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WCAP-13907

Analysis of Containment Response Following Loss-of-Coolant Accidents for Diablo Canyon Units 1 and 2 (including addendum)

December 1993

WESTINGHOUSE CLASS 3

WCAP-13907

"ANALYSIS OF CONTAINMENT RESPONSE FOLLOWING LOSS-OF-COOLANT ACCIDENTS FOR DIABLO CANYON UNITS 1 AND 2"

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by

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December 1993

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EXECUTIVE SUMMARY

Containment Integrity Analyses have been performed as part of the Diablo Canyon Containment Margin Improvement Program. The objective of the program was to provide containment integrity analysis results using the current Diablo Canyon specific information and new more realistic models. In this way the licensing basis for Units 1 and 2 is clarified and updated, and pressure margin for operation of Units 1 and 2 has been determined and thus made available for possible future use.

The results of the analysis ensure that the pressure inside containment will remain below the containment building design pressure if a Loss-of-Coolant-Accident (LOCA) inside containment should occur during plant operation. The peak calculated pressure for the limiting LOCA is 41.53 psig. The design pressure is 47 psig.

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1.0 INTRODUCTION

1.1 PURPOSE OF ANALYSES

The purpose of this analysis was to calculate the Diablo Canyon long term Loss of Coolant Accident (LOCA) mass and energy releases and resulting containment response for the double–ended pump suction (DEPS) and double–ended hot leg (DEHL) break cases using the operating conditions discussed in this report. This effort was performed as part of the Containment Reanalysis Program and incorporated revised containment models.

This report provides the analytical basis with respect to the LOCA containment response for operation of the Diablo Canyon Nuclear Power Plant Units 1 and 2 at the described conditions.

The analyses presented address the consequences of the mass and energy that is released to containment as a result of a design basis LOCA. The mass and energy release data is subsequently used to verify, via calculations, that the containment design pressure is not exceeded in the event of a LOCA. In this manner, the analysis results demonstrate the acceptability of operation by showing that the containment peak pressure resulting from a design basis large break LOCA event will not exceed the containment design pressure. Section 2.0 presents the long term mass and energy release analysis. Section 3.0 presents the results of the containment integrity response calculations following a postulated LOCA.

Bounding initial temperatures and pressures for the containment integrity analyses were selected to envelop the limiting conditions at the operating conditions detailed in this report. In this manner, the most limiting conditions for operation at full NSSS power (3423 MWt) were conservatively chosen.

1.2 MAJOR ANALYTICAL ASSUMPTIONS

The evaluation model used for the long term LOCA mass and energy release calculations was the March 1979 model described in Reference 1. This evaluation model has been reviewed and approved by the NRC, and has been used in the analysis of other dry containment plants.

For the long term mass and energy release calculations, operating temperatures for the highest average coolant temperature case were selected as the bounding analysis conditions. The modeled power level of 3423 MWt (NSSS) adjusted for calorimetric error (+2 percent of power) was the basis in the analysis. The use of higher temperatures is conservative because the initial fluid energy is based on coolant temperatures which are at the maximum levels attained in steady state operation, Additionally, an allowance of +5.0 °F is reflected in the temperatures in order to account for instrument error and deadband. The initial RCS pressure in this analysis is based on a nominal value of 2250 psia. Also included is an allowance of +58 psi, which accounts for the measurement uncertainty on pressurizer pressure. The selection of 2250 psia as the limiting pressure is considered to affect the blowdown phase results only, since this represents the initial pressure of the RCS. The RCS rapidly depressurizes from this value until the point at which it equilibrates with containment pressure.

The rate at which the RCS blows down is initially more severe at the higher RCS pressure. Additionally the RCS has a higher fluid density at the higher pressure (assuming a constant temperature) and subsequently has a higher RCS mass is available for release. Thus, 2308 psia initial pressure was selected as the limiting case for the long term mass and energy release calculations. These assumptions conservatively maximize the mass and energy in the RCS.

The selection of fuel allowance for the long term mass and energy calculation and subsequent LOCA containment integrity calculation is based on the need to conservatively maximize the core stored energy. The margin in core stored energy was chosen to be +15 percent. Thus, the analysis very conservatively accounts for the stored energy in the core. The fuel conditions were adjusted to provide a bounding analysis for both the Vantage Five and standard Westinghouse 17x17 fuels.

Margin in RCS volume of 3% (which is composed of 1.6% allowance for thermal expansion and 1.4% for uncertainty) is modeled (Reference 1).

Regarding ECCS flow, the mass and energy calculation considered both minimum and maximum ECCS flowrates. Further details about the assumptions are contained in Section 2.

The COCO Code has been used and found acceptable to calculate containment pressure transients for dry containment plants. This code has been successfully used for the other dry containment plants in their FSAR analyses.

As input to the COCO computer code, mass and energy release rates as described in Section 2 of this report will be used. For the minimum ECCS case, the failure of one solid state protection system train will be considered. For maximum ECCS cases, the failure of either a containment spray pump or a containment fan cooler will be considered. This is consistent with the requirements to analyze the worst single failure.

Thus, based on the previously mentioned conditions and assumptions, a bounding containment analysis of Diablo Canyon Units 1 and 2 is made for the release of mass and energy from the RCS in the event of a LOCA.

2.0 LONG TERM LOCA MASS AND ENERGY RELEASE ANALYSIS

2.1 INTRODUCTION

This report section presents the long term LOCA mass and energy releases that were generated in support of the containment reanalysis effort for Diablo Canyon Units 1 and 2. These mass and energy releases are then subsequently used in the COCO containment integrity analysis peak pressure calculation.

2.2 LOCA MASS AND ENERGY RELEASE PHASES

The LOCA transient is typically divided into four phases:

1. Blowdown – which includes the period from accident initiation (when the reactor is at steady state operation) to the time that the RCS reaches initial equilibration with containment.

2. Refill – the period of time when the lower plenum is being filled by accumulator and ECCS water. At the end of blowdown, a large amount of water remains in the cold legs, downcomer, and lower plenum. To conservatively consider the refill period for the purpose of containment mass and energy releases, this water is instantaneously transferred to the lower plenum along with sufficient accumulator water to completely fill the lower plenum. This allows an uninterrupted release of mass and energy to containment. Thus, the refill period is conservatively neglected in the mass and energy release calculation.

3. Reflood – begins when the water from the lower plenum enters the core and ends when the core is completely quenched.

4. Post–Reflood (Froth) – describes the period following the reflood transient. For the pump suction break, a two–phase mixture exits the core, passes through the hot legs,

and is superheated in the steam generators. After the broken loop steam generator cools, the break flow becomes two phase.

2.3 BREAK SIZE AND LOCATION

Generic studies have been performed with respect to the effect on the LOCA mass and energy releases relative to postulated break size. The double ended guillotine break has been found to be limiting due to larger mass flow rates during the blowdown phase of the transient. During the reflood and froth phases, the break size has little effect on the releases.

Three distinct locations in the reactor coolant system loop can be postulated for pipe rupture:

1. Hot leg (between vessel and steam generator)
2. Cold leg (between pump and vessel)
3. Pump suction (between steam generator and pump)

The break locations analyzed for this program are the double−ended pump suction guillotine break (10.48 ft^2) and the double−end hot leg guillotine break (9.17 ft^2). Pump Suction break mass and energy releases have been calculated for the blowdown, reflood, and post−reflood phases of the LOCA and the hot leg break mass and energy releases have been calculated for only the blowdown phase. The following information provides a discussion on each break location.

The double ended hot leg guillotine has been shown in previous studies to result in the highest blowdown mass and energy release rates. Although the core flooding rate would be highest for this break location, the amount of energy released from the steam generator secondary is minimal because the majority of the fluid which exits the core bypasses the steam generators in venting to containment. As a result, the reflood mass and energy releases are reduced significantly as compared to either the pump suction or cold leg break locations where the core exit mixture must pass through the steam generators before venting through the break.

For the hot leg break, there is no reflood peak as determined by generic studies (i.e., from the end of the blowdown period the releases would continually decrease). Therefore the reflood (and subsequent

post−reflood) releases are not calculated for a hot leg break. The mass and energy releases for the hot leg break have been included in the scope of this containment integrity analysis because there is the possibility that the peak pressure could occur during this phase, as was the case for some other dry containment plants.

The cold leg break location has also been found in previous studies to be much less limiting than the hot leg or pump suction locations in terms of the overall containment peak pressure. The cold leg blowdown is faster than that of the pump suction break, and more mass is released into the containment. However, the core heat transfer is greatly reduced, and this results in a considerably lower energy release into containment. Studies have determined that the blowdown transient is, in general, less limiting than the pump suction break. During reflood, the flooding rate is greatly reduced and the energy release rate into the containment is reduced. Therefore, the cold leg break is not included in the scope of this reanalysis.

The pump suction break combines the effects of the relatively high core flooding rate, as in the hot leg break, and the addition of the stored energy in the steam generators. As a result, the pump suction break yields the highest energy flow rates during the post−blowdown period by including all of the available energy of the Reactor Coolant System in calculating the releases to containment. The analysis of this break location for Diablo Canyon Units 1 and 2 as the limiting break for post-blowdown containment integrity is consistent with other dry containment plants.

2.4 APPLICATION OF SINGLE FAILURE CRITERION

An analysis of the effects of the single failure criterion has been performed on the mass and energy release rates for the double ended pump suction (DEPS) break. For the DEPS break results presented in this report, an inherent assumption in the generation of the mass and energy releases is that offsite power is lost. This results in the actuation of the emergency diesel generators, required to power the emergency core cooling system. This is not an issue for the blowdown period, which is limited by the DEHL break. Thus, the generation of mass and energy releases assumed loss of offsite power for the DEPS breaks and offsite power available for the DEHL break. The ECCS delay time for the minimum safeguards DEPS case was 27 seconds. For the maximum safeguards DEPS case, the

ECCS system was assumed to begin injecting coincident with the end of blowdown. Finally, for the DEHL break, a zero second delay time was assumed for the ECCS system.

Three cases have been analyzed for the effects of a single failure. The double ended pump suction case with both minimum and maximum safeguards was analyzed. The limiting minimum safeguards case was determined based upon consideration of ECCS flow rates, initiation time of all relevant components, including CFCU and containment spray pumps, and containment cooling capability. Table 2-1 presents the ECCS and containment cooling components that would be available for various bus, Solid State Protection System (SSPS), or containment heat removal systems failures. The data for this table has assumed two of five containment fan coolers out of service. In addition to a bus or SSPS failure, the failure of any single component could occur. In the case of minimum safeguards, the single failure postulated to occur is the loss of one SSPS Train. This results in the loss of one pumped emergency core cooling train, thereby minimizing the ECCS flow. The SSPS failure also results in a loss of one containment spray pump and the loss of an additional CFCU, thereby minimizing containment heat removal capability. For the case analyzing maximum ECCS, the assumption of a loss of either one containment fan cooler unit (CFCU) or one containment spray pump (CSP) was used. This maximizes ECCS flow by assuming operability of all ECCS pumps. The loss of either a containment spray pump or a CFCU represents the two worst failures of the containment heat removal system. The analysis of both maximum and minimum safeguards cases ensure that the effects of all credible single failures is bounded.

2.5 MASS AND ENERGY RELEASE DATA

2.5.1 Blowdown Mass and Energy Release Data

The SATAN–VI code is used for computing the blowdown transient, and is the same as that used for the Emergency Core Cooling System (ECCS) calculation in Reference 2. The methodology for the use of this model is described in Reference 1.

Table 2-2 presents the calculated mass and energy release for the blowdown phase of the DEPS break. The mass and energy release for the double-ended pump suction break, given in Table 2-2, terminate 25.8 seconds after the initiation of the postulated accident. For the pumps suction breaks,

break path 1 in the mass and energy release tables refers to the mass and energy exiting from the steam generator side of the break. Likewise, for the pump suction breaks, break path 2 in the mass and energy release tables refers to the mass and energy exiting from the pump side of the break.

Table 2-3 presents the calculated mass and energy release for the blowdown phase of the DEHL break. The mass and energy releases for the DEHL break terminate 28.5 seconds after initiation of the postulated accident. For the hot leg break mass and energy tables, break path 1 refers to the mass and energy exiting from the reactor vessel side of the break. Break path 2 refers to the mass and energy exiting from the steam generator side of the break.

2.5.2 Reflood Mass and Energy Release Data

The WREFLOOD code is used for computing the reflood transient, and is a modified version of that used in the ECCS calculation in Reference 2. The methodology for the use of this model is described in Reference 1.

A complete thermal equilibrium mixing condition for the steam and emergency core cooling water during the reflood phase has been assumed for each loop receiving ECCS water. This is consistent with the usage and application of the Reference 1 mass and energy release evaluation model, in recent analyses, e.g. D.C. Cook Docket [Reference 3]. Even though the Reference 1 model credits steam/mixing only in the intact loop and not in the broken loop, justification, applicability, and NRC approval for using the mixing model in the broken loop has been documented [Reference 3]. This assumption is justified and supported by test data, and is summarized as follows:

The model assumes a complete mixing condition (i.e., thermal equilibrium) for the steam/water interaction. The complete mixing process, however, is made up of two distinct physical processes. The first is a two phase interaction with condensation of steam by cold ECCS water. The second is a single phase mixing of condensate and ECCS water. Since the steam release is the most important influence to the containment pressure transient, the steam condensation part of the mixing process is the only part that need be considered. (Any spillage directly heats only the sump.)

The most applicable steam/water mixing test data has been reviewed for validation of the containment integrity reflood steam/water mixing model. This data is that generated in 1/3 scale tests (Reference 4), which are the largest scale data available and thus most closely simulates the flow regimes and gravitational effects that would occur in a PWR. These tests were designed specifically to study the steam/water interaction for PWR reflood conditions.

From the entire series of 1/3 scale tests, a group corresponds almost directly to containment integrity reflood conditions. The injection flowrates for this group cover all phases and mixing conditions calculated during the reflood transient. The data from these tests were reviewed and discussed in detail in Reference 1. For all of these tests, the data clearly indicates the occurrence of very effective mixing with rapid steam condensation. The mixing model used in the containment integrity reflood calculation is therefore wholly supported by the 1/3 scale steam/water mixing data.

Additionally, the following justification is also noted. The post-blowdown limiting break for the containment integrity peak pressure analysis is the double ended pump suction break. For this break, there are two flowpaths available in the RCS by which mass and energy may be released to containment. One is through the outlet of the steam generator, the other via reverse flow through the reactor coolant pump. Steam which is not condensed by ECCS injection in the intact RCS loops passes around the downcomer and through the broken loop cold leg and pump in venting to containment. This steam also encounters ECCS injection water as it passes through the broken loop cold leg, complete mixing occurs and a portion of it is condensed. It is this portion of steam which is condensed that is taken credit for in this analysis. This assumption is justified based upon the postulated break location, and the actual physical presence of the ECCS injection nozzle. A description of the test and test results is contained in References 1 and 4.

The methodology previously discussed and described in Reference 1 has been utilized and approved on the Dockets for Catawba Units 1 & 2, McGuire Units 1 & 2, Sequoyah Units 1 & 2, Watts Bar Units 1 & 2, Cook Units 1 & 2, Millstone Unit 3, Beaver Valley Unit 2 and Surry Units 1 & 2.

Table 2-4 and Table 2-5 presents the calculated mass and energy release for the reflood phase of the Double-Ended Pump Suction break with minimum and maximum safeguards, respectively.

The transient of the principal parameters during reflood are given in Tables 2-6 and 2-7 for the minimum and maximum safeguards double ended pump suction break cases.

2.5.3 Post-Reflood Mass and Energy Release Data

The FROTH code [Reference 5] is used for computing the post-reflood transient. The methodology for the use of this model is described in Reference 1. The mass and energy release rates calculated by FROTH are used in the containment analysis to the time of RCS depressurization.

After depressurization, the mass and energy release from decay heat is based on the 1979 ANSI/ANS Standard, shown in Reference 6, and the following input:

1. Decay heat sources considered are fission product decay and heavy element decay of U-239 and Np-239.

2. Decay heat power from fissioning isotopes other than U-235 is assumed to be identical to that of U-235.

3. Fission rate is constant over the operating history of maximum power level.

4. The factor accounting for neutron capture in fission products has been taken from Table 10 of ANS (1979).

5. Operation time before shutdown is 3 years.

6. The total recoverable energy associated with one fission has been assumed to be 200 MeV/fission.

7. Two sigma uncertainty (2 times the standard deviation) has been applied to the fission product decay.

Table 2-8 presents the two phase (froth) mass and energy release data for the double-ended pump suction break with minimum ECCS . Tables 2-9 and 2-10 present the two phase mass and energy release for the double-ended pump suction break with maximum ECCS, and a failure of a containment spray pump or containment fan cooler, respectively.

2.6 SOURCES OF MASS AND ENERGY

The sources of mass considered in the LOCA mass and energy release analysis are given in Tables 2-11, 2-12, 2-13, and 2-17. These sources are the reactor coolant system, accumulators, and pumped ECCS water.

The energy inventories considered in the LOCA mass and energy release analysis are given in Tables 2-14, 2-15, 2-16, and 2-18. The energy sources include:

1. Reactor Coolant System Water
2. Accumulator Water
3. Pumped Injection Water
4. Decay Heat (see Table 2-19)
5. Core Stored Energy
6. Reactor Coolant System Metal
7. Steam Generator Metal
8. Steam Generator Secondary Energy
9. Secondary Transfer of Energy (feedwater into and steam out of the steam generator secondary)

In the mass and energy release data presented, no Zirc-water reaction heat was considered because the clad temperature did not rise high enough for the rate of the Zirc-water reaction heat to be of any significance (Reference 1).

System parameters needed to perform confirmatory analyses are provided in Table 2-20.

The consideration of the various energy sources in the mass and energy release analysis provides assurance that all available sources of energy have been included in this analysis. Thus the review guidelines presented in Standard Review Plan section 6.2.1.3 have been satisfied.

The mass and energy inventories are presented at the following times, as appropriate:

1. Time zero (initial conditions)
2. End of blowdown time
3. End of refill time
4. End of reflood time
5. Time of broken loop depressurization
6. Time of intact loop depressurization
7. One hour after accident initiation

The methods and assumptions used to release the various energy sources are given in Reference 1, except as noted in section 2.5.2 of this document, which has been approved as a valid evaluation model by the Nuclear Regulatory Commission.

2.7 SIGNIFICANT MODELING ASSUMPTIONS

The following items ensure that the mass and energy releases are conservatively calculated for maximum containment pressure:

1. A maximum expected operating temperature of the reactor coolant system;

2. An allowance in temperature for instrument error and dead band (+5°F);

3. A margin in volume of +3% (composed of 1.6% allowance for thermal expansion, and 1.4% for uncertainty);

4. An NSSS power level of 3423 MWt;

5. An allowance for calorimetric error (+2 percent of the license power);

6. Conservatively modified coefficients of heat transfer (Reference 1).

7. An allowance in core stored energy for effect of fuel densification;

8. A margin in core stored energy (typically +15 percent included to account for manufacturing tolerances);

9. An allowance for RCS initial pressure uncertainty (+58 psi);

10. A maximum containment backpressure equal to design pressure. This assumption is based upon sensitivities performed with respect to this topic in Reference 1.

TABLE 2-1

FAILURES SUMMARY

Failure	Number of Charging Pumps	Number of Safety Injection Pumps	Number of RHR Pumps	Number of Containment Spray Pumps	Number of CFCUs
Bus F	1	1	2	2	2
Bus G	1	2	1	1	2
Bus H	2	1	1	1	2
SSPS	1	1	1	1	2
CSP	2	2	2	1	3
CFCU	2	2	2	2	2

TABLE 2-2

BLOWDOWN MASS AND ENERGY RELEASES

DEPS 3423 MWt

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
0.0000	0.0	0.0	0.0	0.0
0.0504	40462.3	21943.6	23632.8	12749.6
0.450	44324.8	24742.9	22476.4	12209.7
0.901	42682.0	24894.9	19239.9	10467.0
1.30	38999.8	23494.3	18408.9	10020.2
2.00	33470.6	21271.2	18203.4	9908.4
2.70	26799.4	18022.8	17207.7	9369.2
3.00	20689.1	14157.4	16658.9	9073.3
3.20	20209.6	13949.1	16264.3	8860.3
4.10	16092.3	11190.0	14779.3	8059.9
4.80	13964.6	9718.8	13949.7	7613.1
5.75	12529.3	8662.9	13129.7	7171.8
6.50	11968.2	8190.1	12452.0	6807.1
7.00	11907.9	8073.8	13347.6	7303.9
8.25	12393.9	8181.2	12594.7	6908.6
9.00	9480.4	7056.2	12304.6	6753.7
9.75	8915.6	6723.8	11907.4	6538.7
11.5	8743.1	6285.4	10931.5	6001.8
15.3	6162.8	4879.3	8900.0	4890.5
19.3	3927.9	3730.2	6683.2	3420.7
19.8	3602.7	3588.0	10163.9	5262.1
20.0	3547.6	3665.1	6085.4	3038.5
20.3	3291.2	3566.1	9654.2	4777.5
20.5	2964.7	3422.6	4705.4	2347.8
20.8	2745.5	3273.0	6925.9	3199.9
21.0	2500.4	3059.1	4374.5	2043.1
21.3	2302.2	2833.3	5746.2	2437.7
21.8	1924.2	2388.0	3921.7	1628.4
22.8	1315.2	1646.7	5549.6	2183.1
23.5	1046.3	1316.3	1534.2	580.8
23.8	952.1	1199.2	3569.0	1131.7
24.3	434.6	548.8	2647.9	800.9
24.5	308.5	390.4	3056.6	939.8
25.0	53.1	67.5	1231.8	388.3
25.8	0.0	0.0	0.0	0.0

