7,     1.16203E9,
                    14.81,     1.44105E7,     1.26211E9,
                    15.00,     1.46659E7,     1.33176E9,
                    15.50,     1.47864E7,     1.36461E9,
                    16.00,     1.48270E7,     1.37570E9,
                    16.50,     1.49086E7,     1.39794E9,
                    17.00,     1.50648E7,     1.44055E9,
                    17.50,     1.51958E7,     1.47627E9,
                    18.00,     1.53111E7,     1.50772E9,
                    19.00,     1.55126E7,     1.56267E9,
                    20.00,     1.56896E7,     1.61093E9,
                    20.70,     4.09956E7,     3.84314E9,
                    22.70,     4.28680E7,     4.00866E9,
                    23.70,     3.86901E7,     3.64111E9,
                    25.70,     3.74203E7,     3.52923E9,
                    30.00,     3.52213E7,     3.33459E9,
                    30.00,     2.22826E7,     2.17256E9,
                    30.70,     2.19246E7,     2.14087E9,
                    35.70,     1.99508E7,     1.96550E9,
                    40.70,     1.83523E7,     1.82305E9,
                    50.70,     1.58621E7,     1.60032E9,
                    60.70,     1.39573E7,     1.42911E9,
                    70.70,     1.24145E7,     1.28971E9,
                    77.70,     1.14841E7,     1.20527E9,
                    78.70,     1.92366E6,     1.39846E8,
                    90.70,     1.99084E6,     1.45758E8,
                    97.70,     2.03015E6,     1.49217E8,
                   120.00,     2.15705E6,     1.60384E8,
                   140.00,     2.27423E6,     1.70696E8,
                   160.00,     2.41117E6,     2.31807E8,
                   180.00,     2.68207E6,     4.19937E8,
                   191.00,     3.03422E6,     5.25998E8,
                   211.00,     4.66592E6,     9.70796E8,
                   231.00,     5.11740E6,     1.09387E9,
```

```
                    251.00,     5.26615E6,     1.13441E9,
                    251.01,     1.47179E6,     1.00082E8,
                      1383,     1.47179E6,     1.00082E8,
                      1383,             0,             0,
                 1.00001E7,             0,             0 $END
```

Case 3, DEDLS LOCA w/ECU Train Failure

This table is identical to Case 2, except for the time to start sump recirculation.

```
$LIST POOL=601,       0.00,     1.29388E7,     1.16203E9,
                     14.81,     1.29388E7,     1.16203E9,
                     14.81,     1.44105E7,     1.26211E9,
                     15.00,     1.46659E7,     1.33176E9,
                     15.50,     1.47864E7,     1.36461E9,
                     16.00,     1.48270E7,     1.37570E9,
                     16.50,     1.49086E7,     1.39794E9,
                     17.00,     1.50648E7,     1.44055E9,
                     17.50,     1.51958E7,     1.47627E9,
                     18.00,     1.53111E7,     1.50772E9,
                     19.00,     1.55126E7,     1.56267E9,
                     20.00,     1.56896E7,     1.61093E9,
                     20.70,     4.09956E7,     3.84314E9,
                     22.70,     4.28680E7,     4.00866E9,
                     23.70,     3.86901E7,     3.64111E9,
                     25.70,     3.74203E7,     3.52923E9,
                     30.00,     3.52213E7,     3.33459E9,
                     30.00,     2.22826E7,     2.17256E9,
                     30.70,     2.19246E7,     2.14087E9,
                     35.70,     1.99508E7,     1.96550E9,
                     40.70,     1.83523E7,     1.82305E9,
                     50.70,     1.58621E7,     1.60032E9,
                     60.70,     1.39573E7,     1.42911E9,
                     70.70,     1.24145E7,     1.28971E9,
                     77.70,     1.14841E7,     1.20527E9,
                     78.70,     1.92366E6,     1.39846E8,
                     90.70,     1.99084E6,     1.45758E8,
                     97.70,     2.03015E6,     1.49217E8,
                    120.00,     2.15705E6,     1.60384E8,
                    140.00,     2.27423E6,     1.70696E8,
                    160.00,     2.41117E6,     2.31807E8,
                    180.00,     2.68207E6,     4.19937E8,
                    191.00,     3.03422E6,     5.25998E8,
                    211.00,     4.66592E6,     9.70796E8,
                    231.00,     5.11740E6,     1.09387E9,
                    251.00,     5.26615E6,     1.13441E9,
                    251.01,     1.47179E6,     1.00082E8,
                      1242,     1.47179E6,     1.00082E8,
                      1242,             0,             0,
                 1.00001E7,             0,             0 $END
```

Case 4, DESLS LOCA w/DG Failure

```
$LIST POOL=601,       0.00,             0,             0,
                     18.41,             0,             0,
                     18.50,     2.45016E5,     6.68232E7,
                     19.00,     4.87476E5,     1.32949E8,
```