TABLE 2-3

BLOWDOWN MASS AND ENERGY RELEASES

DEHL 3423 MWt

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
0.0000	0.0	0.0	0.0	0.0
0.0504	54523.2	34880.0	26628.5	16797.5
0.100	45237.2	28904.3	26750.9	16875.8
0.200	32331.4	20917.7	23011.3	14452.5
0.301	33402.7	21505.0	20799.9	12927.3
0.400	32454.8	20885.0	19641.7	12027.0
0.700	32006.4	20645.0	17888.1	10508.3
1.20	30234.4	19908.1	16654.8	9384.2
1.80	27991.2	18907.0	16763.3	9185.8
2.50	25088.9	17223.9	17180.9	9268.0
2.90	23682.4	16332.5	17176.1	9237.1
3.70	21469.6	14782.1	16796.3	9024.4
4.50	20131.0	13677.4	16221.9	8727.1
5.50	19383.9	12834.7	15040.3	8124.7
6.00	19446.6	12703.8	14217.7	7705.0
6.75	19951.2	12820.0	12976.2	7067.0
7.00	20723.2	13772.1	12589.1	6865.8
7.25	15626.3	10801.8	12217.7	6671.5
8.25	15933.9	10757.0	11259.9	6163.7
9.50	15544.0	10437.5	9861.8	5422.1
10.8	14917.5	9840.3	8334.5	4623.8
12.0	13873.8	9042.5	7032.5	3951.1
13.0	12707.2	8279.6	6143.6	3501.6
14.8	10517.4	7010.5	4903.2	2891.5
18.0	5033.0	4658.3	2797.9	1942.2
19.0	3670.1	3624.9	2353.6	1702.8
19.5	2375.2	2671.8	2170.7	1612.9
20.0	1741.9	2082.3	1936.1	1533.6
20.8	1295.3	1602.8	1483.1	1401.2
21.5	955.8	1206.0	742.5	913.0
23.0	423.5	538.5	0.0	0.0
23.8	195.3	249.2	84.0	109.5
26.0	136.4	177.1	0.0	0.0
27.5	530.7	649.0	0.0	0.0
28.5	0.0	0.0	0.0	0.0

TABLE 2-4

REFLOOD MASS AND ENERGY RELEASES

DEPS - MIN ECCS

TIME SECONDS	BREAK PATH NO.1 FLOW LBM/SEC	BREAK PATH NO.1 FLOW THOUSAND BTU/SEC	BREAK PATH NO.2 FLOW LBM/SEC	BREAK PATH NO.2 FLOW THOUSAND BTU/SEC
25.8	0.0	0.0	0.0	0.0
26.3	0.0	0.0	0.0	0.0
26.5	0.0	0.0	148.6	10.1
26.7	0.0	0.0	148.6	10.1
26.8	98.0	115.4	148.6	10.1
27.0	25.7	30.3	148.6	10.1
28.1	71.3	84.0	148.6	10.1
29.8	112.3	132.4	148.6	10.1
31.8	147.3	173.7	148.6	10.1
32.8	263.4	311.1	2330.4	296.2
33.0	382.3	452.6	3709.9	496.8
33.9	514.7	610.8	5022.5	717.3
34.9	517.0	613.6	5037.3	730.5
35.9	508.0	602.8	4957.2	721.6
39.9	472.0	559.8	4629.8	682.3
40.9	463.8	549.9	4553.3	673.0
42.9	448.3	531.5	4407.9	655.3
44.9	434.1	514.4	4272.0	638.7
46.9	421.0	498.7	4144.8	623.2
50.9	397.5	470.7	3913.1	595.0
54.9	377.0	446.2	3707.0	569.8
55.9	443.4	525.5	327.0	235.9
56.9	451.5	535.2	330.3	240.9
58.9	435.5	516.1	323.2	231.4
62.9	405.2	479.9	309.8	213.5
69.9	361.1	427.3	290.5	188.0
73.9	339.2	401.3	281.1	175.5
81.9	301.7	356.6	265.0	154.6
100.9	239.8	283.1	239.2	121.5
109.4	221.6	261.6	231.8	112.1
116.9	209.4	247.2	227.0	105.9
144.9	185.7	219.1	217.5	93.9
158.9	181.6	214.3	215.8	91.8
178.9	180.3	212.8	215.1	90.9
192.6	183.3	216.3	219.2	92.5

TABLE 2-5

REFLOOD MASS AND ENERGY RELEASES

DEPS - MAX ECCS

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
25.8	0.0	0.0	0.0	0.0
26.2	0.0	0.0	312.9	21.3
26.6	0.0	0.0	312.9	21.3
26.8	28.1	33.2	312.9	21.3
28.8	97.9	115.4	312.9	21.3
31.8	156.2	184.2	312.9	21.3
32.7	486.7	577.2	4786.8	627.8
32.8	525.5	623.7	5162.6	687.4
33.9	570.8	678.2	5540.4	774.5
34.9	562.7	668.5	5471.2	767.7
36.9	543.4	645.4	5304.4	747.6
38.9	525.1	623.4	5142.6	727.7
40.9	508.2	603.0	4990.3	708.8
42.9	492.5	584.3	4848.0	691.2
44.9	478.1	567.1	4714.8	674.7
46.9	464.8	551.2	4590.3	659.3
47.9	458.5	543.6	4530.9	652.0
49.9	446.6	529.4	4417.7	637.9
51.9	435.5	516.1	4311.0	624.7
53.9	425.1	503.7	4210.3	612.2
55.9	415.4	492.1	4114.9	600.3
56.9	194.2	229.2	917.5	228.8
58.9	193.9	228.8	917.9	228.4
64.9	190.8	225.1	923.8	226.7
79.9	183.2	216.1	937.9	222.4
80.9	182.7	215.5	938.8	222.2
96.9	174.6	206.0	953.9	217.9
100.9	172.6	203.6	957.7	216.8
116.9	164.3	193.8	973.4	212.8
120.9	162.2	191.3	977.4	211.8
128.9	157.9	186.2	985.4	209.9
144.9	149.0	175.7	1001.5	206.1
164.9	143.1	168.7	1012.8	202.7
196.9	136.0	160.4	1026.5	197.3
207.1	133.9	157.9	1030.7	195.4

TABLE 2-6

REFLOOD PRINCIPAL PARAMETERS

DEPS - MIN ECCS

TIME	FLOODING TEMP	FLOODING RATE	CARRYOVER FRACTION	CORE HEIGHT	DOWNCOMER HEIGHT	FLOW FRACTION	INJECTION TOTAL	INJECTION ACCUMULATOR	INJECTION SPILL	ENTHALPY
SECONDS	DEGREE F	IN/SEC		FT	FT		(POUNDS MASS PER SECOND)			BTU/LBM
25.8	219.3	0.000	0.000	0.00	0.00	0.250	0.0	0.0	0.0	0.00
26.5	216.4	23.190	0.000	0.56	1.31	0.000	8690.5	8095.9	0.0	88.01
26.7	213.9	28.212	0.000	1.11	1.41	0.000	8597.9	8003.3	0.0	88.00
28.0	212.8	2.434	0.305	1.50	4.50	0.335	8201.3	7606.8	0.0	87.92
28.8	212.7	2.334	0.405	1.61	6.53	0.352	7991.1	7396.5	0.0	87.88
33.0	212.1	3.991	0.636	2.00	15.87	0.559	6665.6	6109.0	0.0	87.69
33.9	211.6	4.717	0.661	2.11	16.06	0.611	6154.4	5631.9	0.0	87.66
35.9	210.6	4.407	0.698	2.35	16.07	0.608	5838.3	5315.1	0.0	87.56
37.4	210.1	4.222	0.713	2.51	16.07	0.605	5665.4	5138.2	0.0	87.48
42.8	209.0	3.796	0.735	3.00	16.07	0.594	5145.7	4607.0	0.0	87.23
49.2	208.8	3.479	0.743	3.50	16.07	0.581	4664.5	4115.6	0.0	86.95
54.9	209.4	3.269	0.746	3.91	16.07	0.571	4314.9	3759.1	0.0	86.71
55.9	209.6	3.668	0.748	3.99	16.00	0.603	540.9	0.0	0.0	68.00
56.1	209.6	3.703	0.748	4.00	15.97	0.604	537.9	0.0	0.0	68.00
62.9	211.4	3.340	0.748	4.51	15.00	0.598	547.7	0.0	0.0	68.00
70.3	214.7	3.001	0.747	5.00	14.21	0.590	557.7	0.0	0.0	68.00
78.9	219.6	2.682	0.746	5.52	13.57	0.581	566.3	0.0	0.0	68.00
87.9	225.5	2.419	0.745	6.00	13.15	0.570	572.4	0.0	0.0	68.00
98.9	233.1	2.176	0.745	6.54	12.91	0.557	577.4	0.0	0.0	68.00
109.4	240.3	2.009	0.746	7.00	12.88	0.546	580.5	0.0	0.0	68.00
122.9	248.2	1.863	0.747	7.55	13.05	0.535	583.0	0.0	0.0	68.00
134.6	253.9	1.783	0.749	8.00	13.32	0.529	584.3	0.0	0.0	68.00
148.9	260.0	1.725	0.753	8.52	13.73	0.524	585.1	0.0	0.0	68.00
162.7	265.1	1.694	0.757	9.00	14.19	0.522	585.5	0.0	0.0	68.00
178.9	270.2	1.677	0.762	9.55	14.77	0.522	585.6	0.0	0.0	68.00
186.9	272.5	1.673	0.765	9.81	15.06	0.522	585.6	0.0	0.0	68.00
192.6	274.1	1.683	0.767	10.00	15.27	0.525	585.4	0.0	0.0	68.00

TABLE 2-7

REFLOOD PRINCIPAL PARAMETERS

DEPS - MAX ECCS

TIME	FLOODING TEMP	FLOODING RATE	CARRYOVER FRACTION	CORE HEIGHT	DOWNCOMER HEIGHT	FLOW FRACTION	INJECTION TOTAL	INJECTION ACCUMULATOR	INJECTION SPILL	ENTHALPY
SECONDS	DEGREE F	IN/SEC		FT	FT		(POUNDS MASS PER SECOND)			BTU/LBM
25.8	218.9	0.000	0.000	0.00	0.00	0.250	0.0	0.0	0.0	0.00
26.4	215.5	25.434	0.000	0.62	1.14	0.000	9435.9	8183.7	0.0	86.63
26.6	213.3	29.628	0.000	1.09	1.23	0.000	9371.9	8119.7	0.0	86.61
27.8	212.0	2.485	0.305	1.50	4.50	0.343	8949.7	7697.6	0.0	86.48
28.8	211.8	2.384	0.422	1.62	7.08	0.359	8695.1	7442.9	0.0	86.39
32.7	211.0	4.697	0.636	2.01	15.97	0.608	7113.7	5966.4	0.0	86.02
33.9	210.2	4.998	0.673	2.18	16.07	0.624	6591.1	5489.3	0.0	85.89
34.9	209.6	4.802	0.692	2.31	16.07	0.623	6450.0	5344.5	0.0	85.80
36.6	208.7	4.558	0.712	2.50	16.07	0.621	6245.5	5131.8	0.0	85.65
41.7	207.2	4.117	0.735	3.00	16.07	0.612	5741.1	4605.6	0.0	85.23
47.5	206.7	3.802	0.743	3.50	16.07	0.602	5289.7	4136.2	0.0	84.80
53.9	207.0	3.548	0.746	4.00	16.07	0.593	4887.3	3719.0	0.0	84.35
56.9	207.4	2.251	0.737	4.21	16.07	0.434	1244.6	0.0	0.0	68.00
62.9	209.0	2.214	0.738	4.51	16.07	0.434	1244.5	0.0	0.0	68.00
73.3	212.9	2.153	0.739	5.00	16.07	0.433	1244.8	0.0	0.0	68.00
84.9	218.6	2.087	0.740	5.53	16.07	0.432	1245.2	0.0	0.0	68.00
95.4	224.5	2.027	0.742	6.00	16.07	0.431	1245.6	0.0	0.0	68.00
108.9	232.6	1.949	0.744	6.58	16.07	0.429	1246.1	0.0	0.0	68.00
119.4	239.0	1.888	0.746	7.00	16.07	0.427	1246.4	0.0	0.0	68.00
132.9	246.6	1.808	0.749	7.53	16.07	0.425	1246.9	0.0	0.0	68.00
145.7	252.8	1.733	0.751	8.00	16.07	0.422	1247.4	0.0	0.0	68.00
160.9	259.1	1.667	0.754	8.53	16.07	0.423	1247.5	0.0	0.0	68.00
174.9	264.1	1.612	0.757	9.00	16.07	0.426	1247.5	0.0	0.0	68.00
190.9	269.1	1.551	0.760	9.51	16.07	0.430	1247.4	0.0	0.0	68.00
207.1	273.3	1.491	0.763	10.00	16.07	0.435	1247.3	0.0	0.0	68.00

TABLE 2-8

POST-REFLOOD MASS AND ENERGY RELEASES

DEPS – MIN ECCS

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
192.7	213.3	264.5	381.1	128.8
217.7	210.6	261.2	383.8	128.4
222.7	210.3	260.8	384.1	128.3
267.7	206.1	255.6	388.3	127.4
287.7	203.6	252.5	390.8	127.2
297.7	202.8	251.6	391.6	126.9
322.7	199.9	247.9	394.5	126.6
347.7	196.5	243.7	397.9	126.4
352.7	196.4	243.5	398.0	126.2
362.7	194.9	241.7	399.5	126.1
397.7	190.2	235.9	404.2	125.8
402.7	190.0	235.6	404.4	125.6
427.7	186.5	231.3	407.9	125.4
442.7	184.8	229.2	409.6	125.1
472.7	180.6	224.0	413.8	124.9
687.7	180.6	224.0	413.8	124.9
687.8	92.4	113.8	502.0	142.0
732.7	91.2	112.3	503.2	143.4
812.7	89.1	109.7	505.3	142.6
847.7	88.4	108.8	506.0	140.5
962.7	85.9	105.8	508.5	139.3
1027.7	84.7	104.3	509.7	137.3
1032.7	84.6	104.2	509.8	136.8
1137.7	83.0	102.2	511.4	137.8
1142.7	83.0	102.1	511.4	137.3
1222.7	81.7	100.6	512.7	136.8
1357.7	79.6	98.0	514.8	134.1
1452.7	78.2	96.2	516.2	133.0
1610.0	78.2	96.2	516.2	133.0
1610.1	75.6	87.0	518.8	46.5
1679.9	75.6	87.0	518.8	46.5
1680.0	81.4	93.8	356.1	78.2
3599.9	81.4	93.8	356.1	78.2
3600.0	61.7	71.0	375.8	82.5
3600.1	52.2	60.1	385.3	65.1
10000.0	38.0	43.7	399.5	67.5
36000.0	26.2	30.2	391.8	48.3
100000.0	19.4	22.3	398.6	49.1
1000000.0	8.3	9.6	409.7	50.5
10000000.0	2.6	3.0	415.4	51.2

TABLE 2-9

POST-REFLOOD MASS AND ENERGY RELEASES

DEPS – MAX ECCS – CSP FAILURE

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
207.1	145.7	182.3	1106.4	191.9
222.1	146.2	182.9	1105.9	191.1
232.1	145.4	181.8	1106.8	190.9
257.1	145.7	182.3	1106.4	189.6
267.1	144.9	181.2	1107.3	189.4
292.1	145.1	181.5	1107.0	188.2
302.1	144.2	180.4	1107.9	188.0
327.1	144.4	180.6	1107.8	186.8
337.1	143.4	179.4	1108.7	186.6
372.1	143.3	179.2	1108.9	185.0
402.1	141.9	177.5	1110.2	184.0
417.1	142.4	178.1	1109.8	183.2
452.1	141.2	176.6	1110.9	181.8
487.1	141.3	176.7	1110.8	180.2
532.1	140.1	175.3	1112.0	178.3
542.1	140.6	175.8	1111.6	177.7
607.1	139.0	173.9	1113.1	178.5
632.1	139.3	174.3	1112.8	177.1
662.1	138.5	173.2	1113.7	175.7
667.1	138.9	173.8	1113.2	175.3
737.1	137.7	172.2	1114.5	175.1
747.1	137.9	172.5	1114.2	174.4
817.1	136.7	171.0	1115.5	173.7
959.9	136.7	171.0	1115.5	173.7
960.0	146.0	181.9	921.1	390.5
1122.1	146.0	181.9	921.1	390.5
1122.2	84.8	105.1	982.3	312.8
1247.1	82.9	102.7	984.2	311.2
1287.1	82.3	101.9	984.8	311.1
1417.1	80.3	99.4	986.8	309.5
1588.5	80.1	99.1	987.0	308.6
1588.6	77.4	89.1	989.7	221.3
3600.0	63.3	72.8	1003.8	223.9
3600.1	54.1	62.2	1013.0	204.8
10000.0	39.3	45.2	1027.8	207.8
100000.0	21.0	24.2	1046.1	211.5
1000000.0	9.0	10.4	1058.1	213.9

TABLE 2-10

POST-REFLOOD MASS AND ENERGY RELEASES

DEPS – MAX ECCS – CFCU FAILURE

TIME	BREAK PATH NO.1 FLOW		BREAK PATH NO.2 FLOW	
SECONDS	LBM/SEC	THOUSAND BTU/SEC	LBM/SEC	THOUSAND BTU/SEC
207.1	145.7	182.3	1106.4	191.9
222.1	146.2	182.9	1105.9	191.1
232.1	145.4	181.8	1106.8	190.9
257.1	145.7	182.3	1106.4	189.6
267.1	144.9	181.2	1107.3	189.4
292.1	145.1	181.5	1107.0	188.2
302.1	144.2	180.4	1107.9	188.0
327.1	144.4	180.6	1107.8	186.8
402.1	141.9	177.5	1110.2	184.0
417.1	142.4	178.1	1109.8	183.2
452.1	141.2	176.6	1110.9	181.8
487.1	141.3	176.7	1110.8	180.2
532.1	140.1	175.3	1112.0	178.3
542.1	140.6	175.8	1111.6	177.7
607.1	139.0	173.9	1113.1	178.5
632.1	139.3	174.3	1112.8	177.1
667.1	138.9	173.8	1113.2	175.3
777.1	137.4	171.8	1114.8	172.7
782.1	346.6	433.6	718.0	252.9
787.1	352.8	441.3	711.8	254.3
857.1	352.8	441.3	711.8	254.3
857.2	88.7	110.0	975.9	323.4
967.1	86.4	107.1	978.2	321.8
972.1	86.3	107.0	978.3	321.4
1147.1	83.4	103.4	981.2	317.6
1267.1	81.6	101.1	983.0	316.8
1307.1	81.0	100.3	983.6	317.3
1427.1	79.1	98.0	985.5	314.4
1588.5	79.1	97.9	985.5	313.9
1588.6	76.4	87.9	988.2	226.6
3600.0	62.2	71.6	1002.4	229.2
3600.1	54.4	62.5	1010.2	209.6
10000.0	39.5	45.5	1025.1	212.7
100000.0	21.1	24.3	1043.5	216.5
1000000.0	9.1	10.4	1055.5	219.0

TABLE 2-11

MASS BALANCE

DEPS – MIN ECCS

	TIME (SECONDS)	0.00	25.75	25.75	192.63	692.70	1609.98	3600.00
		MASS (THOUSAND LBM)						
INITIAL	IN RCS AND ACC	758.33	758.33	758.33	758.33	758.33	758.33	758.33
ADDED MASS	PUMPED INJECTION	0.00	0.00	0.00	95.29	392.49	913.83	1784.44
	TOTAL ADDED	0.00	0.00	0.00	95.29	392.49	913.83	1784.44
*** TOTAL	AVAILABLE ***	758.33	758.33	758.33	853.62	1150.82	1672.16	2542.77
DISTRIBUTION	REACTOR COOLANT	539.17	43.89	65.86	141.18	141.18	141.18	141.18
	ACCUMULATOR	219.16	176.48	154.51	0.00	0.00	0.00	0.00
	TOTAL CONTENTS	758.33	220.37	220.37	141.18	141.18	141.18	141.18
EFFLUENT	BREAK FLOW	0.00	537.95	537.95	712.43	1009.63	1530.97	2401.58
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	537.95	537.95	712.43	1009.63	1530.97	2401.58
*** TOTAL	ACCOUNTABLE ***	758.33	758.32	758.32	853.61	1150.81	1672.15	2542.77

TABLE 2-12

MASS BALANCE

DEPS – MAX ECCS – CSP FAILURE

	TIME (SECONDS)	0.00	25.75	25.75	207.06	1127.10	1588.53	3600.00
		MASS (THOUSAND LBM)						
INITIAL	IN RCS AND ACC	758.33	758.33	758.33	758.33	758.33	758.33	758.33
ADDED MASS	PUMPED INJECTION	0.00	0.00	0.00	223.41	1344.85	1837.24	3983.68
	TOTAL ADDED	0.00	0.00	0.00	223.41	1344.85	1837.24	3983.68
*** TOTAL	AVAILABLE ***	758.33	758.33	758.33	981.74	2103.18	2595.56	4742.01
DISTRIBUTION	REACTOR COOLANT	539.17	43.89	64.37	142.61	142.61	142.61	142.61
	ACCUMULATOR	219.16	176.48	156.00	0.00	0.00	0.00	0.00
	TOTAL CONTENTS	758.33	220.37	220.37	142.61	142.61	142.61	142.61
EFFLUENT	BREAK FLOW	0.00	537.95	537.95	839.13	1960.56	2452.95	4599.40
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	537.95	537.95	839.13	1960.56	2452.95	4599.40
*** TOTAL	ACCOUNTABLE ***	758.33	758.32	758.32	981.73	2103.17	2595.56	4742.00

TABLE 2-13

MASS BALANCE

DEPS – MAX ECCS – CFCU FAILURE

	TIME (SECONDS)	0.00	25.75	25.75	207.06	862.10	1588.53	3600.00
		MASS (THOUSAND LBM)						
INITIAL	IN RCS AND ACC	758.33	758.33	758.33	758.33	758.33	758.33	758.33
ADDED MASS	PUMPED INJECTION	0.00	0.00	0.00	223.41	1028.56	1801.91	3943.33
	TOTAL ADDED	0.00	0.00	0.00	223.41	1028.56	1801.91	3943.33
*** TOTAL	AVAILABLE ***	758.33	758.33	758.33	981.74	1786.89	2560.24	4701.66
DISTRIBUTION	REACTOR COOLANT	539.17	43.89	64.37	142.61	142.61	142.61	142.61
	ACCUMULATOR	219.16	176.48	156.00	0.00	0.00	0.00	0.00
	TOTAL CONTENTS	758.33	220.37	220.37	142.61	142.61	142.61	142.61
EFFLUENT	BREAK FLOW	0.00	537.95	537.95	839.13	1644.28	2417.63	4559.04
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	537.95	537.95	839.13	1644.28	2417.63	4559.04
*** TOTAL	ACCOUNTABLE ***	758.33	758.32	758.32	981.73	1786.88	2560.23	4701.65

TABLE 2-14

ENERGY BALANCE

DEPS – MIN ECCS

	TIME (SECONDS)	0.00	25.75	25.75	192.63	692.70	1609.98	3600.00
		ENERGY (MILLION BTU)						
INITIAL ENERGY	IN RCS,ACC,S GEN	891.96	891.96	891.96	891.96	891.96	891.96	891.96
ADDED ENERGY	PUMPED INJECTION	0.00	0.00	0.00	6.48	26.69	68.86	215.90
	DECAY HEAT	0.00	8.58	8.58	28.46	73.28	138.91	251.99
	HEAT FROM SECONDAR	0.00	-1.32	-1.32	-1.32	-1.32	-1.32	-1.32
	TOTAL ADDED	0.00	7.26	7.26	33.63	98.65	206.46	466.57
*** TOTAL AVAILABLE ***		891.96	899.23	899.23	925.59	990.61	1098.42	1358.54
DISTRIBUTION	REACTOR COOLANT	316.62	12.11	14.07	38.02	38.02	38.02	38.02
	ACCUMULATOR	19.61	15.79	13.83	0.00	0.00	0.00	0.00
	CORE STORED	26.06	11.97	11.97	4.85	4.64	4.22	3.33
	PRIMARY METAL	153.60	145.25	145.25	117.98	84.47	62.68	48.52
	SECONDARY METAL	98.19	98.42	98.42	89.25	69.88	47.03	36.03
	STEAM GENERATOR	277.89	284.77	284.77	254.50	193.47	125.71	95.36
	TOTAL CONTENTS	891.96	568.30	568.30	504.60	390.48	277.66	221.26
EFFLUENT	BREAK FLOW	0.00	330.93	330.93	413.26	592.41	813.03	1129.55
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	330.93	330.93	413.26	592.41	813.03	1129.55
*** TOTAL ACCOUNTABLE ***		891.96	899.23	899.23	917.86	982.89	1090.69	1350.81

TABLE 2-15

ENERGY BALANCE

DEPS – MAX ECCS – CSP FAILURE

	TIME (SECONDS)	0.00	25.75	25.75	207.06	1127.10	1588.53	3600.00
		ENERGY (MILLION BTU)						
INITIAL ENERGY	IN RCS,ACC,S GEN	891.96	891.96	891.96	891.96	891.96	891.96	891.96
ADDED ENERGY	PUMPED INJECTION	0.00	0.00	0.00	15.19	115.07	214.61	648.54
	DECAY HEAT	0.00	8.58	8.58	29.94	106.06	137.52	252.02
	HEAT FROM SECONDAR	0.00	-1.32	-1.32	-1.32	-1.32	-1.32	-1.32
	TOTAL ADDED	0.00	7.26	7.26	43.82	219.82	350.81	899.24
*** TOTAL	AVAILABLE ***	891.96	899.23	899.23	935.78	1111.78	1242.78	1791.20
DISTRIBUTION	REACTOR COOLANT	316.62	12.11	13.94	38.54	38.54	38.54	38.54
	ACCUMULATOR	19.61	15.79	13.96	0.00	0.00	0.00	0.00
	CORE STORED	26.06	11.97	11.97	4.85	4.64	4.39	3.33
	PRIMARY METAL	153.60	145.25	145.25	117.14	75.21	63.93	48.45
	SECONDARY METAL	98.19	98.42	98.42	89.79	59.09	47.45	35.96
	STEAM GENERATOR	277.89	284.77	284.77	255.69	159.98	126.76	95.15
	TOTAL CONTENTS	891.96	568.30	568.30	506.02	337.47	281.07	221.43
EFFLUENT	BREAK FLOW	0.00	330.93	330.93	422.00	766.55	953.95	1562.01
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	330.93	330.93	422.00	766.55	953.95	1562.01
*** TOTAL	ACCOUNTABLE ***	891.96	899.23	899.23	928.02	1104.02	1235.02	1783.44

TABLE 2-16

ENERGY BALANCE

DEPS – MAX ECCS – CFCU FAILURE

	TIME (SECONDS)	0.00	25.75	25.75	207.06	862.10	1588.53	3600.00
		ENERGY (MILLION BTU)						
INITIAL ENERGY	IN RCS,ACC,S GEN	891.96	891.96	891.96	891.96	891.96	891.96	891.96
ADDED ENERGY	PUMPED INJECTION	0.00	0.00	0.00	15.19	81.82	242.25	686.49
	DECAY HEAT	0.00	8.58	8.58	29.94	86.52	137.52	252.02
	HEAT FROM SECONDAR	0.00	-1.32	-1.32	-1.32	-1.32	-1.32	-1.32
	TOTAL ADDED	0.00	7.26	7.26	43.82	167.03	378.45	937.19
*** TOTAL AVAILABLE ***		891.96	899.23	899.23	935.78	1058.99	1270.42	1829.16
DISTRIBUTION	REACTOR COOLANT	316.62	12.11	13.94	38.54	38.54	38.54	38.54
	ACCUMULATOR	19.61	15.79	13.96	0.00	0.00	0.00	0.00
	CORE STORED	26.06	11.97	11.97	4.85	4.64	4.29	3.33
	PRIMARY METAL	153.60	145.25	145.25	117.14	80.66	63.13	48.46
	SECONDARY METAL	98.19	98.42	98.42	89.79	65.45	47.16	35.97
	STEAM GENERATOR	277.89	284.77	284.77	255.69	179.39	126.03	95.19
	TOTAL CONTENTS	891.96	568.30	568.30	506.02	368.68	279.15	221.49
EFFLUENT	BREAK FLOW	0.00	330.93	330.93	422.00	682.55	983.50	1599.90
	ECCS SPILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	330.93	330.93	422.00	682.55	983.50	1599.90
*** TOTAL ACCOUNTABLE ***		891.96	899.23	899.23	928.02	1051.23	1262.66	1821.40

TABLE 2-17

MASS BALANCE

DEHL

	TIME (SECONDS)	0.00	28.50	28.50
	MASS (THOUSAND LBM)			
INITIAL	IN RCS AND ACC	758.33	758.33	758.33
ADDED MASS	PUMPED INJECTION	0.00	0.00	0.00
	TOTAL ADDED	0.00	0.00	0.00
*** TOTAL	AVAILABLE ***	758.33	758.33	758.33
DISTRIBUTION	REACTOR COOLANT	539.17	117.88	131.58
	ACCUMULATOR	219.16	135.08	121.38
	TOTAL CONTENTS	758.33	252.96	252.96
EFFLUENT	BREAK FLOW	0.00	518.48	518.48
	ECCS SPILL	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	518.48	518.48
*** TOTAL	ACCOUNTABLE ***	758.33	771.44	771.44

TABLE 2-18

ENERGY BALANCE

DEHL

	TIME (SECONDS)	0.00	28.50	28.50
	ENERGY (MILLION BTU)			
INITIAL ENERGY	IN RCS,ACC,S GEN	891.96	891.96	891.96
ADDED ENERGY	PUMPED INJECTION	0.00	0.00	0.00
	DECAY HEAT	0.00	9.59	9.59
	HEAT FROM SECONDAR	0.00	-2.90	-2.90
	TOTAL ADDED	0.00	6.69	6.69
*** TOTAL	AVAILABLE ***	891.96	898.66	898.66
DISTRIBUTION	REACTOR COOLANT	316.62	26.13	27.33
	ACCUMULATOR	19.61	12.09	10.88
	CORE STORED	26.06	10.13	10.13
	PRIMARY METAL	153.60	142.97	142.97
	SECONDARY METAL	98.19	96.78	96.78
	STEAM GENERATOR	277.89	278.94	278.94
	TOTAL CONTENTS	891.96	567.05	567.05
EFFLUENT	BREAK FLOW	0.00	332.50	332.50
	ECCS SPILL	0.00	0.00	0.00
	TOTAL EFFLUENT	0.00	332.50	332.50
*** TOTAL	ACCOUNTABLE ***	891.96	899.55	899.55

TABLE 2-19

3423 MWt SPECIFIC DECAY HEAT CURVE

Time (sec)	Energy Rate (Btu/sec)
1.00E+01	1.749E+05
1.50E+01	1.636E+05
2.00E+01	1.559E+05
4.00E+01	1.377E+05
6.00E+01	1.274E+05
8.00E+01	1.203E+05
1.00E+02	1.151E+05
1.50E+02	1.062E+05
2.00E+02	1.004E+05
4.00E+02	8.791E+04
6.00E+02	8.094E+04
8.00E+02	7.593E+04
1.00E+03	7.193E+04
1.50E+03	6.467E+04
2.00E+03	5.946E+04
4.00E+03	4.799E+04
6.00E+03	4.233E+04
8.00E+03	3.896E+04
1.00E+04	3.656E+04
1.50E+04	3.278E+04
4.00E+04	2.525E+04
1.00E+05	1.955E+04
4.00E+05	1.224E+04
6.00E+05	1.039E+04
8.00E+05	9.200E+03
1.00E+06	8.376E+03
1.50E+06	8.214E+03
2.00E+06	6.198E+03
4.00E+06	4.399E+03
6.00E+06	3.542E+03
8.00E+06	3.010E+03
1.00E+07	2.623E+03

TABLE 2-20

SYSTEM PARAMETERS

Parameter	Value
Core Inlet Temperature (+5.0°F)	550.1°F
Initial Steam Generator Steam Pressure	844.0 psig
Assumed Maximum Containment Back Pressure	61.7 psia

3.0 CONTAINMENT INTEGRITY ANALYSIS

3.1 DESCRIPTION OF COCO MODEL

Calculation of containment pressure and temperature transients is accomplished by use of the digital computer code, COCO (Reference [7]). The COCO code has been used and found acceptable to calculate containment pressure transients for many dry containment plants. Transient phenomena within the reactor coolant system affect containment conditions by means of convective mass and energy transport through the pipe break.

For analytical rigor and convenience, the containment air-steam-water mixture is separated into systems. The first system consists of the air-steam phase; the second consists of the water phase. Sufficient relationships to describe the transient are provided by the equations of conservation of mass and energy as applied to each system, together with appropriate boundary conditions. As thermodynamic equations of state and conditions may vary during the transient, the equations have been derived for all possible cases of superheated or saturated steam and subcooled or saturated water. Switching between states is handled automatically by the code. The following are the major assumptions made in the analysis:

(a) Discharge mass and energy flow rates through the reactor coolant system breaks are established from the analysis in Section 2.

(b) For the blowdown portion of the LOCA analysis, the discharge flow separates into steam and water phases at the break point. The saturated water phase is at the total containment pressure, while the steam phase is at the partial pressure of the steam in the containment. For the post-blowdown portion of the LOCA analysis, steam and water releases are input separately.

(c) Homogeneous mixing is assumed. The steam-air mixture and the water phase each have uniform properties. More specifically, thermal equilibrium between the air and steam is assumed. This does not imply thermal equilibrium between the steam-air mixture and water phase.

(d) Air is taken as an ideal gas, while compressed water and steam tables are employed for water and steam thermodynamic properties.

(e) The saturation temperature at the partial pressure of the steam is used for heat transfer to the heat sinks and the fan coolers.

3.2 CONTAINMENT PRESSURE CALCULATION

The following are the major input assumptions used in the COCO analysis for the hot leg (blowdown only) and the pump suction pipe rupture case with the steam generators considered as an active heat source for the Diablo Canyon Units 1 and 2 Nuclear Plant Containment:

1. A containment safeguards failure is employed in all calculations, depending upon the assumed single-active failure and consistent with the mass and energy release rate calculation (see Table 2-1). [Due to the duration of the hot leg transient, no containment safeguards equipment is modeled.]

2. The blowdown, reflood, and post reflood mass and energy releases described in Section 2 are used.

3. An ASW temperature of 64°F is used for the component cooling heat exchanger.

4. The component cooling water flowrate for the fan cooler was 1600 gpm for the injection phase and 1490 gpm for the recirculation phase of the accident.

5. The initial conditions in the containment are a temperature of 120°F and a pressure of 16.0 psia.

6. Containment structural heat sinks are assumed with conservatively low heat transfer rates. (See Table 3-1)

7. The operation of one RHR heat exchanger (UA = 1.64×10^6 Btu/hr-°F) for core cooling. The component cooling heat exchanger was modeled at UA = 4.10×10^6 Btu/hr-°F.

8. The ASW flow to the component cooling heat exchanger was modeled as 10,300 gpm. (Reference 8). The component cooling water flow to the component cooling water heat exchanger was modeled as 10,500 gpm (Reference 8).

9. Revised ECCS pump flows have been used.

3.3 HEAT REMOVAL SYSTEMS

The significant heat removal source during the early portion of the transient is the structural heat sinks. Provision is made in the containment pressure transient analysis for heat transfer through, and heat storage in, both interior and exterior walls. Every wall is divided into a large number of nodes. For each node, a conservation of energy equation expressed in finite-difference form accounts for transient conduction into and out of the node and temperature rise of the node. Table 3-1 is the summary of the containment structural heat sinks used in the analysis.

The heat transfer coefficient to the containment structure is calculated by the code based primarily on the work of Tagami (Reference [9]). From this work, it was determined that the value of the heat transfer coefficient increases parabolically to a peak value at the end of blowdown for LOCA. The value then decreases exponentially to a stagnant heat transfer coefficient which is a function of steam-to-air-weight ratio.

Tagami presents a plot of the maximum value of h as a function of "coolant energy transfer speed," defined as follows:

$$\frac{\text{total coolant energy transferred into containment}}{\text{(containment volume) (time interval to peak pressure)}}$$

From this, the maximum h of steel is calculated:

$$h_{max} = 75 \left[\frac{E}{t_p V} \right]^{0.60} \tag{3.3-1}$$

where:

h_{max} = maximum value of h (Btu/hr ft^2 °F).

t_p = time from start of accident to end of blowdown for LOCA and steam line isolation for secondary breaks (sec).

V = containment volume (ft^3).

E = coolant energy discharge (Btu).

The parabolic increase to the peak value is given by:

$$h_s = h_{max} \left[\frac{t}{t_p} \right]^{0.5}, \; 0 \leq t \leq t_p \tag{3.3-2}$$

where:

h_s = heat transfer coefficient for steel (Btu/hr ft^2 °F).

t = time from start of accident (sec).

For concrete, the heat transfer coefficient is taken as 40 percent of the value calculated for steel (Reference [7]).

The exponential decrease of the heat transfer coefficient is given by:

$$h_s = h_{stag} + (h_{max} - h_{stag})e^{-0.05(t-t_p)} \quad t > t_p \tag{3.3-3}$$

where:

h_{stag} = $2 + 50X$, $0 \leq X \leq 1.4$.

h_{stag} = h for stagnant conditions (Btu/hr ft^2 °F).

X = steam-to-air weight ratio in containment.

For a large break, the engineered safety features are quickly brought into operation. Because of the brief period of time required to depressurize the reactor coolant system, the containment safeguards are not a major influence on the blowdown peak pressure; however, they reduce the containment pressure after the blowdown and maintain a low long-term pressure. Also, although the containment structure is not a very effective heat sink during the initial reactor coolant system blowdown, it still contributes significantly as a form of heat removal throughout the rest of the transient.

During the injection phase of post-accident operation, the emergency core cooling system pumps water from the refueling water storage tank into the reactor vessel. Since this water enters the vessel at refueling water storage tank temperature, which is less than the temperature of the water in the vessel, it can absorb heat from the core until saturation temperature is reached. During the recirculation phase of operation, water is taken from the containment sump and cooled in the residual heat removal heat exchanger. The cooled water is then pumped back to the reactor vessel to absorb more decay heat. The heat is removed from the residual heat exchanger by component cooling water.

Another containment heat removal system is the containment spray. Containment spray is used for rapid pressure reduction and for containment iodine removal. During the injection phase of operation, the containment spray pumps draw water from the RWST and sprays it into the containment through nozzles mounted high above the operating deck. As the spray droplets fall, they absorb heat from the containment atmosphere. Since the water comes from the RWST, the entire

heat capacity of the spray from the RWST temperature to the temperature of the containment atmosphere is available for energy absorption. During the recirculation phase of post-accident operation, water can conceivably be drawn from the residual heat removal heat exchanger outlet and sprayed into the containment atmosphere via the recirculation spray system. However, recirculation spray is not modeled in the COCO code in the analyses reported herein.

When a spray drop enters the hot, saturated, steam-air containment environment following a loss-of-coolant accident, the vapor pressure of the water at its surface is much less than the partial pressure of the steam in the atmosphere. Hence, there will be diffusion of steam to the drop surface and condensation on the drop. This mass flow will carry energy to the drop. Simultaneously, the temperature difference between the atmosphere and the drop will cause the drop temperature and vapor pressure to rise. The vapor pressure of the drop will eventually become equal to the partial pressure of the steam, and the condensation will cease. The temperature of the drop will essentially equal the temperature of the steam-air mixture.

The equations describing the temperature rise of a falling drop are as follows:

$$\frac{d}{dt}(Mu) = mh_s + q \tag{3.3-4}$$

$$\frac{d}{dt}(M) = m \tag{3.3-5}$$

where:

$$q = h_c A (T_s - T).$$

$$m = k_g A (P_s - P_v).$$

The coefficients of heat transfer (h_c) and mass transfer (k_g) are calculated from the Nusselt number for heat transfer, Nu, and the Nusselt number for mass transfer, Nu'.

Both Nu and Nu' may be calculated from the equations of Ranz and Marshall (Reference [10).

$$N = 2 + 0.6(\underline{Re})^{1/2}(\underline{Pr})^{1/3} \quad (3.3\text{-}6)$$

$$Nu' = 2 + 0.6(\underline{Re})^{1/2}(\underline{Sc})^{1/3} \quad (3.3\text{-}7)$$

Thus, Equations 3.3-4 and 3.3-5 can be integrated numerically to find the internal energy and mass of the drop as a function of time as it falls through the atmosphere. Analysis shows that the temperature of the (mass) mean drop produced by the spray nozzles rises to a value within 99 percent of the bulk containment temperature in less than 2 seconds.

Drops of this size will reach temperature equilibrium with the steam-air containment atmosphere after falling through less than half the available spray fall height.

Detailed calculations of the heatup of spray drops in post-accident containment atmospheres by Parsly (Reference [11]) show that drops of all sizes encountered in the containment spray reach equilibrium in a fraction of their residence time in a typical pressurized water reactor containment.

These results confirm the assumption that the containment spray will be 100 percent effective in removing heat from the atmosphere. Nomenclature used in this section is as follows:

Nomenclature

A = area.

h_c = coefficient of heat transfer.

k_g = coefficient of mass transfer.

h_g = steam enthalpy.

M = droplet mass.

m = diffusion rate.

$\underline{Nu}$ = Nusselt number for heat transfer.

$\underline{Nu'}$ = Nusselt number for mass transfer,

P_s = steam partial pressure.

P_v = droplet vapor pressure.

$\underline{Pr}$ = Prandtl number.

q = heat flow rate.

$\underline{Re}$ = Reynolds number.

$\underline{Sc}$ = Schmidt number.

T = droplet temperature.

T_s = steam temperature.

t = time.

u = internal energy.

The reactor containment fan coolers are a final means of heat removal. The fan coolers consists of the fan and the banks of cooling coils. The fans draw the dense post-accident atmosphere through banks of finned cooling coils and mix the cooled steam/air mixture with the rest of the containment atmosphere. The coils are kept at a low temperature by a constant flow of component cooling water (CCW). Since this system does not use water from the RWST, the mode of operation remains the same both before and after the spray system and emergency core cooling system change to the recirculation mode. However, CCW is also used to cool the RHR heat exchanger(s) during

recirculation. This will adversely affect fan cooler performance due to increased CCW temperatures and lower CCW flowrates to the fan coolers.

With these assumptions, the heat removal capability of the passive and active containment heat removal systems are sufficient to absorb the energy releases and still keep the maximum calculated pressure below the design pressure for the LOCA transient.

3.4 ANALYSIS RESULTS

The results of the analysis shows that the maximum calculated containment pressure for the double-ended pump suction minimum safeguards break case is 38.71 psig and for the double-ended hot leg break case is 41.53 psig. The pressure peaks occur at approximately 700.2 seconds and 22.5 seconds, respectively. The containment peak pressure for double-ended pump suction maximum safeguards case with a CSP failure is 38.14 psig occurring at 23.7 seconds. For max safeguards with a CFCU failure, the peak pressure is 38.14 at 23.9 seconds.

The following plots show the containment integrity transient, as calculated by the COCO code.

Figure 3-1, Containment Pressure Transient – DEPS Minimum ECCS
Figure 3-2, Containment Pressure Transient – DEHL
Figure 3-3, Containment Pressure Transient – DEPS – Maximum ECCS – CSP Failure
Figure 3-4, Containment Pressure Transient – DEPS – Maximum ECCS – CFCU Failure
Figure 3-5, Containment Temperature Transient – DEPS Minimum ECCS
Figure 3-6, Containment Temperature Transient – DEHL
Figure 3-7, Containment Temperature Transient – DEPS – Maximum ECCS – CSP Failure
Figure 3-8, Containment Temperature Transient – DEPS – Maximum ECCS – CFCU Failure

Table 3-1 shows the containment structural heat sink and material properties data used in the analysis, respectively. Table 3-2 shows the assumptions and initial conditions for the containment analysis.

The accident chronology for the double-ended pump suction loss-of-coolant accident (minimum ECCS case) and the double-ended hot leg case are shown in Tables 3-3 and 3-4, respectively. The

accident chronology shows significant events which affect the containment pressure and temperature transient. Tables 3-5 and 3-6 show the accident chronology for the DEPS MAX ECCS, CSP failure and CFCU failure cases, respectively.

A composite temperature plot is provided in Figure 3-9. The composite plot represents a bounding containment temperature profile for the DEPS and DEHL cases. Digitized data for the composite plot is provided in Table 3-7. Figure 3-10 presents the containment sump temperature transient for the DEPS minimum ECCS case.

Investigation of the ECCS delay time assumption showed very little effect on peak pressure due to the delay time. Therefore, the assumption of loss of offsite power for the DEPS maximum safeguards case is reasonable, since this will delay operation of containment safeguards systems.

3.5 CONTAINMENT FAN COOLER SENSITIVITY

The analysis discussed in this report supports the conclusion that the double-ended pump suction break with minimum safeguards is the limiting break for post-blowdown. Sensitivity analyses were performed with respect to containment fan cooler unit availability for this case. Cases were run for both one and no fan coolers available during the accident. The remaining input parameters were kept the same as the DEPS MIN ECCS case discussed in the previous sections. This includes one containment spray operating, and one CCW heat exchanger available.

Figures 3-11 and 3-12 show the pressure transient for the one and zero fan coolers available cases, respectively. Figures 3-13 and 3-14 show the corresponding temperature profiles.

The peak containment pressure with one fan cooler was 50.5 psig at 22937.2 seconds. The pressure transient figure shows a significant rise in pressure following termination of containment spray. Switchover to recirculation spray would be able to reduce this peak, if it were available at Diablo Canyon. The sensitivity to zero fan coolers also showed a rapid pressure increase following the termination of containment spray.