```
                    19.50,      5.45166E5,      1.48683E8,
                    19.80,      6.56838E5,      1.70140E8,
                    20.00,      7.58268E5,      2.06802E8,
                    20.30,      8.96040E5,      2.44377E8,
                    20.50,      9.80748E5,      2.67479E8,
                    21.00,      1.17572E6,      3.20655E8,
                    21.60,      1.38881E6,      3.78770E8,
                    23.30,      3.36829E7,      3.27793E9,
                    25.30,      3.12365E7,      3.06455E9,
                    30.30,      2.66106E7,      2.65719E9,
                    35.30,      2.32559E7,      2.35940E9,
                    40.30,      2.06477E7,      2.12674E9,
                    45.30,      1.85265E7,      1.93681E9,
                    50.30,      1.67467E7,      1.77687E9,
                    60.30,      1.38817E7,      1.51815E9,
                    70.30,      1.16402E7,      1.31426E9,
                    83.30,      9.37296E6,      1.14946E9,
                    86.30,      8.93570E6,      1.13810E9,
                    90.30,      8.37749E6,      1.12791E9,
                    91.30,      7.60716E5,      2.07369E8,
                    99.30,      5.77980E5,      1.57560E8,
                   120.00,      5.86944E5,      1.59994E8,
                   140.00,      7.81956E5,      2.13158E8,
                   160.00,      9.59076E5,      2.61443E8,
                   177.70,      1.08083E6,      2.94634E8,
                   197.70,      1.93338E6,      5.27033E8,
                   217.70,      2.01856E6,      5.50253E8,
                   237.70,      2.06788E6,      5.63695E8,
                   257.70,      2.10794E6,      5.74618E8,
                   257.71,              0,              0,
                1.00001E7,              0,              0 $END
```

Case 5, DESLS LOCA w/CS Train Failure

```
$LIST POOL=601,     0.00,              0,              0,
                    18.41,              0,              0,
                    18.50,      2.51388E5,      6.85609E7,
                    19.00,      5.06016E5,      1.38006E8,
                    19.50,      5.69304E5,      1.55266E8,
                    19.80,      6.93324E5,      1.89090E8,
                    20.00,      7.99524E5,      2.18054E8,
                    20.30,      9.42624E5,      2.57082E8,
                    20.50,      1.03061E6,      2.81078E8,
                    21.00,      1.23365E6,      3.36453E8,
                    21.60,      1.45667E6,      3.97278E8,
                    22.30,      3.73554E7,      3.59879E9,
                    25.30,      3.35592E7,      3.26901E9,
                    30.30,      2.89367E7,      2.86182E9,
                    35.30,      2.55857E7,      2.56432E9,
                    40.30,      2.29813E7,      2.33200E9,
                    45.30,      2.08641E7,      2.14241E9,
                    50.30,      1.90880E7,      1.98281E9,
                    60.30,      1.62309E7,      1.72477E9,
                    70.30,      1.39972E7,      1.52157E9,
                    80.30,      1.21702E7,      1.35433E9,
                    83.30,      1.17431E7,      1.35368E9,
                    86.30,      1.13067E7,      1.34779E9,
                    90.30,      1.07515E7,      1.33787E9,
                    91.30,      1.00228E6,      2.48180E8,
```

```
                    93.30,      1.05955E6,      2.79703E8,
                    95.30,      1.15085E6,      3.13713E8,
                    99.30,      1.39990E6,      3.81607E8,
                   120.00,      2.19575E6,      5.98558E8,
                   140.60,      2.62213E6,      7.14784E8,
                   160.60,      2.12494E6,      5.79247E8,
                   180.60,      2.32938E6,      6.34982E8,
                   180.61,              0,              0,
                 1.00001E7,             0,              0 $END
```

Case 6, DESLS LOCA w/ECU Train Failure

This table is identical to Case 5, except for the time to start sump recirculation.

```
$LIST POOL=601,      0.00,              0,              0,
                    18.41,              0,              0,
                    18.50,      2.51388E5,      6.85609E7,
                    19.00,      5.06016E5,      1.38006E8,
                    19.50,      5.69304E5,      1.55266E8,
                    19.80,      6.93324E5,      1.89090E8,
                    20.00,      7.99524E5,      2.18054E8,
                    20.30,      9.42624E5,      2.57082E8,
                    20.50,      1.03061E6,      2.81078E8,
                    21.00,      1.23365E6,      3.36453E8,
                    21.60,      1.45667E6,      3.97278E8,
                    22.30,      3.73554E7,      3.59879E9,
                    25.30,      3.35592E7,      3.26901E9,
                    30.30,      2.89367E7,      2.86182E9,
                    35.30,      2.55857E7,      2.56432E9,
                    40.30,      2.29813E7,      2.33200E9,
                    45.30,      2.08641E7,      2.14241E9,
                    50.30,      1.90880E7,      1.98281E9,
                    60.30,      1.62309E7,      1.72477E9,
                    70.30,      1.39972E7,      1.52157E9,
                    80.30,      1.21702E7,      1.35433E9,
                    83.30,      1.17431E7,      1.35368E9,
                    86.30,      1.13067E7,      1.34779E9,
                    90.30,      1.07515E7,      1.33787E9,
                    91.30,      1.00228E6,      2.48180E8,
                    93.30,      1.05955E6,      2.79703E8,
                    95.30,      1.15085E6,      3.13713E8,
                    99.30,      1.39990E6,      3.81607E8,
                   120.00,      2.19575E6,      5.98558E8,
                   140.60,      2.62213E6,      7.14784E8,
                   160.60,      2.12494E6,      5.79247E8,
                   180.60,      2.32938E6,      6.34982E8,
                   180.61,              0,              0,
                 1.00001E7,             0,              0 $END
```

Case 7, DEHLS LOCA w/DG Failure

```
$LIST POOL=601,          0,      0,      0,
              1.00001E7,      0,      0 $END
```

Case 8, DEHLS LOCA w/CS Train Failure

```
$LIST POOL=601,          0,      0,      0,
              1.00001E7,      0,      0 $END
```

Case 9, DEHLS LOCA w/ECU Train Failure

```
$LIST POOL=601,          0,      0,      0,
              1.00001E7,      0,      0 $END
```