3.6 RELEVANT ACCEPTANCE CRITERIA

The LOCA mass and energy analysis has been performed in accordance with the criteria shown in the Standard Review Plan (SRP) section 6.2.1.3. In this analysis, the relevant requirements of General Design Criteria (GDC) 50 and 10 CFR Part 50 Appendix K have been met since the calculated pressure is less than the design pressure, and because all available sources of energy have been included. These sources include: reactor power, decay heat, core stored energy, energy stored in the reactor vessel and internals, metal-water reaction energy, and stored energy in the secondary system.

The containment integrity peak pressure analysis has been performed in accordance with the criteria shown in the SRP section 6.2.1.1.A, for dry PWR containments. Conformance to GDC's 16, 38, and 50 is demonstrated by showing that the containment design pressure is not exceeded at any time in the transient. This analysis also demonstrates that the containment heat removal systems function to rapidly reduce the containment pressure and temperature in the event of a LOCA.

The mass and energy release and containment analysis has been performed in accordance with NUREG-0588 [Reference 12]. Appendix A of NUREG-0588 lists WCAP-8312A [Reference 5] as an acceptable method of calculating mass and energy releases for Westinghouse plants. The NRC considers the new methodology used herein [Reference 1] as a revision to WCAP-8312A. Therefore, NUREG-0588 is still satisfied.

FIGURE 3-1

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

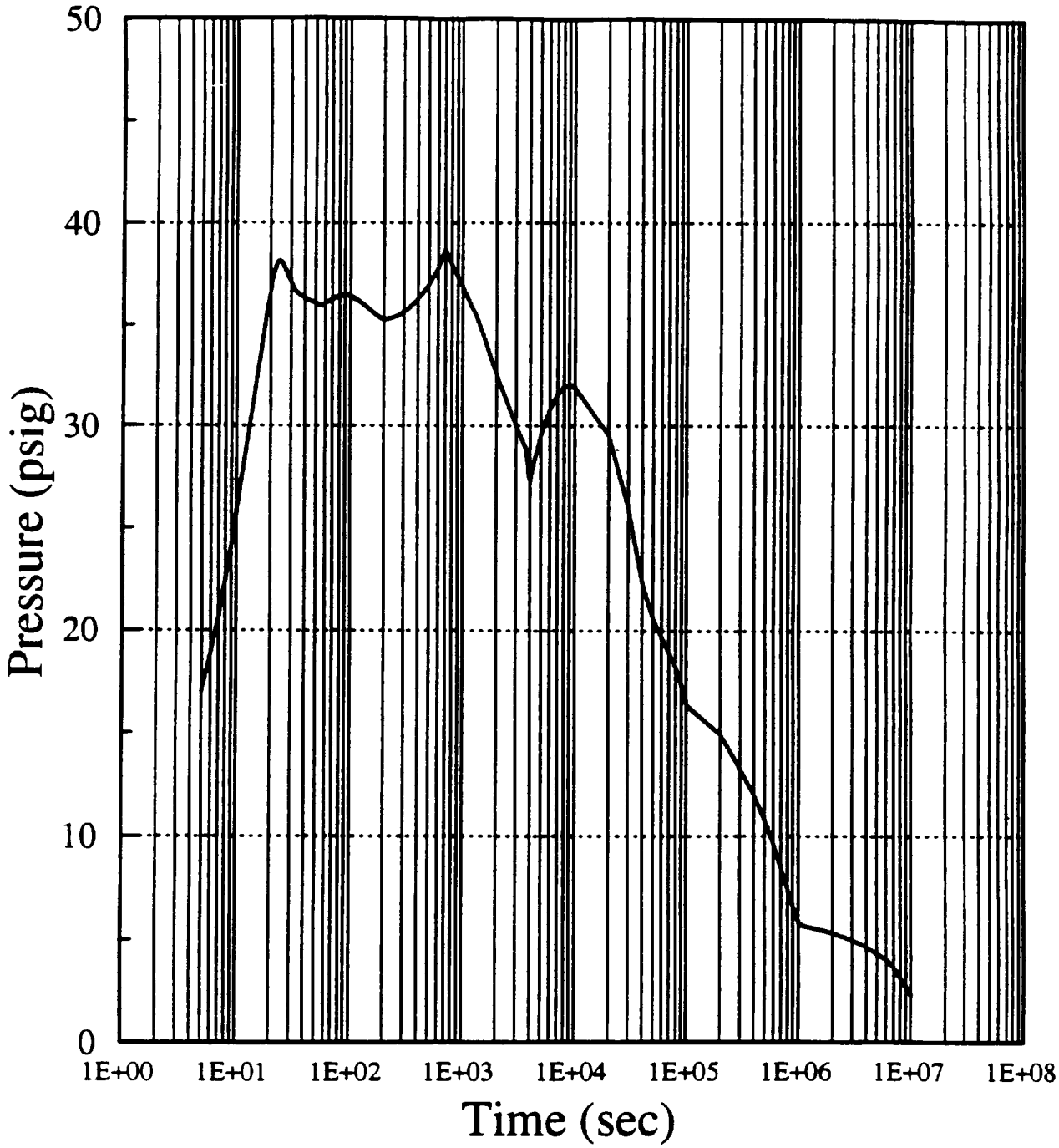

FIGURE 3-2

CONTAINMENT PRESSURE vs. TIME

DEHL

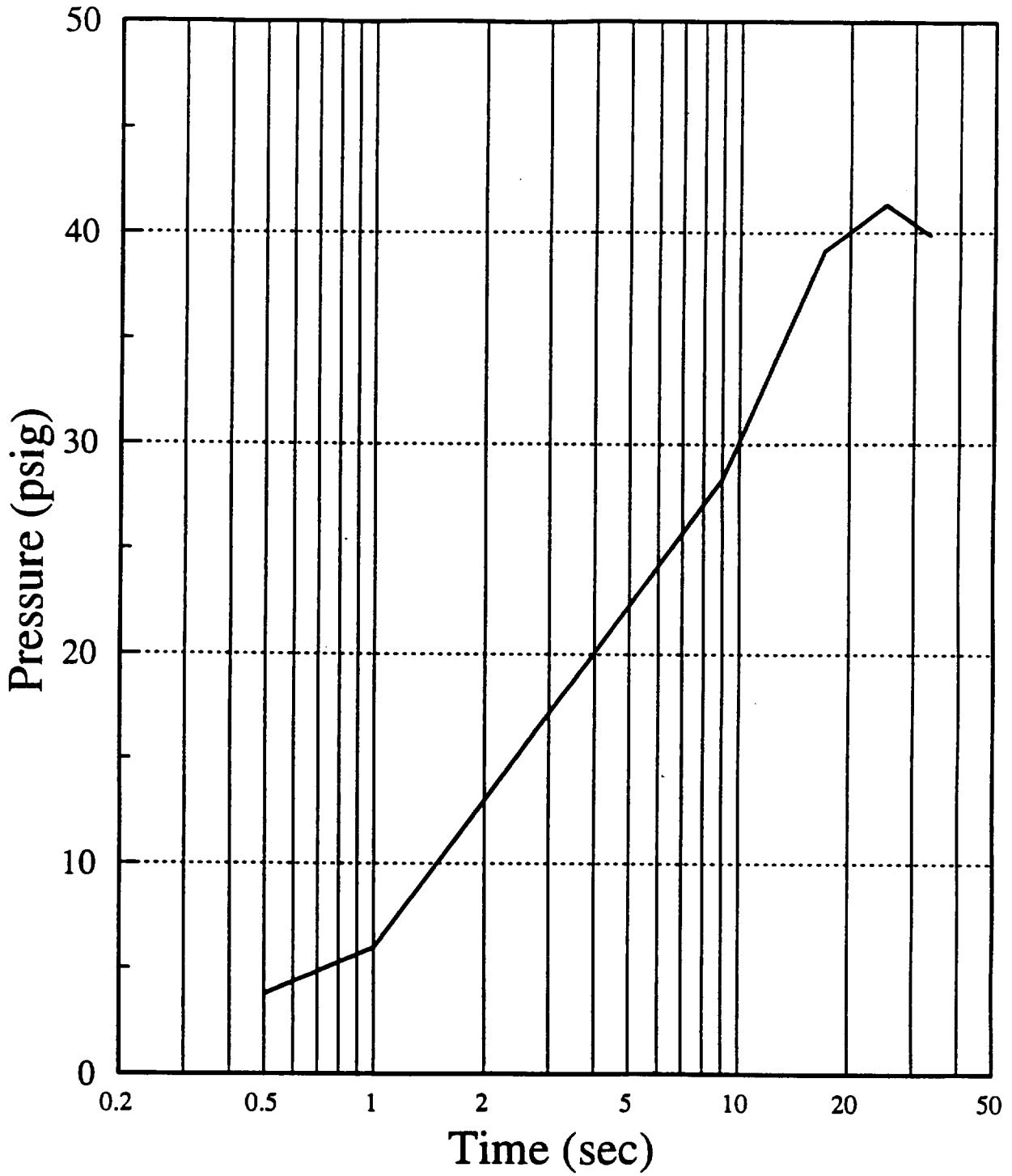

FIGURE 3-3

CONTAINMENT PRESSURE vs. TIME

DEPS – MAX ECCS – CSP FAILURE

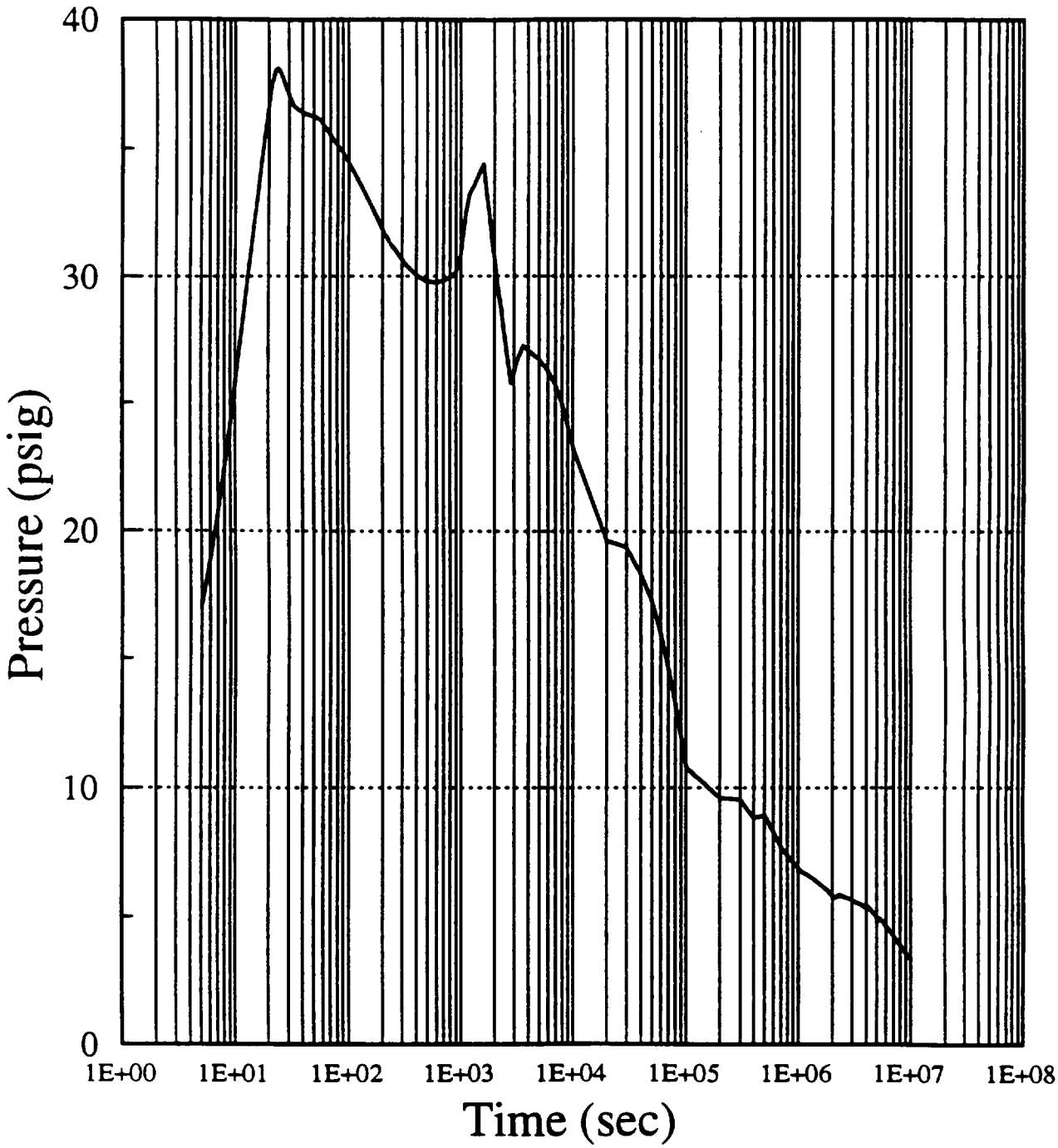

FIGURE 3-4

CONTAINMENT PRESSURE vs. TIME

DEPS – MAX ECCS – CFCU FAILURE

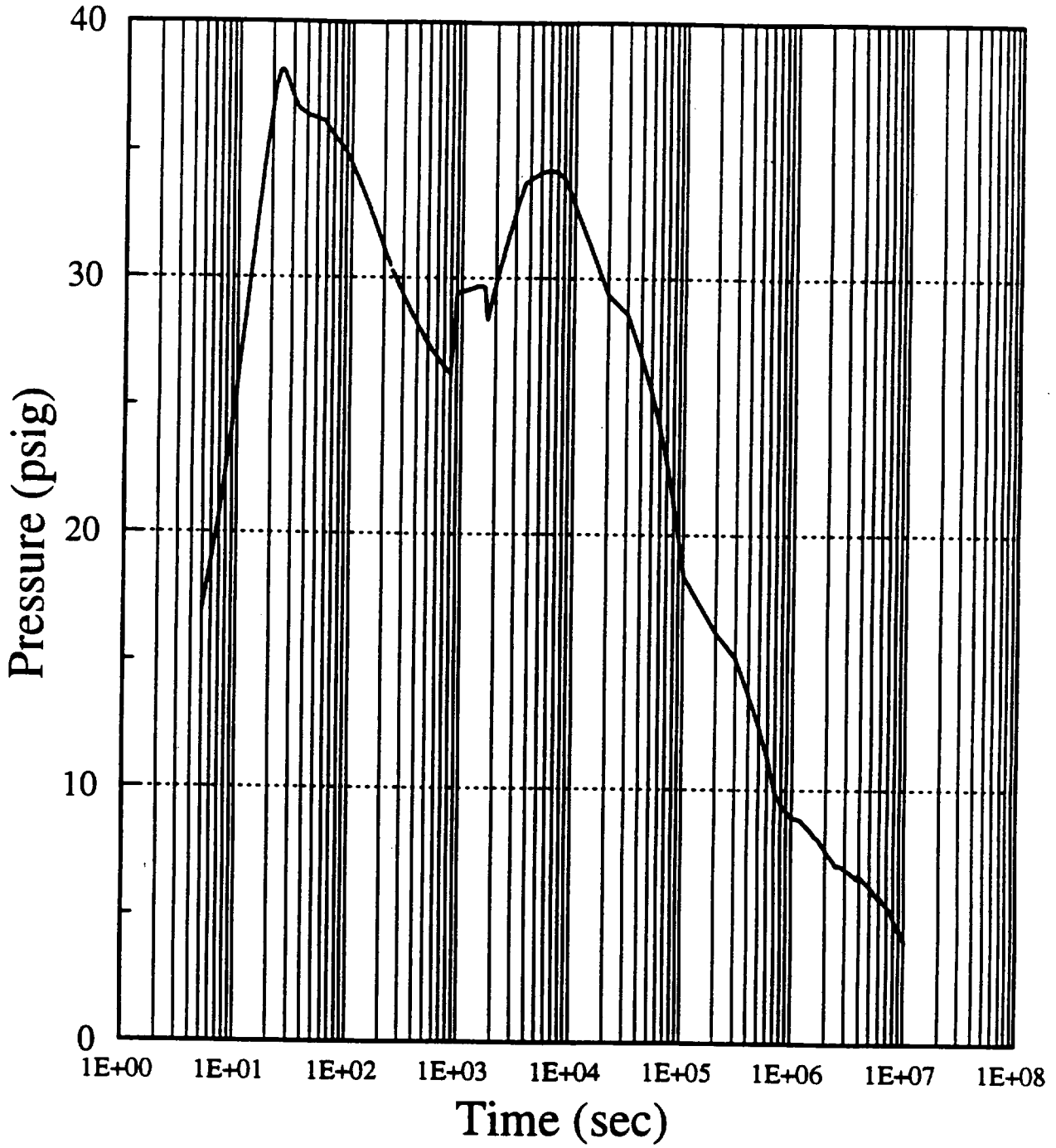

FIGURE 3-5

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

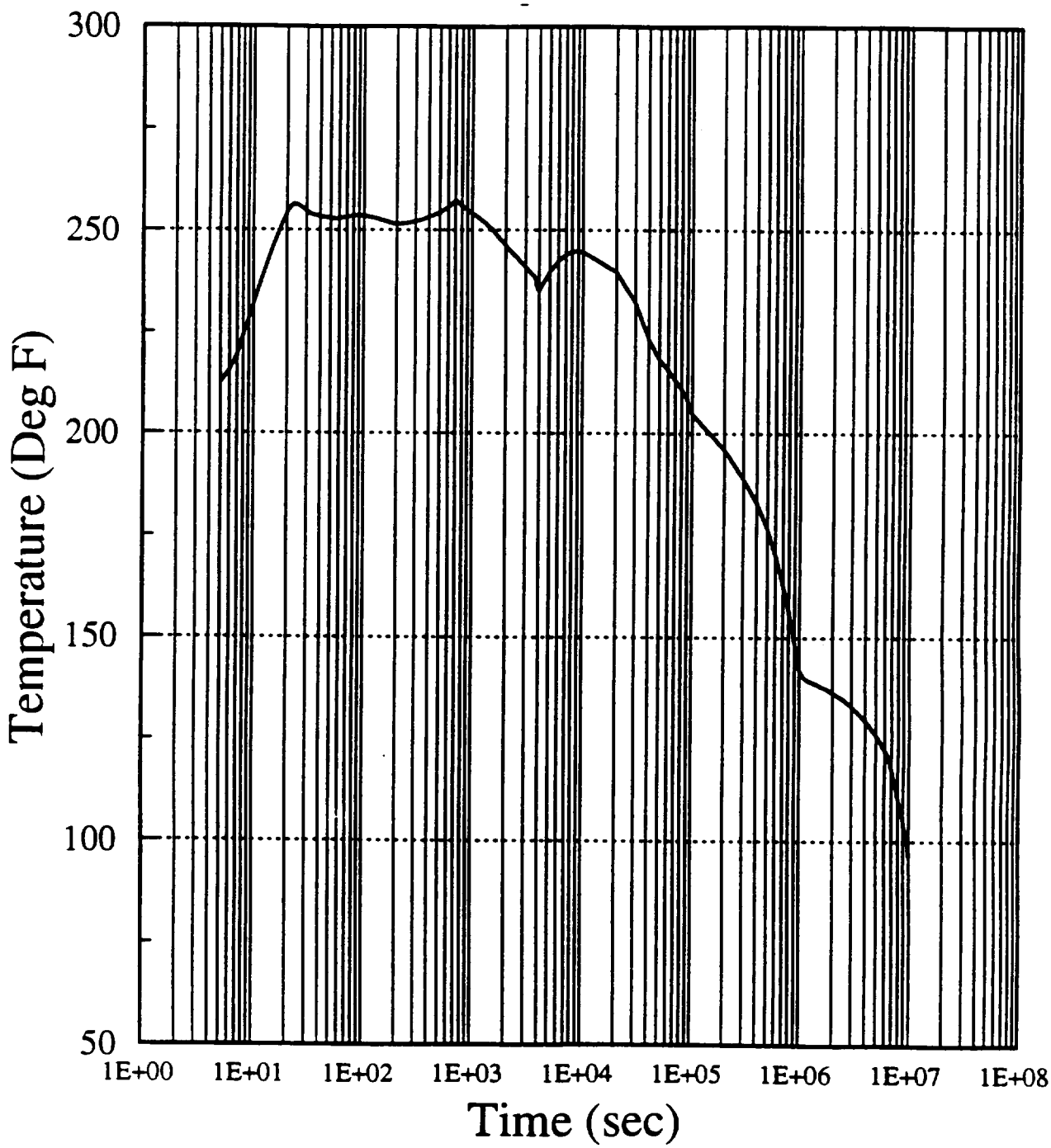

FIGURE 3-6

CONTAINMENT TEMPERATURE vs. TIME

DEHL

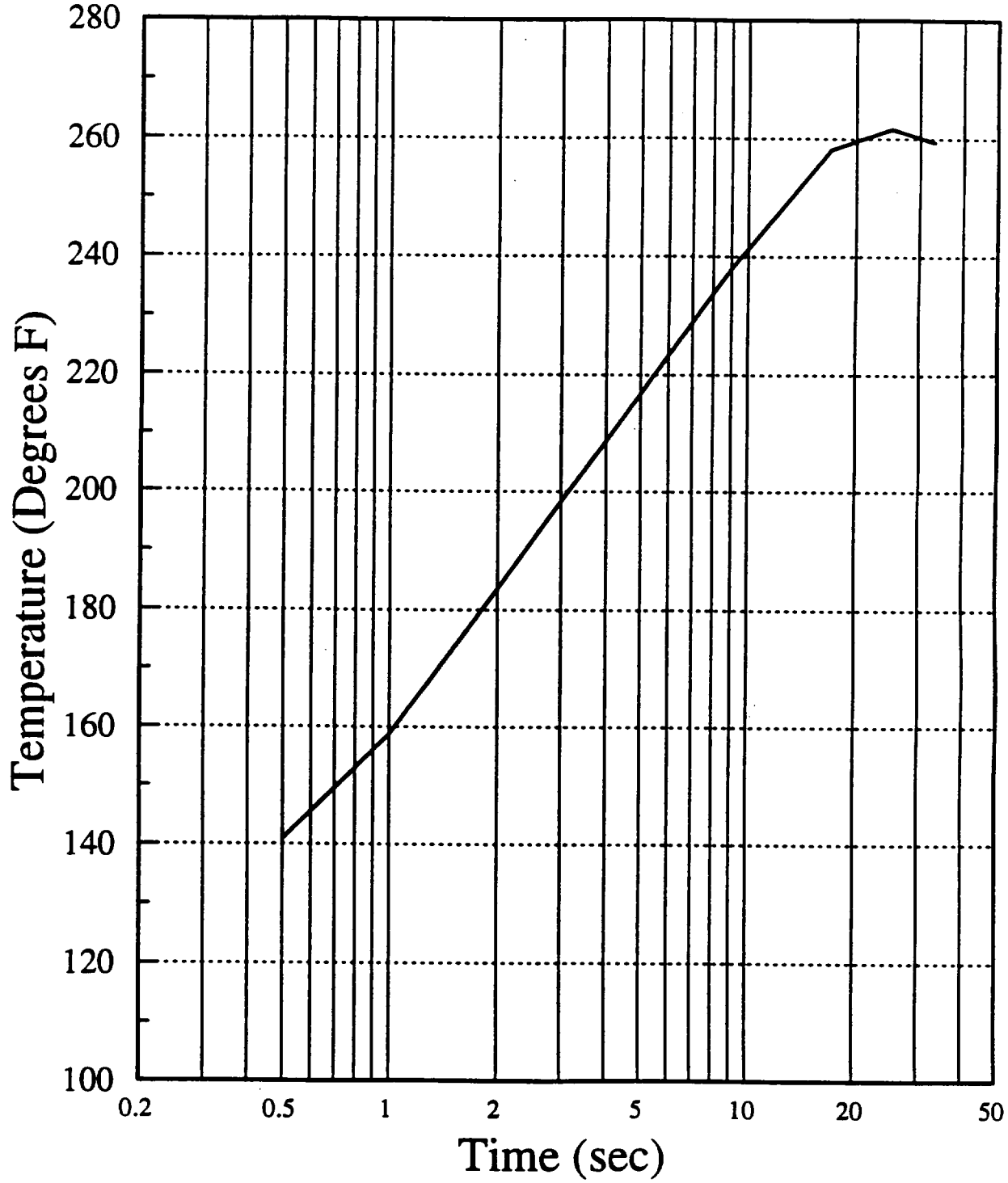

FIGURE 3-7

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MAX ECCS – CSP FAILURE

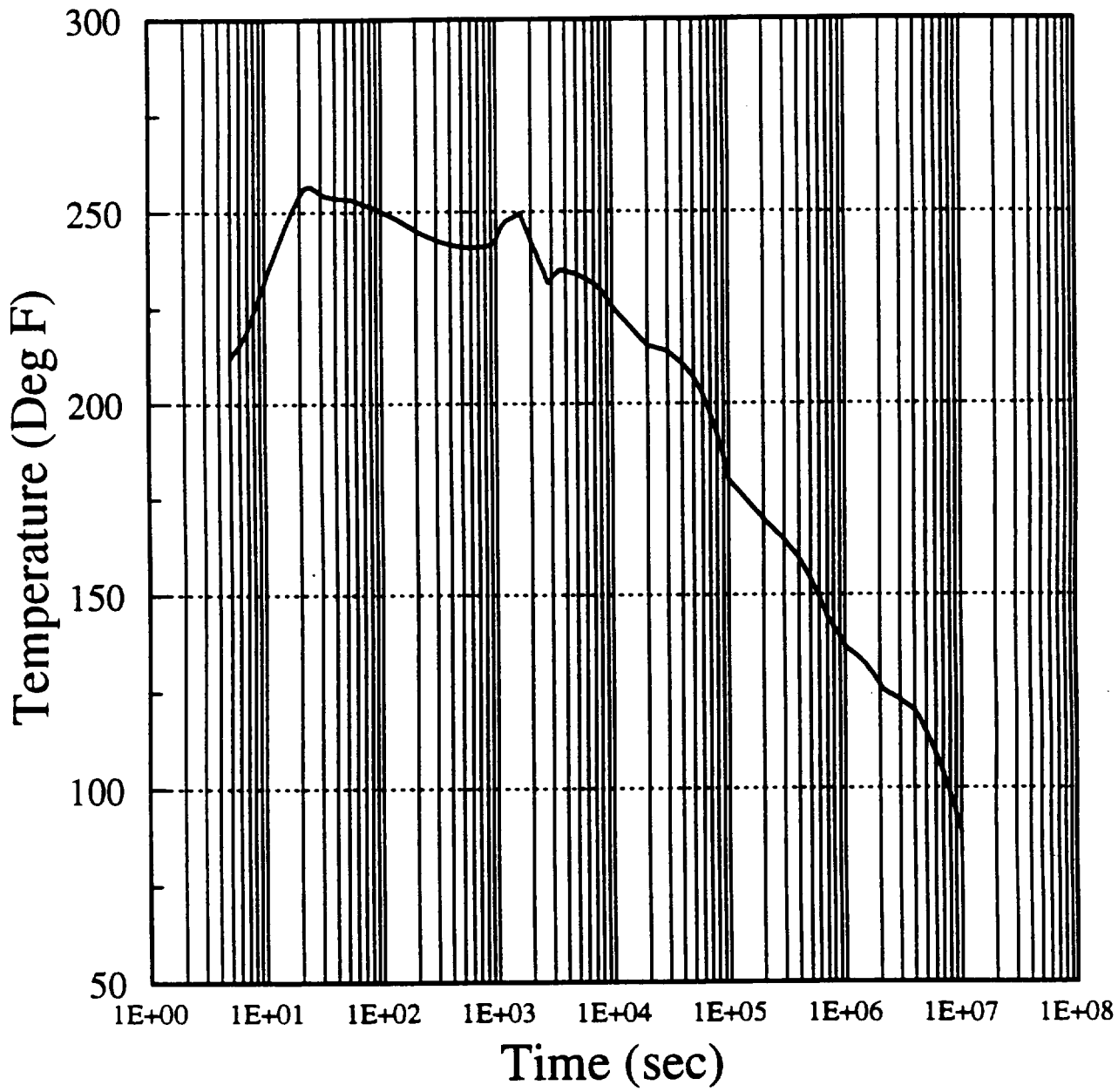

FIGURE 3-8

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MAX ECCS – CFCU FAILURE

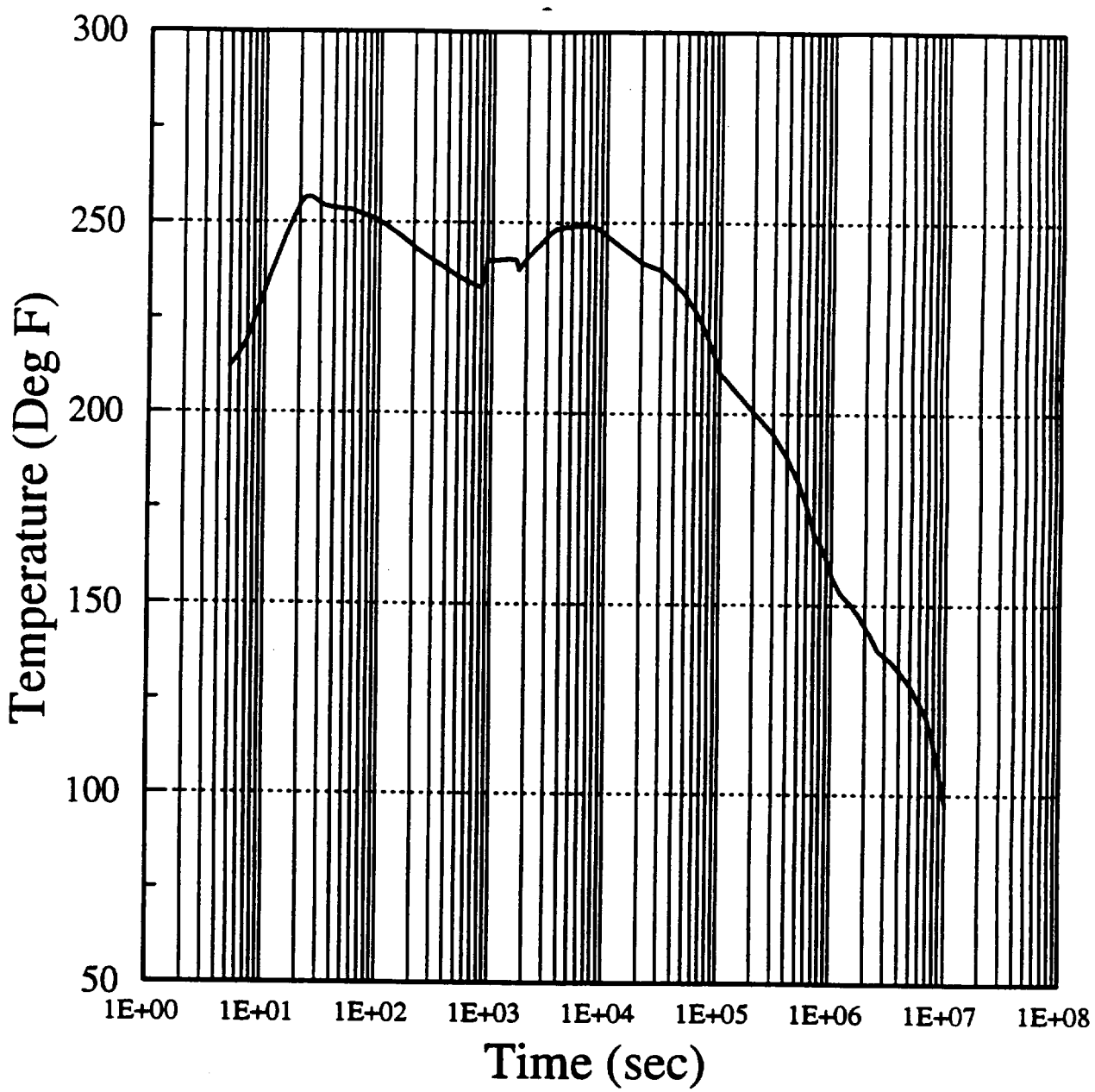

FIGURE 3-9

COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

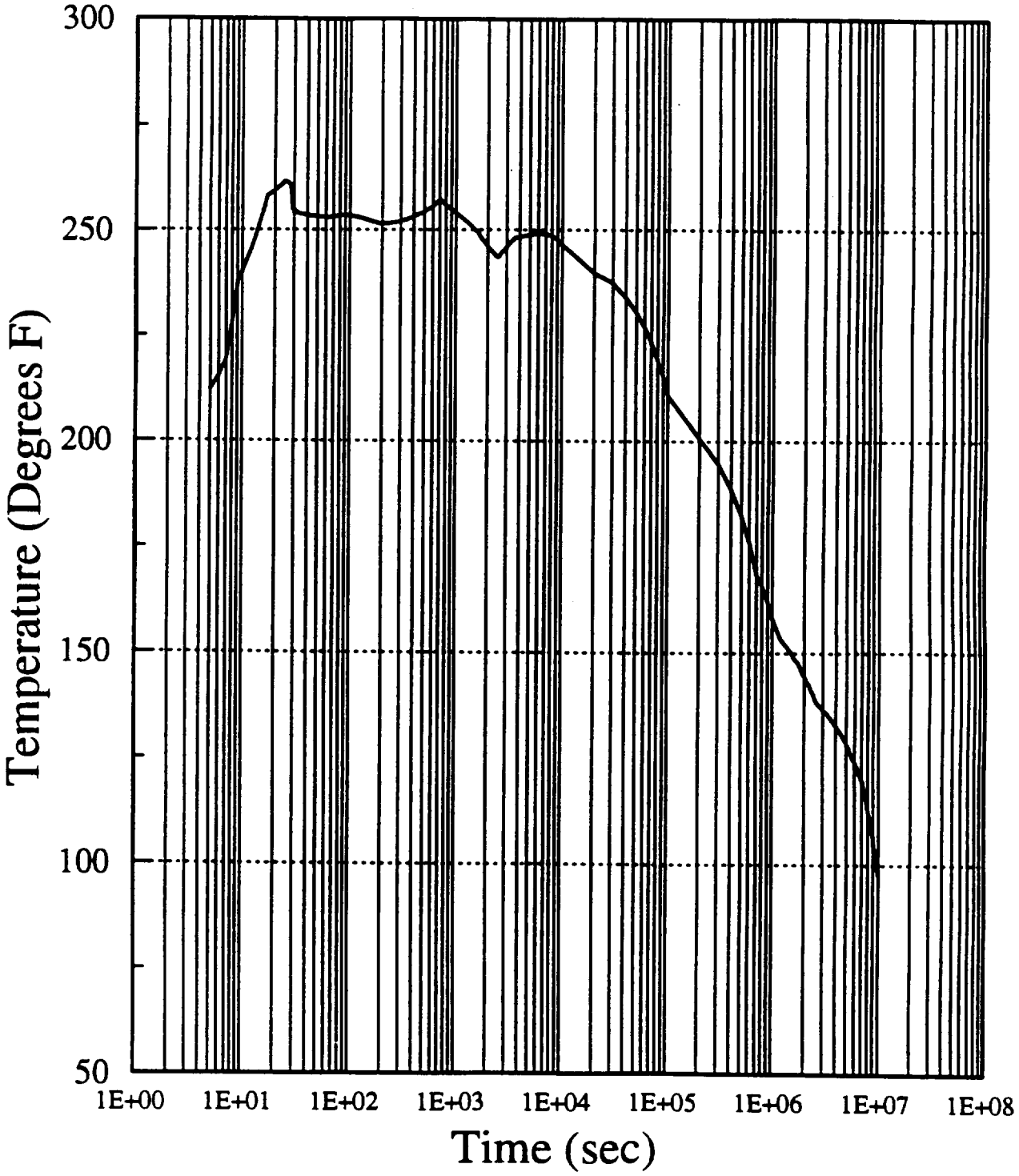

FIGURE 3-10

CONTAINMENT SUMP TEMPERATURE vs. TIME

DEPS – MIN ECCS

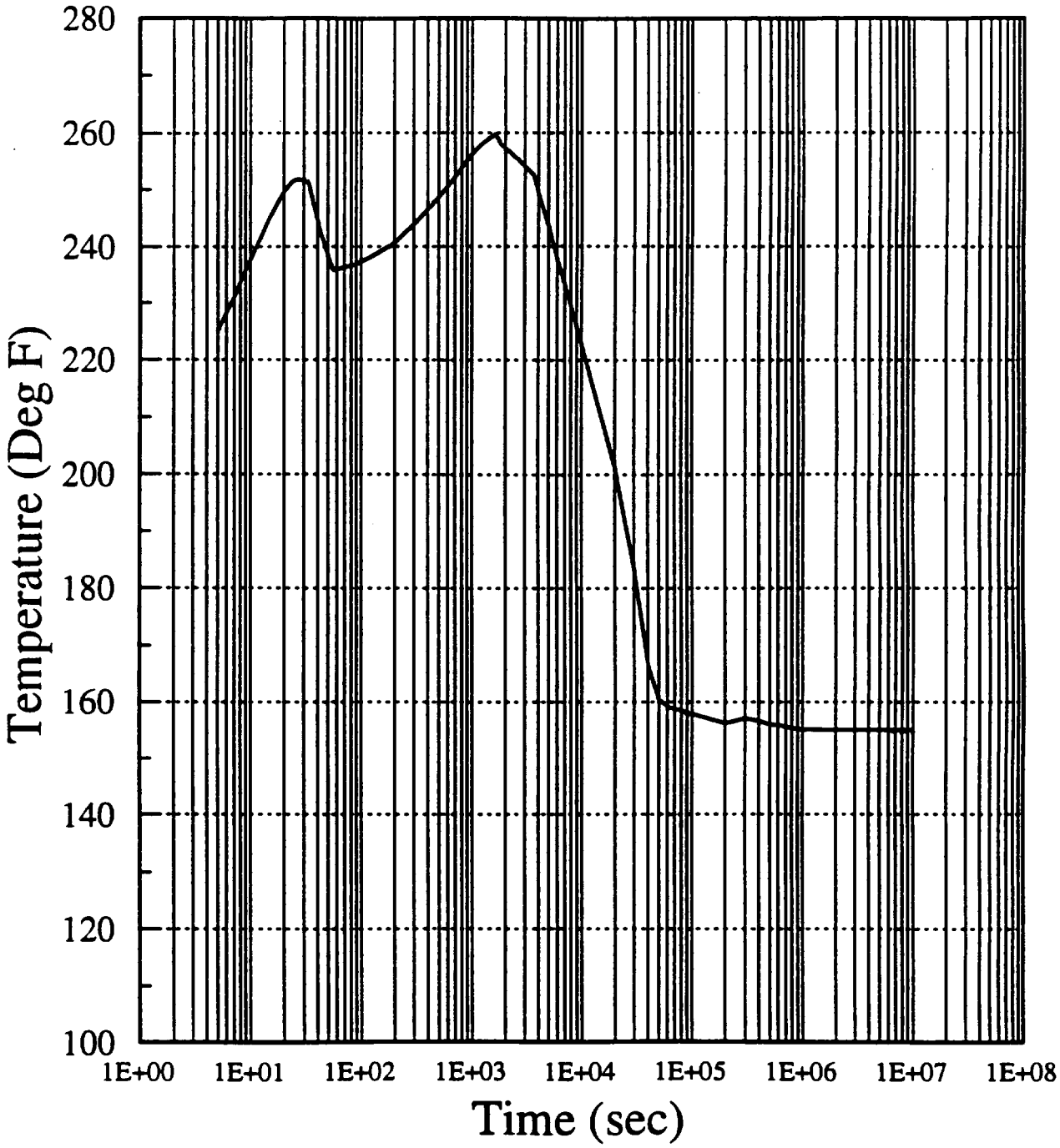

FIGURE 3-11

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

ONE CFCU SENSITIVITY

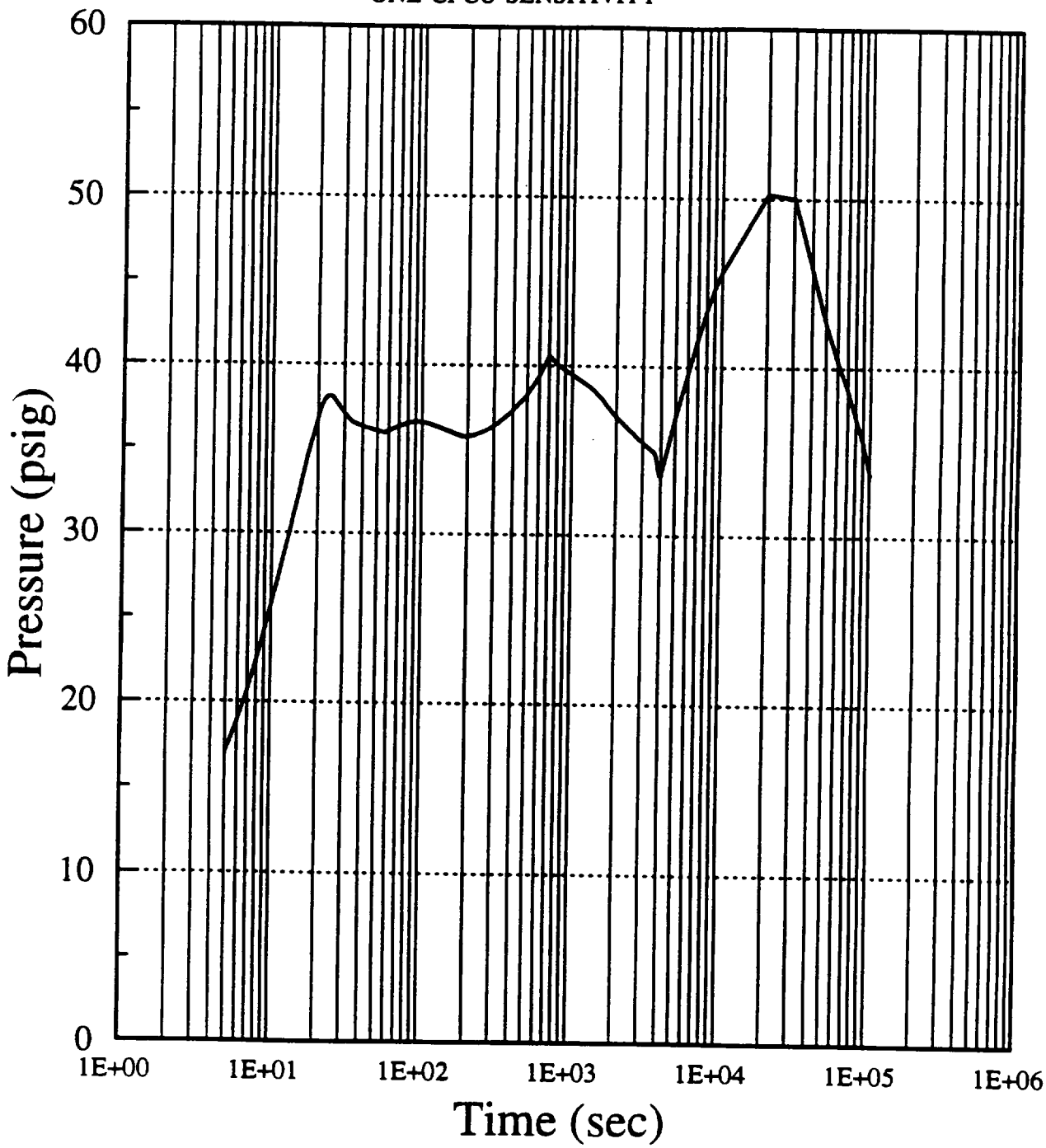

FIGURE 3-12

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

NO CFCU SENSITIVITY

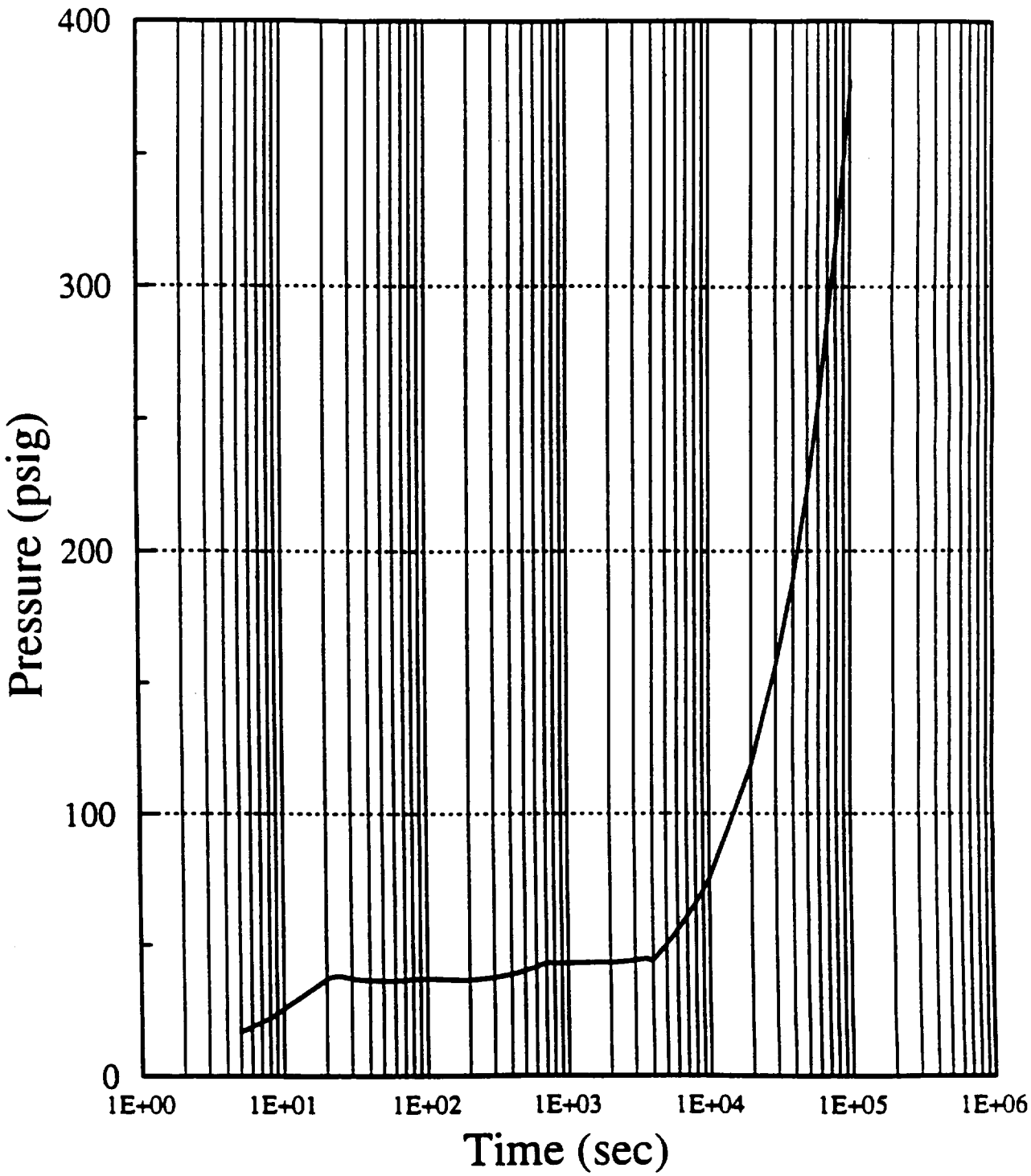

FIGURE 3-13

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

ONE CFCU SENSITIVITY

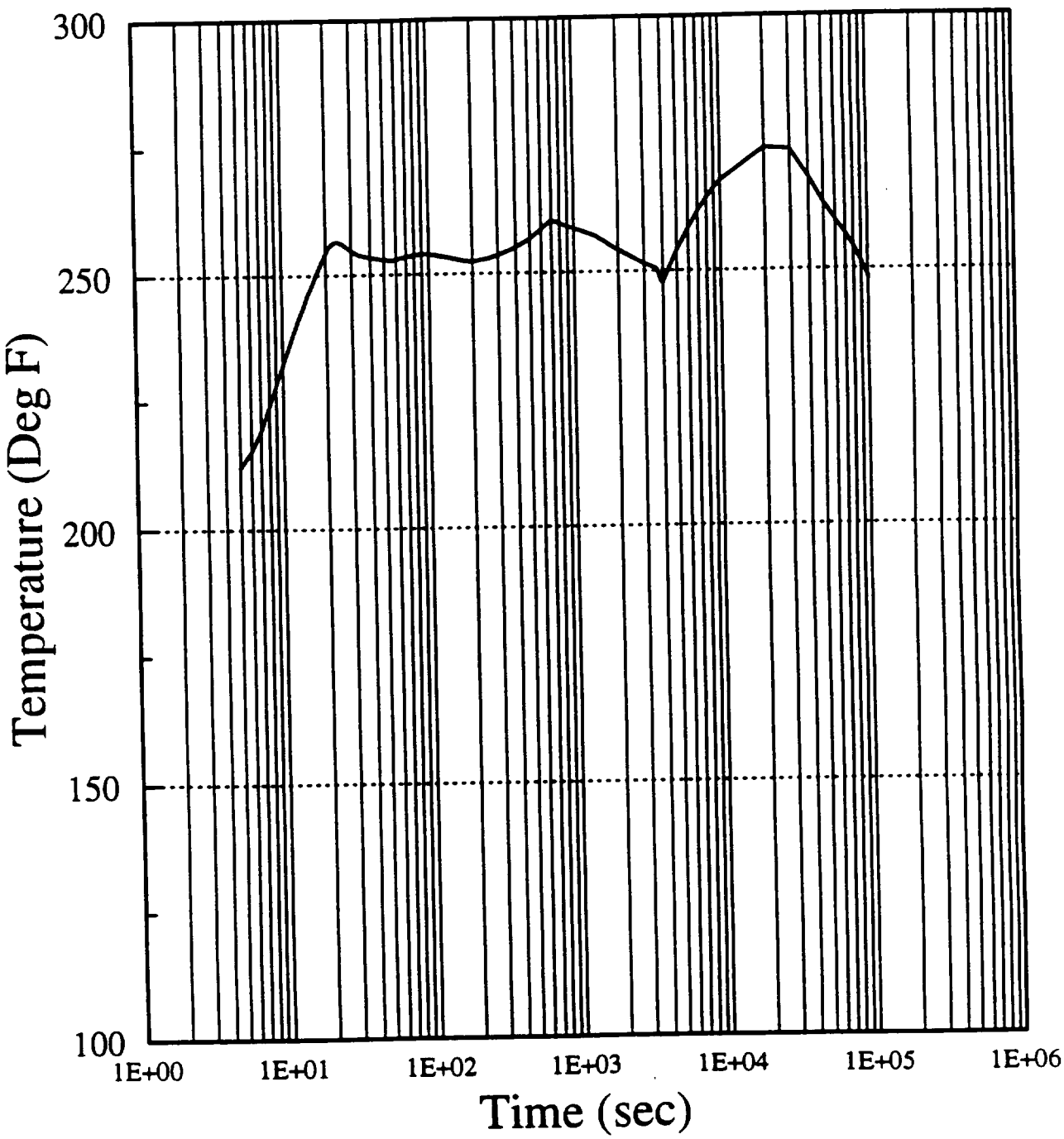

FIGURE 3-14

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

NO CFCU SENSITIVITY

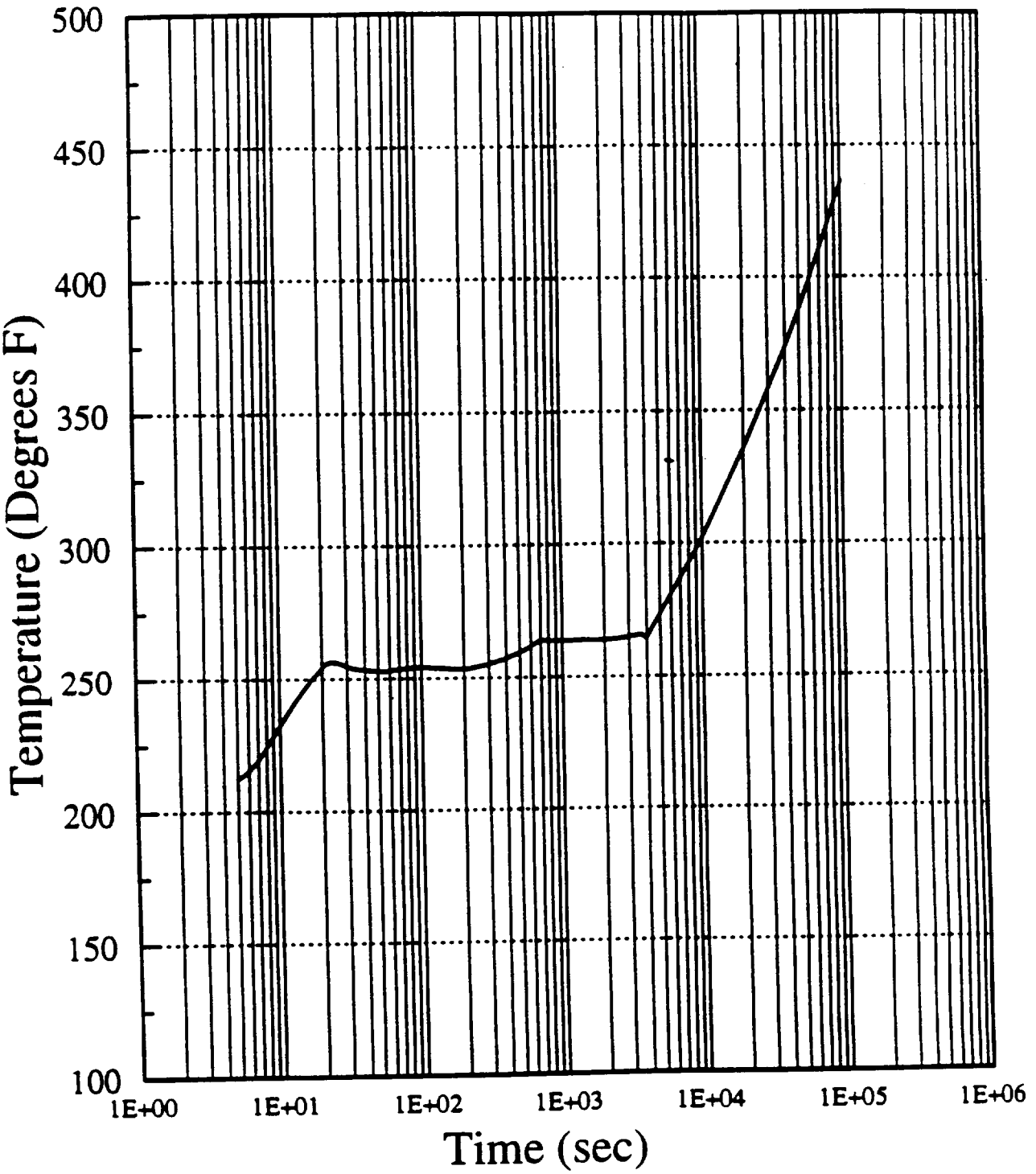

TABLE 3-1
DESIGN BASIS CONTAINMENT INTEGRITY HEAT SINK DATA

Item	Material	Weight (Kips)	Area (Ft^2)	Effective Thickness (Inches)
Annulus Steel-Structural Steel Grating	Carbon Carbon	953 78	41,269 21,900	0.565 0.088
Class I Platform-Structural Steel Grating	Carbon Carbon	87 28	9,634 7,700	0.22 0.088
Class II Platform-Steel & Grating	Carbon	89	21,307	0.102
Ventilation (HVAC) System	Carbon	53	18,424	0.071
Polar Crane & Dome Service Crane (including Mods, Hook, Block & Cable)	Carbon	685	23,682	0.708
Conduit and Trays	Carbon	155	30,000	0.127
Rupture Restraints	Carbon	316	10,004	0.773
Containment Liner Plate	Carbon	1386	90,560	0.375
Equipment Hatch & Personnel Locks	Carbon	91	1,391	1.596
NSSS Equipment Supports	Carbon	857	19,111	1.098
Embeds	Carbon	187	6,141	0.745
Containment Penetrations	Carbon	28	720	0.96
Fuel Transfer Canal (Stainless Steel)	Stainless	52	8,852	0.144
Other Misc. Stainless Steel Structures	Stainless	23	857	0.654
Reactor Missile Shield Structure	Carbon	33	1,248	0.642
Concrete Floors at 140'-0 & Below	Concrete	-	21,867	12"
Concrete Floors at 91'-0 (2'-0 thick)	Concrete	-	13,012	24"
Concrete Walls Below El. 140'-0	Concrete	-	43,803	12"
Concrete Walls Above El. 140'0	Concrete	-	14,295	12"
S/G Snubbers	Carbon	64.0	522	3.0
Large Bore Pipe Supports	Carbon	488.4	15,947	0.75
Fan Coolers, 120°F Initial Temperature	Carbon	-	7,750	1.68
Accumulators, 120°F Initial Temperature	Carbon	-	3,650	1.92
RCP Motors, 200°F Initial Temperature(b)	Carbon	-	1,610	6.99

(a) Density of carbon and stainless steel is 490 lb/ft^3

(b) Reactor coolant pump motor temperature determined from average °F static temperature was determined from RTD readings.

TABLE 3-2

CONTAINMENT ANALYSIS PARAMETERS

Service water temperature (°F)	64
Refueling water temperature (°F)	100
RWST water deliverable volume (gal)	3.50×10^5
Initial containment temperature (°F)	120
Initial containment pressure (psia)	16.0
Initial relative humidity (%)	18
Net free volume (ft^3)	2.55×10^6
Initial CCW Temperature (°F)	80
<u>Fan Coolers</u>	
Total	5
Analysis maximum	3
Analysis minimum	2
Setpoint (psig)	5.0
Delay time (sec)	48.0
<u>Spray Pumps</u>	
Total	2
Analysis maximum	2
Analysis minimum	1
Setpoint (psig)	24.7
Delay time (sec)	80

TABLE 3-3

CHRONOLOGY OF EVENTS FOR LOCA – DEPS MIN ECCS

Time (Seconds)	Event
0.0	Start of accident
25.8	End of blowdown phase
28.2	Pumped emergency core cooling starts
49.3	Containment fan coolers start
55.9	Accumulators Emptied
89.4	Containment sprays start
192.6	End of reflood phase
692.7	Broken Loops Steam Generator Equilibriates
700.2	Peak Pressure Reached
1610.0	Intact Loop Steam Generator Equilibriates
1680.0	Sump recirculation starts
3900.0	Containment Spray Shut Off

TABLE 3-4

CHRONOLOGY OF EVENTS FOR LOCA – DEHL

Time (Seconds)	Event
0.0	Start of accident
22.5	Peak Pressure Reached
28.5	End of blowdown phase

TABLE 3-5

CHRONOLOGY OF EVENTS FOR LOCA – DEPS MAX ECCS - CSP FAIL

Time (Seconds)	Event
0.0	Start of accident
23.7	Peak Pressure Reached
25.8	End of blowdown phase
25.8	Pumped emergency core cooling starts
49.3	Containment fan coolers start
56.9	Accumulators Emptied
89.4	Containment sprays start
207.1	End of reflood phase
960.0	Sump recirculation starts
1127.1	Broken Loops Steam Generator Equilibriates
1588.5	Intact Loop Steam Generator Equilibriates
2820.0	Containment Spray Shut Off

TABLE 3-6

CHRONOLOGY OF EVENTS FOR LOCA – DEPS MAX ECCS - CFCU FAIL

Time (Seconds)	Event
0.0	Start of accident
23.9	Peak Pressure Reached
25.8	End of blowdown phase
25.8	Pumped emergency core cooling starts
49.3	Containment fan coolers start
56.9	Accumulators Emptied
89.4	Containment sprays start
207.1	End of reflood phase
780.0	Sump recirculation starts
862.1	Broken Loops Steam Generator Equilibriates
1588.5	Intact Loop Steam Generator Equilibriates
1680.0	Containment Spray Shut Off

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
0	120
5	212.1854
6	215.2934
7	219.2307
8	228.0533
9	237.9600
10	240.4803
11	243.0006
12	245.5209
13	248.0411
14	250.5614
15	253.0817
16	255.6020
17	258.1223
18	258.5633
19	259.0043
20	259.4453
21	259.8863
22	260.3273
23	260.7684
24	261.2094
25	261.6504
26	261.3651
27	261.0799
28	260.7946
29	255.0275
30	254.7391
31	254.4698
32	254.2185
33	254.0183
34	253.9147
35	253.8406
36	253.7744
37	253.7140
38	253.6577
39	253.6066
40	253.5589
41	253.5157
42	253.4756
43	253.4394
44	253.4059
45	253.3759
46	253.3483
47	253.3238
48	253.3014
49	253.2817
50	253.2537
51	253.2237

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
52	253.1951
53	253.1687
54	253.1437
55	253.1207
56	253.0989
57	253.0641
58	252.9748
59	252.8833
60	252.8705
61	252.9171
62	252.9616
63	253.0042
64	253.0453
65	253.0850
66	253.1233
67	253.1602
68	253.1956
69	253.2294
70	253.2534
71	253.2840
72	253.3142
73	253.3433
74	253.3712
75	253.3979
76	253.4233
77	253.4474
78	253.4702
79	253.4916
80	253.5115
81	253.5298
82	253.5468
83	253.5624
84	253.5773
85	253.5916
86	253.6052
87	253.6179
88	253.6298
89	253.6408
90	253.6412
91	253.6313
92	253.6208
93	253.6095
94	253.5974
95	253.5843
96	253.5705
97	253.5557
98	253.5400
99	253.5233

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
100	253.5058
101	253.4873
102	253.468
103	253.4482
104	253.4281
105	253.4074
106	253.3864
107	253.3649
108	253.3429
109	253.3205
110	253.2977
111	253.2747
112	253.2513
113	253.2277
114	253.2039
115	253.1797
116	253.1553
117	253.1306
118	253.1056
119	253.0807
120	253.0558
121	253.0310
122	253.0063
123	252.9815
124	252.9569
125	252.9322
126	252.9076
127	252.8830
128	252.8584
129	252.8338
130	252.8091
131	252.7846
132	252.7599
133	252.7353
134	252.7106
135	252.6860
136	252.6612
137	252.6365
138	252.6117
139	252.5869
140	252.5620
141	252.5371
142	252.5121
143	252.4871
144	252.4620
145	252.4369
146	252.4117
147	252.3867

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
148	252.3619
149	252.3374
150	252.3130
151	252.2888
152	252.2648
153	252.241
154	252.2173
155	252.1939
156	252.1706
157	252.1475
158	252.1245
159	252.1018
160	252.0792
161	252.0568
162	252.0348
163	252.0130
164	251.9915
165	251.9702
166	251.9492
167	251.9284
168	251.9079
169	251.8877
170	251.8676
171	251.8479
172	251.8284
173	251.8091
174	251.7900
175	251.7712
176	251.7526
177	251.7343
178	251.7162
179	251.6983
180	251.6806
181	251.6633
182	251.6463
183	251.6297
184	251.6134
185	251.5975
186	251.5819
187	251.5666
188	251.5517
189	251.5371
190	251.5228
191	251.5088
192	251.4952
193	251.4819
194	251.4792
195	251.4799

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
196	251.4807
197	251.4816
198	251.4826
199	251.4838
209	251.5029
219	251.5339
229	251.5767
239	251.6304
249	251.6930
259	251.7633
269	251.8434
279	251.9297
289	252.0190
299	252.1179
309	252.2177
319	252.3233
329	252.4306
339	252.5409
349	252.6525
359	252.7667
369	252.8816
379	252.9968
389	253.1125
399	253.2318
409	253.3487
419	253.4683
429	253.5843
439	253.7019
449	253.8163
459	253.9319
469	254.0433
479	254.1553
489	254.2684
499	254.3845
599	255.7301
699	257.3081
799	256.0032
899	255.0020
999	254.1205
1099	253.2261
1199	252.4236
1299	251.6687
1399	250.8689
1499	250.0463
1599	249.4923
1699	248.3400
1799	247.5070
1899	246.8036

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
1999	246.1386
2099	245.5083
2199	244.9049
2299	244.3305
2399	243.7792
2499	243.5937
2599	244.1398
2699	244.6538
2799	245.1437
2899	245.6044
2999	246.0435
3099	246.4553
3199	246.8473
3299	247.2134
3399	247.5610
3499	247.8833
3599	248.182
3699	248.2793
3799	248.3108
3899	248.3574
3999	248.4108
4999	248.9493
5999	249.1464
6999	249.0119
7999	248.5653
8999	247.7010
9999	246.5028
19999	239.7851
29999	237.4916
39999	233.9414
49999	230.6394
59999	227.0885
69999	223.2899
79999	219.3216
89999	215.1703
99999	210.8063
199999	200.4555
299999	194.4821
399999	188.3973
499999	182.2248
599999	175.6962
699999	168.5536
799999	165.5226
899999	161.9543
999999	158.0637
1099999	155.2531
1199999	153.3116
1299999	152.1637

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
1399999	151.0641
1499999	150.0615
1599999	148.7924
1699999	147.9611
1799999	146.7748
1899999	145.5399
1999999	144.4332
2099999	143.2378
2199999	142.3539
2299999	141.2247
2399999	140.3246
2499999	138.9137
2599999	138.1023
2699999	137.6463
2799999	137.2593
2899999	136.8099
2999999	136.4984
3099999	136.2694
3199999	135.8239
3299999	135.4247
3399999	135.0141
3499999	134.6089
3599999	134.1994
3699999	133.7923
3799999	133.3857
3899999	132.8435
3999999	132.6265
4099999	132.1907
4199999	131.7888
4299999	131.3859
4399999	130.9852
4499999	130.5417
4599999	130.1855
4699999	129.7742
4799999	129.3712
4899999	128.9672
4999999	128.5699
5099999	128.1458
5199999	127.7484
5299999	127.3600
5399999	126.4477
5499999	125.8890
5599999	125.6622
5699999	125.2686
5799999	124.7863
5899999	124.4406
5999999	124.1436
6099999	123.8383

TABLE 3-7
COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

Time	Temperature (°F)
6199999	123.1948
6299999	123.0134
6399999	122.3869
6499999	121.9093
6599999	121.5082
6699999	121.1333
6799999	120.7427
6899999	120.3156
6999999	119.8989
7099999	119.1968
7199999	118.4404
7299999	117.7172
7399999	117.0803
7499999	116.4293
7599999	115.7124
7699999	114.9251
7799999	114.1680
7899999	113.4107
7999999	112.6611
8099999	111.9121
8199999	111.1902
8299999	110.4737
8399999	109.7378
8499999	109.0186
8599999	108.2987
8699999	107.5801
8799999	106.8403
8899999	106.0412
8999999	104.9293
9099999	104.2230
9199999	103.4702
9299999	102.7329
9399999	102.007
9499999	101.2897
9599999	100.4706
9699999	99.69315
9799999	98.94286
9899999	98.18476
9999999	97.39374

4.0 CONCLUSIONS

Based upon the information provided in this report, it is demonstrated that the containment safeguards system are fully capable of mitigating the consequences of a hypothetical loss-of-coolant accident. This analysis, based on current operating conditions, resulted in an overall peak containment pressure of 41.53 psig for the DEHL break. The peak post blowdown containment pressure was also demonstrated to be 38.71 psig for the DEPS break.

The calculated containment margin is 5.47 psig to a containment design pressure of 47.0 psig. Thus, the most limiting LOCA cases have been considered and have been demonstrated to yield acceptable results. The containment pressure and temperature response is determined for both loss of coolant and main steamline break accidents. Hence, the main steamline break accident may bound the LOCA results.

The composite temperature curve [Figure 3-9 and Table 3-7] has been compared to the Reference 13 DEPS LOCA temperature curve. The Reference 13 curve is bounding for the post-blowdown period. The new composite curve yields slightly higher temperatures during the blowdown phase due to the inclusion of the hot leg break. The Reference 13 curve was for the pump suction break only, and did not include the hot leg break. The hot leg break has been shown to bound the pump suction break during the blowdown period.

TABLE 4-1

CONTAINMENT PEAK PRESSURE - SUMMARY

BREAK	Peak Pressure (psig)
Double-ended hot leg	
3423 MWt	41.53
Double-ended pump suction	
3433 MWt	
Revised RHR, CCP, and SI flows	
Reduced Containment Spray Setpoint	
Min ECCS	38.71
Max ECCS - CSP Failure	38.14
Max ECCS - CFCU Failure	38.14

5.0 REFERENCES

1. "Westinghouse LOCA Mass and Energy Release Model for Containment Design – March 1979 Version", WCAP-10325-P-A, May 1983 (Proprietary), WCAP-10326-A (Non-Proprietary).

2. "Westinghouse ECCS Evaluation Model – 1981 Version", WCAP-9220-P-A, Rev. 1, February 1982 (Proprietary), WCAP-9221-A, Rev. 1 (Non Proprietary).

3. Docket No. 50-315, "Amendment No., 126 Facility Operating License No. DPR-58 (TAC No. 7106), for D. C. Cook Nuclear Plant Unit 1," June 9, 1989.

4. EPRI 294-2, Mixing of Emergency Core Cooling Water with Steam: 1/3 Scale Test and Summary, (WCAP-8423), Final Report June 1975.

5. "Westinghouse Mass and Energy Release Data For Containment Design", WCAP 8264-P-A, Rev. 1, August 1975 (Proprietary), WCAP-8312-A (Non Proprietary).

6. ANSI/ANS-5.1-1979, "American National Standard for Decay Heat Power in Light Water Reactors", August 1979.

7. "Containment Pressure Analysis Code (COCO)", WCAP-8326, July 1974 (Non Proprietary) WCAP-8327 (Proprietary).

8. Letter from M.R. Tressler to S. A. McHugh, "Input Data for New Containment Analysis," dated 6-28-93.

9. Takashi Tagami, "Interim Report on Safety Assessments and Facilities Establishment Project in Japan for Period Ending June 1965", No. 1.

11. L. F. Parsly, "Spray Tests at the Nuclear Safety Pilot Plant", Nuclear Safety Program Annual Progress Report for Period Ending December 31, 1970, ORNL-4647, 1971, p. 82.

12. "Topical Report - Westinghouse Mass and Energy Release Data for Containment Design", WCAP-8264, August 1975 (Proprietary), WCAP-8312 (Non-Proprietary).

13. SECL-91-458, Rev 1, "EOP Change to Address Excessive CCW System Temperature During Recirculation Phase"

ADDENDUM

The attached pages supersede the same numbered pages in WCAP-13907:

3-9, 3-10, 3-12, 3-14, 3-15, 3-16, 3-18, 3-19, 3-20, 3-21, 3-22, 3-23, 3-24, 3-25, 3-28, 3-30, 3-31, 3-32, 3-33, 3-34, 3-35, 3-36, 4-1, and 4-2

recirculation. This will adversely affect fan cooler performance due to increased CCW temperatures and lower CCW flowrates to the fan coolers.

With the assumptions, the heat removal capability of the passive and active containment heat removal systems are sufficient to absorb the energy releases and still keep the maximum calculated pressure below the design pressure for the LOCA transient.

3.4 ANALYSIS RESULTS

The results of the analysis shows that the maximum calculated containment pressure for the double-ended pump suction minimum safeguards break case is 39.83 psig and for the double-ended hot leg break case is 41.53 psig. The pressure peaks occur at approximately 23.5 seconds and 22.5 seconds, respectively. The containment peak pressure for the double-ended pump suction maximum safeguards case with a CSP failure is 39.83 psig occurring at 23.5 seconds. For max safeguards with a CFCU failure, the peak pressure is 39.83 psig at 23.9 seconds.

The following plots show the containment integrity transient, as calculated by the COCO code.

Figure 3-1, Containment Pressure Transient - DEPS Minimum ECCS

Figure 3-2, Containment Pressure Transient - DEHL

Figure 3-3, Containment Pressure Transient - DEPS - Maximum ECCS - CSP Failure

Figure 3-4, Containment Pressure Transient - DEPS - Maximum ECCS - CFCU Failure

Figure 3-5, Containment Temperature Transient - DEPS Minimum ECCS

Figure 3-6, Containment Temperature Transient - DEHL

Figure 3-7, Containment Temperature Transient - DEPS - Maximum ECCS - CSP Failure

Figure 3-8, Containment Temperature Transient - DEPS - Maximum ECCS - CFCU Failure

Table 3-1 shows the containment structural heat sink and material properties data used in the analysis, respectively. Table 3-2 shows the assumptions and initial conditions for the containment analysis.

The accident chronology for the double-ended pump suction loss-of-coolant accident (minimum ECCS case) and the double-ended hot leg case shown in Tables 3-3 and 3-4, respectively. The

accident chronology shows significant events which affect the containment pressure and temperature transient. Table 3-5 and 3-6 show the accident chronology for the DEPS MAX ECCS, CSP failure and CFCU failure cases, respectively.

A composite temperature plot is provided in Figure 3-9. The composite plot represents a bounding containment temperature profiles for the DEPS and DEHL cases. Digitized data for the composite plot is provided in Table 3-7. Figure 3-10 presents the containment sump temperature transient for the DEPS minimum ECCS case.

Investigation of the ECCS delay time assumptions showed very little effect on peak pressure due to the delay time. Therefore, the assumption of loss of offsite power for the DEPS maximum safeguards case is reasonable, since this will delay operation of containment safeguards systems.

3.5 CONTAINMENT FAN COOLER SENSITIVITY

The analysis discussed in this report supports the conclusion that the double-ended pump suction break with minimum safeguards is the limiting break for post-blowdown. Sensitivity analyses were performed with respect to containment fan cooler unit availability for this case. Cases were run for both one and no fan coolers available during the accident. The remaining input parameters were kept the same as the DEPS MIN ECCS case discussed in the previous sections. This includes one containment spray operating, and one CCW heat exchanger available.

Figures 3-11 and 3-12 show the pressure transient for the one and zero fan coolers available cases, respectively. Figures 3-13 and 3-14 show the corresponding temperature profiles.

The peak containment pressure with one fan cooler was 50.4 psig occurring at 22870.6 seconds. The pressure transient shows a significant rise in pressure following termination of containment spray. Switchover to recirculation spray would be able to reduce this peak, if it were available at Diablo Canyon. The sensitivity to zero fan coolers also showed a rapid pressure increase following the termination of containment spray.

FIGURE 3-1

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

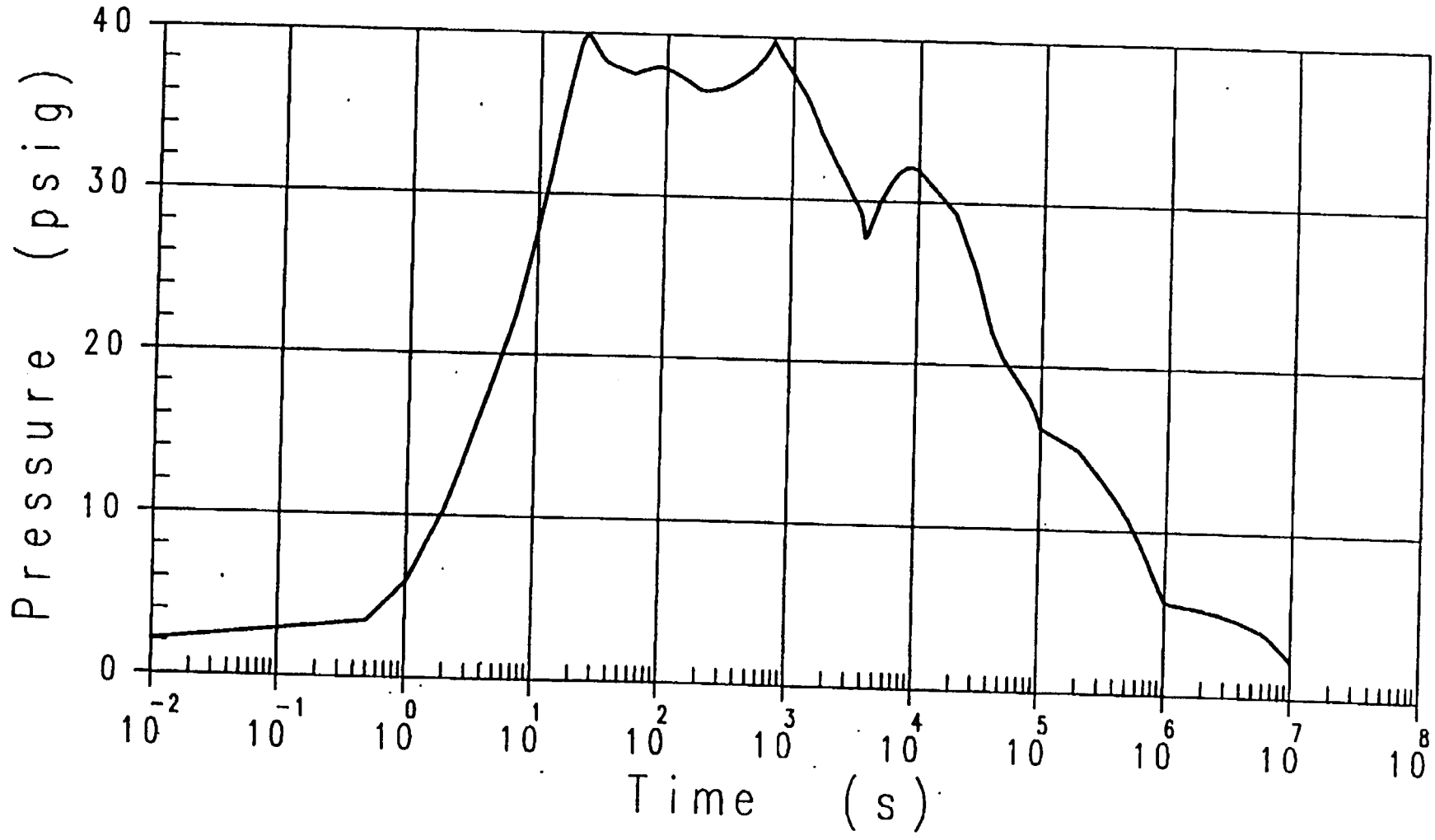

FIGURE 3-3

CONTAINMENT PRESSURE vs. TIME

DEPS – MAX ECCS – CSP FAILURE

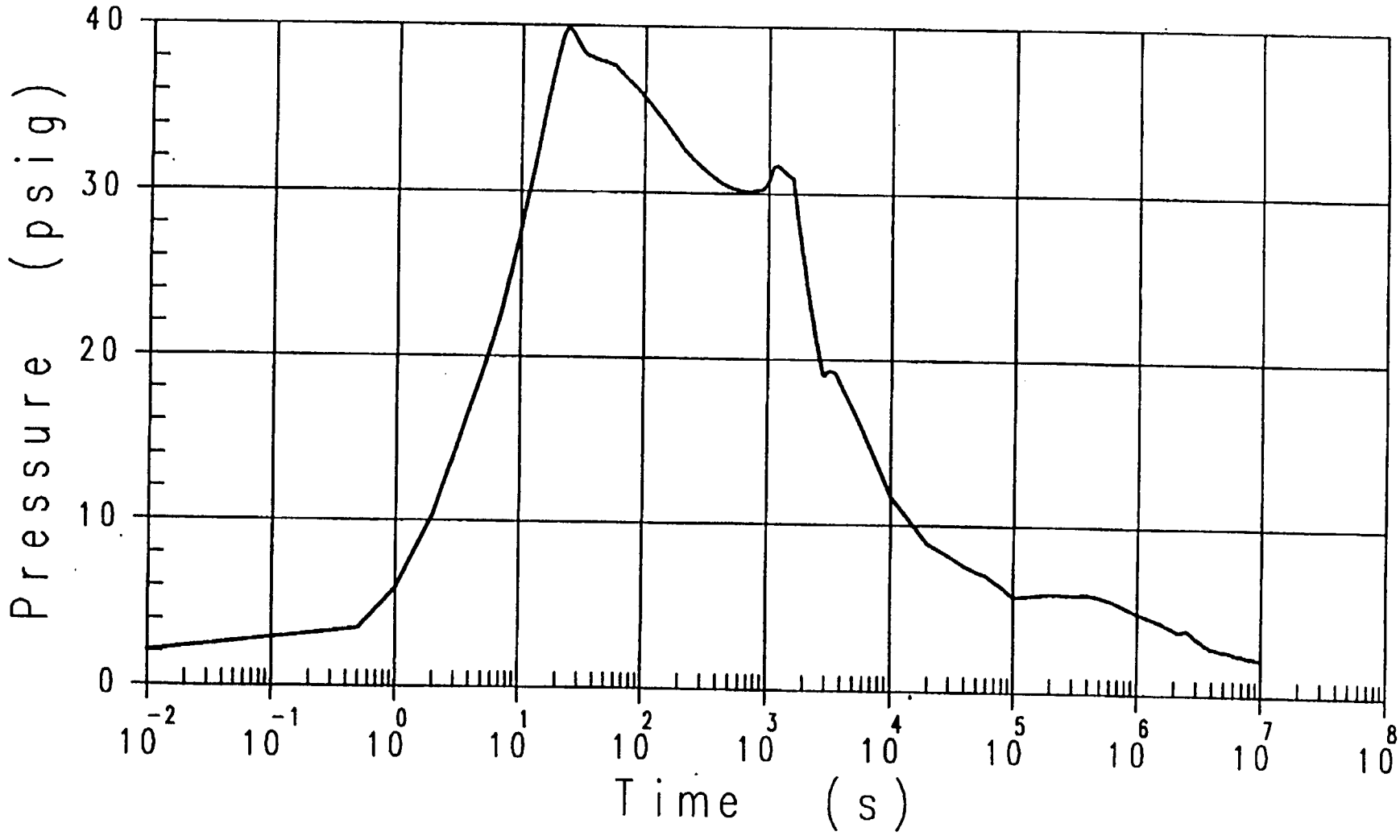

FIGURE 3-4

CONTAINMENT PRESSURE vs. TIME

DEPS – MAX ECCS – CFCU FAILURE

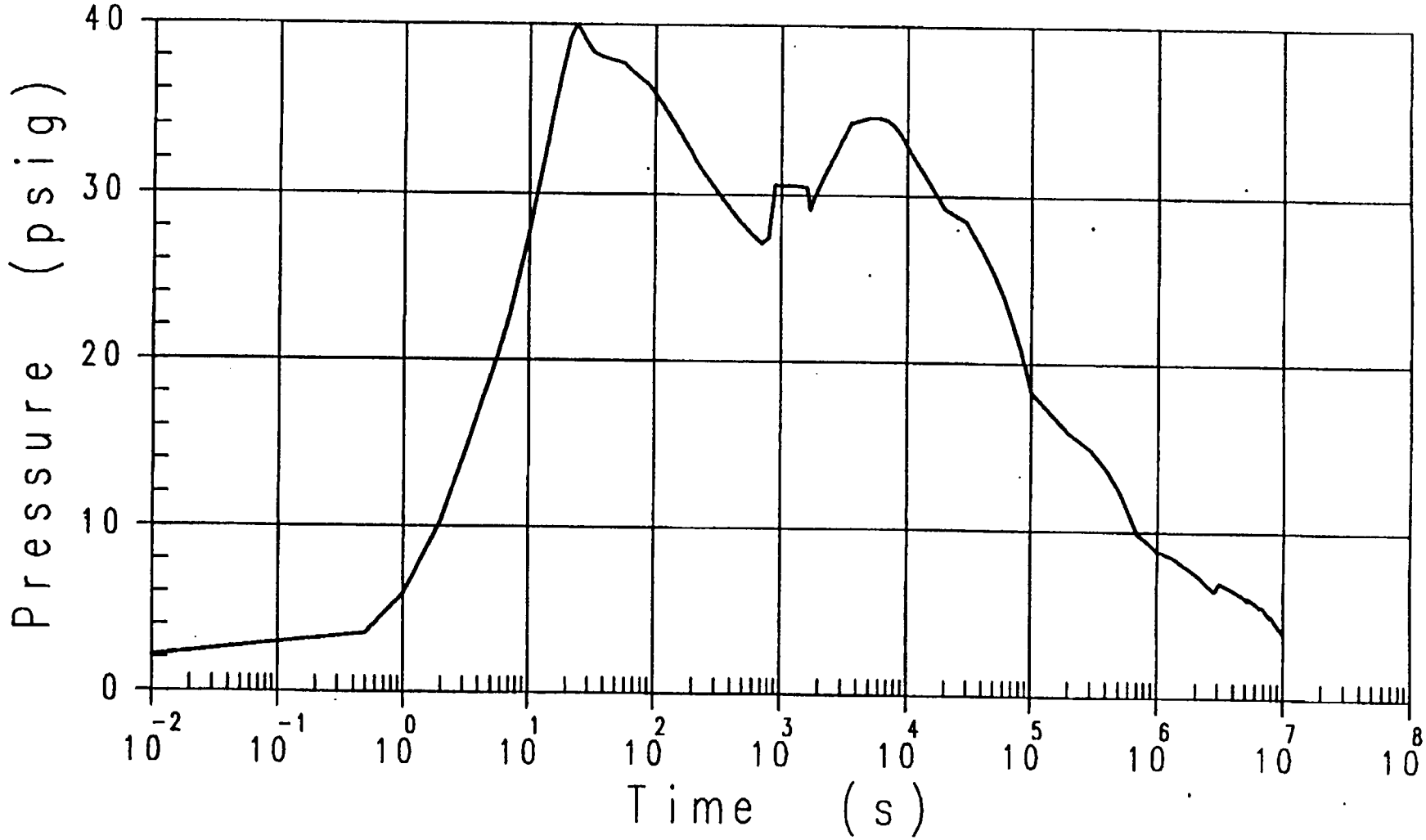

FIGURE 3-5

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

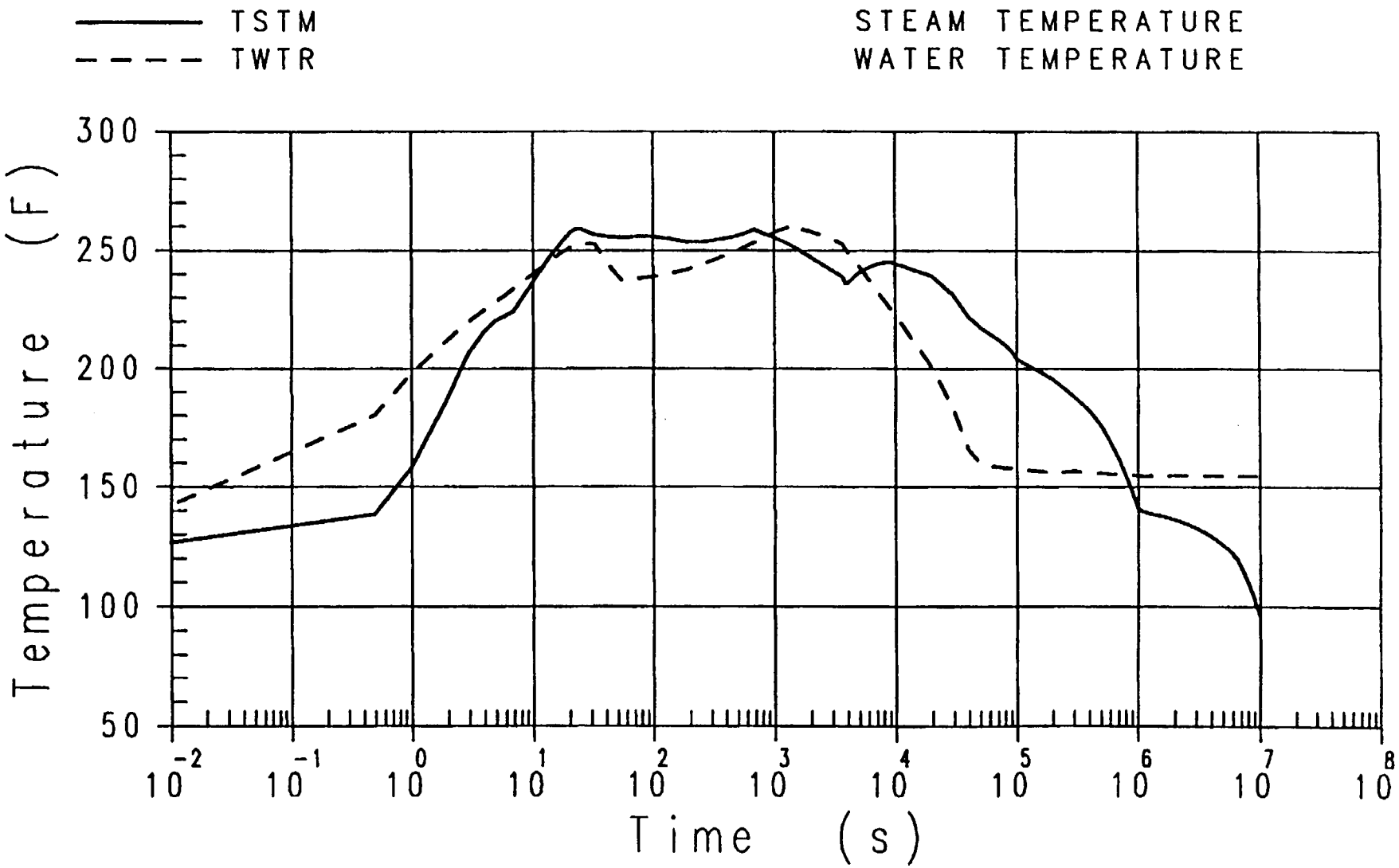

FIGURE 3-7

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MAX ECCS – CSP FAILURE

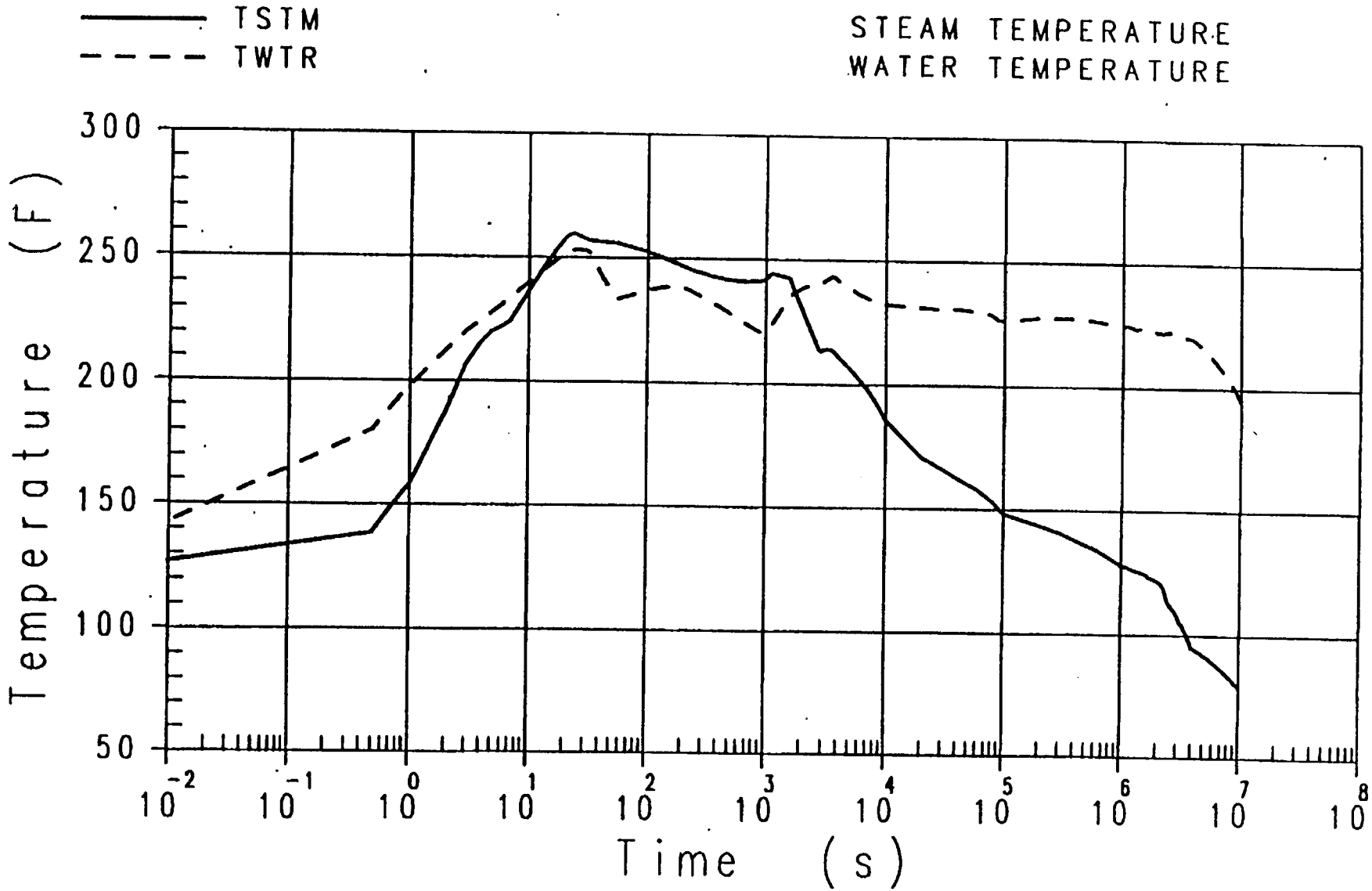

FIGURE 3-8

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MAX ECCS – CFCU FAILURE

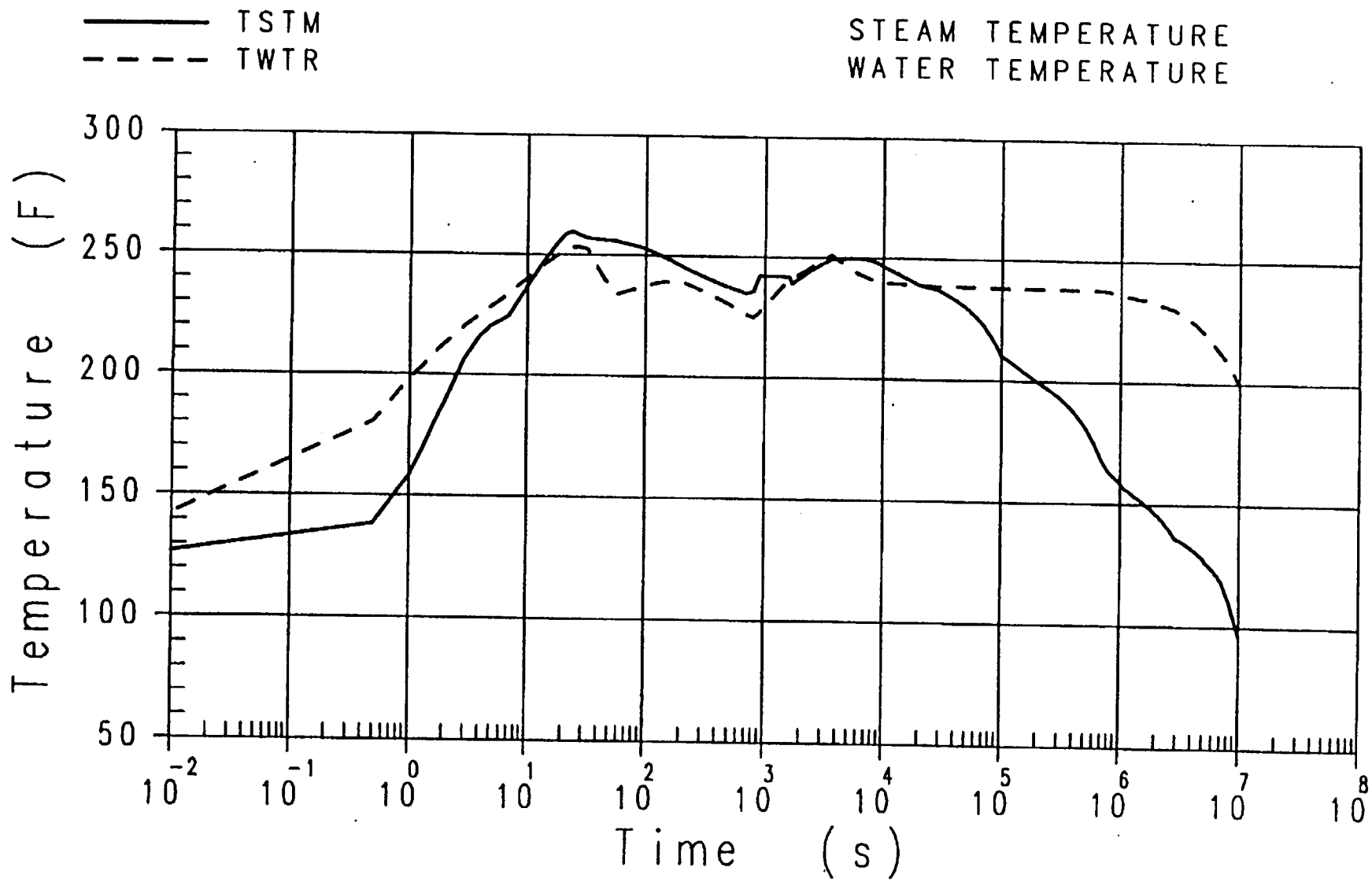

FIGURE 3-9

COMPOSITE CONTAINMENT TEMPERATURE vs. TIME

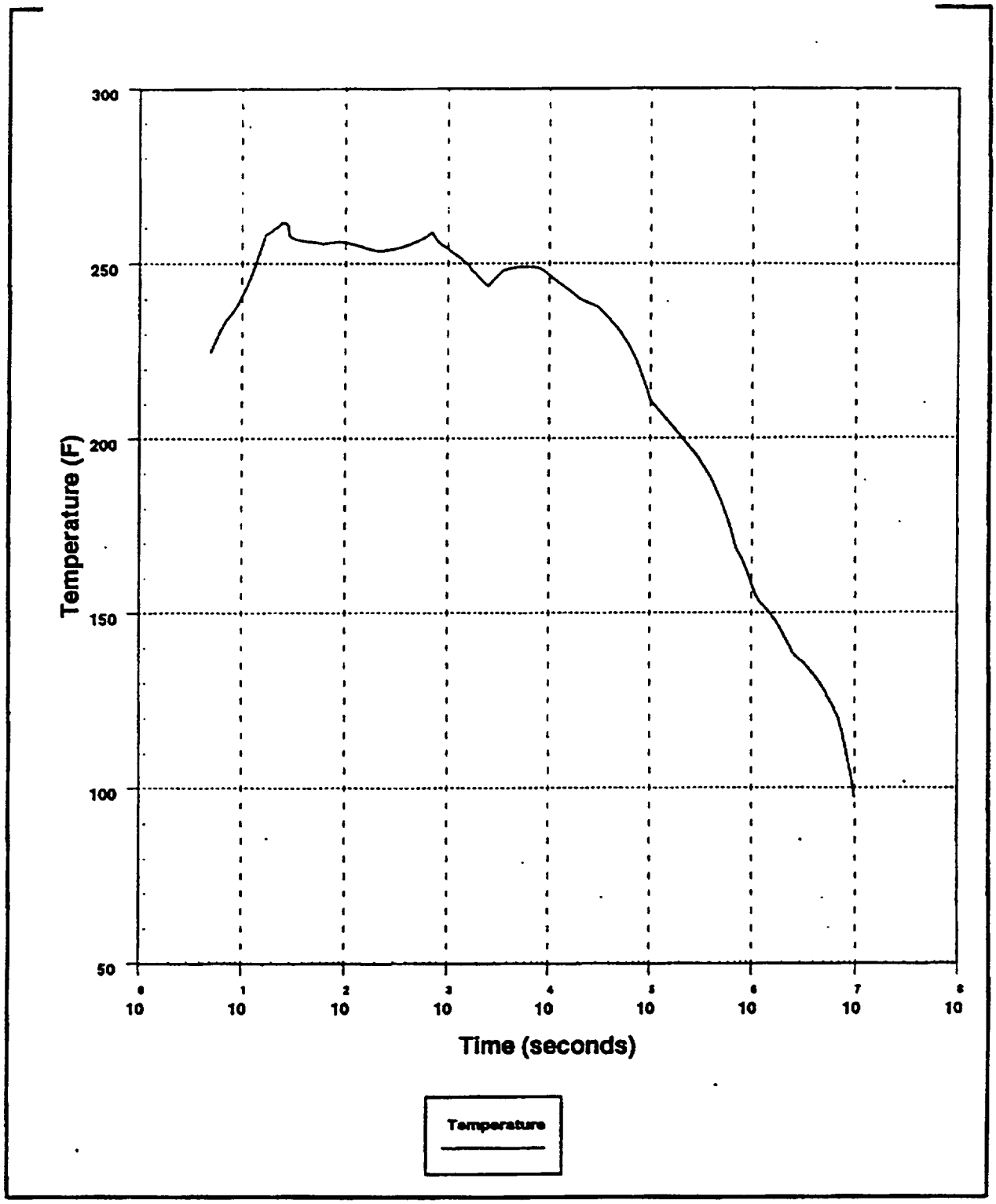

FIGURE 3-10

CONTAINMENT SUMP TEMPERATURE vs. TIME

DEPS – MIN ECCS

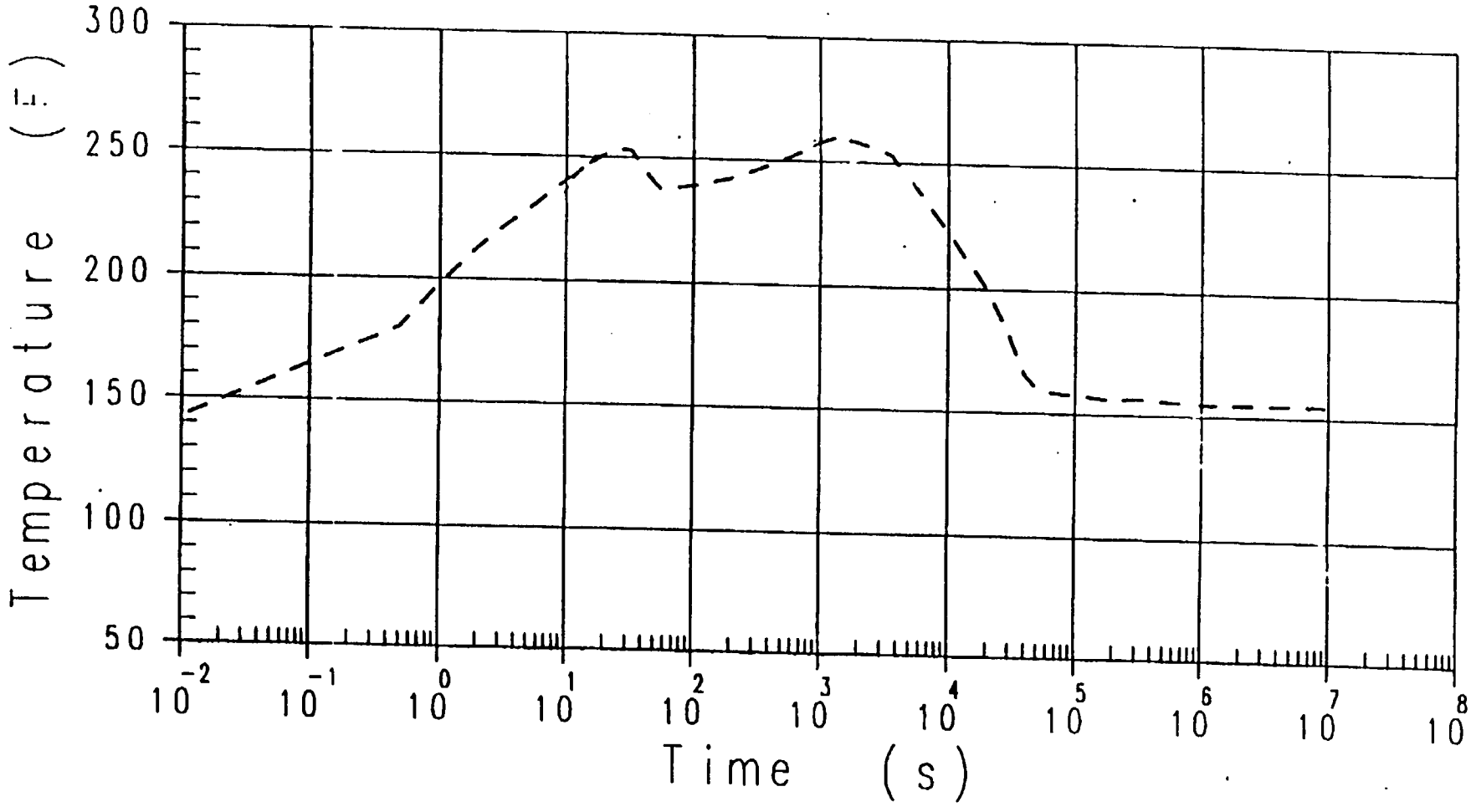

FIGURE 3-11

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

ONE CFCU SENSITIVITY

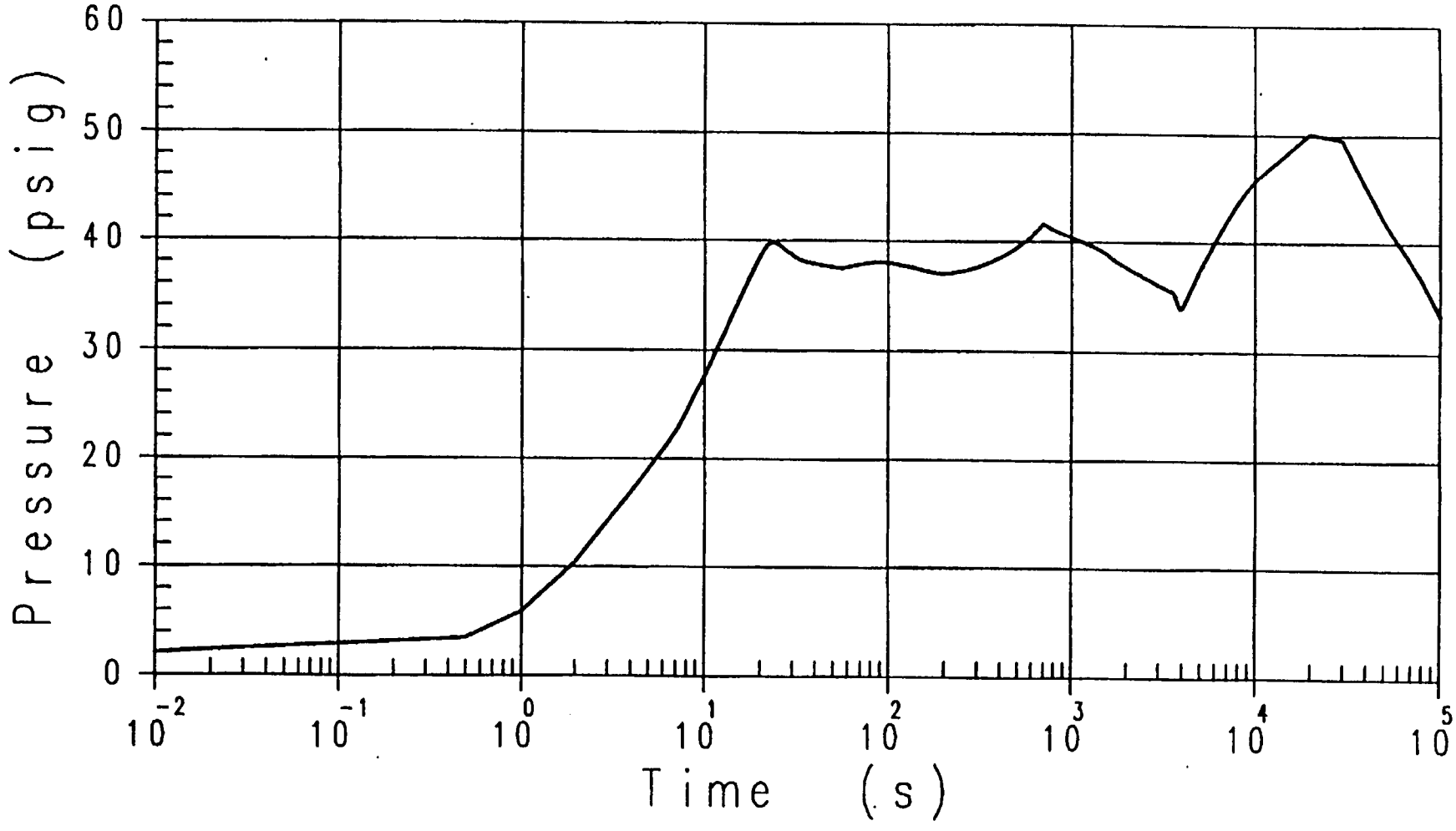

FIGURE 3-12

CONTAINMENT PRESSURE vs. TIME

DEPS – MIN ECCS

NO CFCU SENSITIVITY

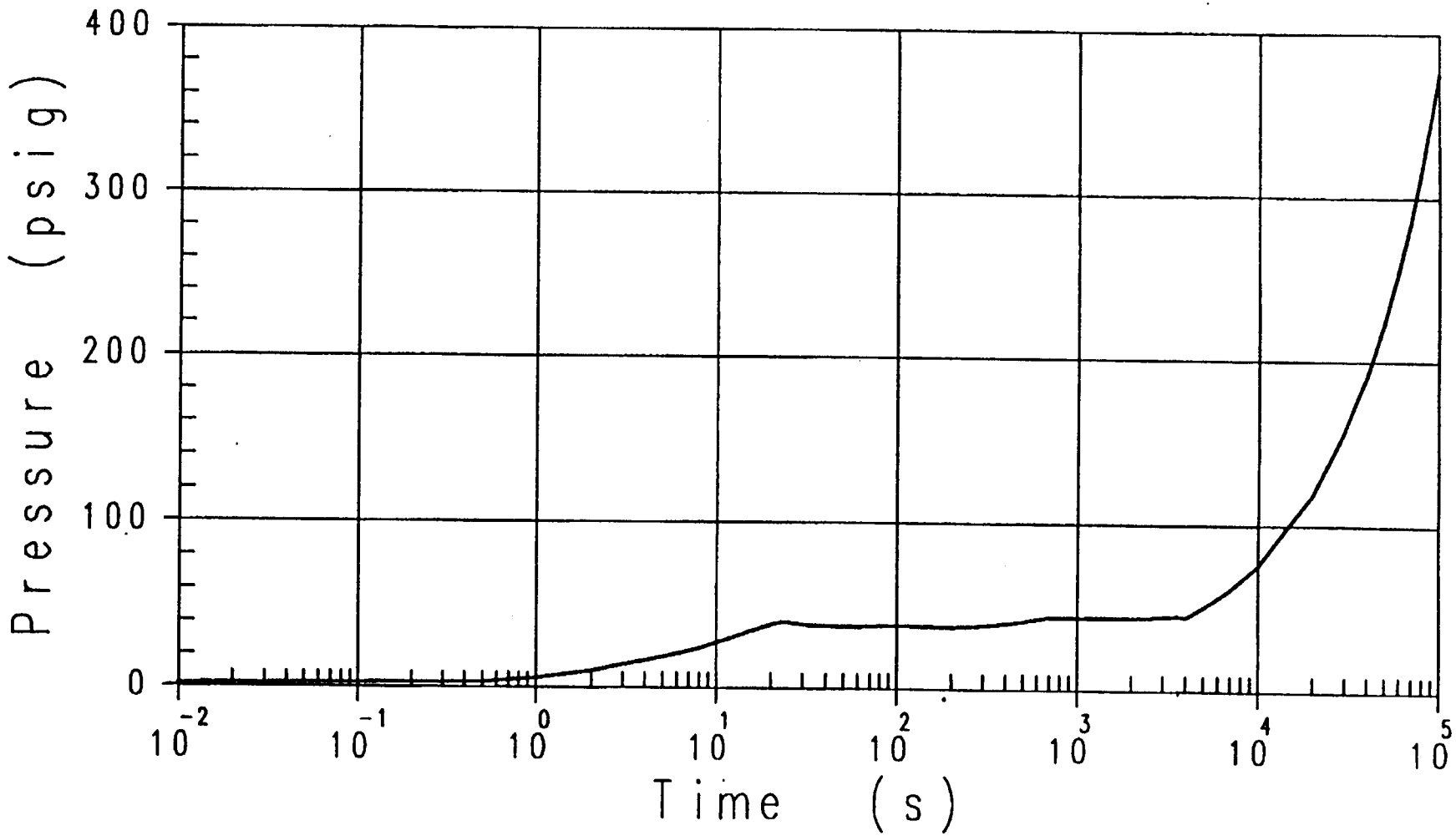

FIGURE 3-13

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

ONE CFCU SENSITIVITY

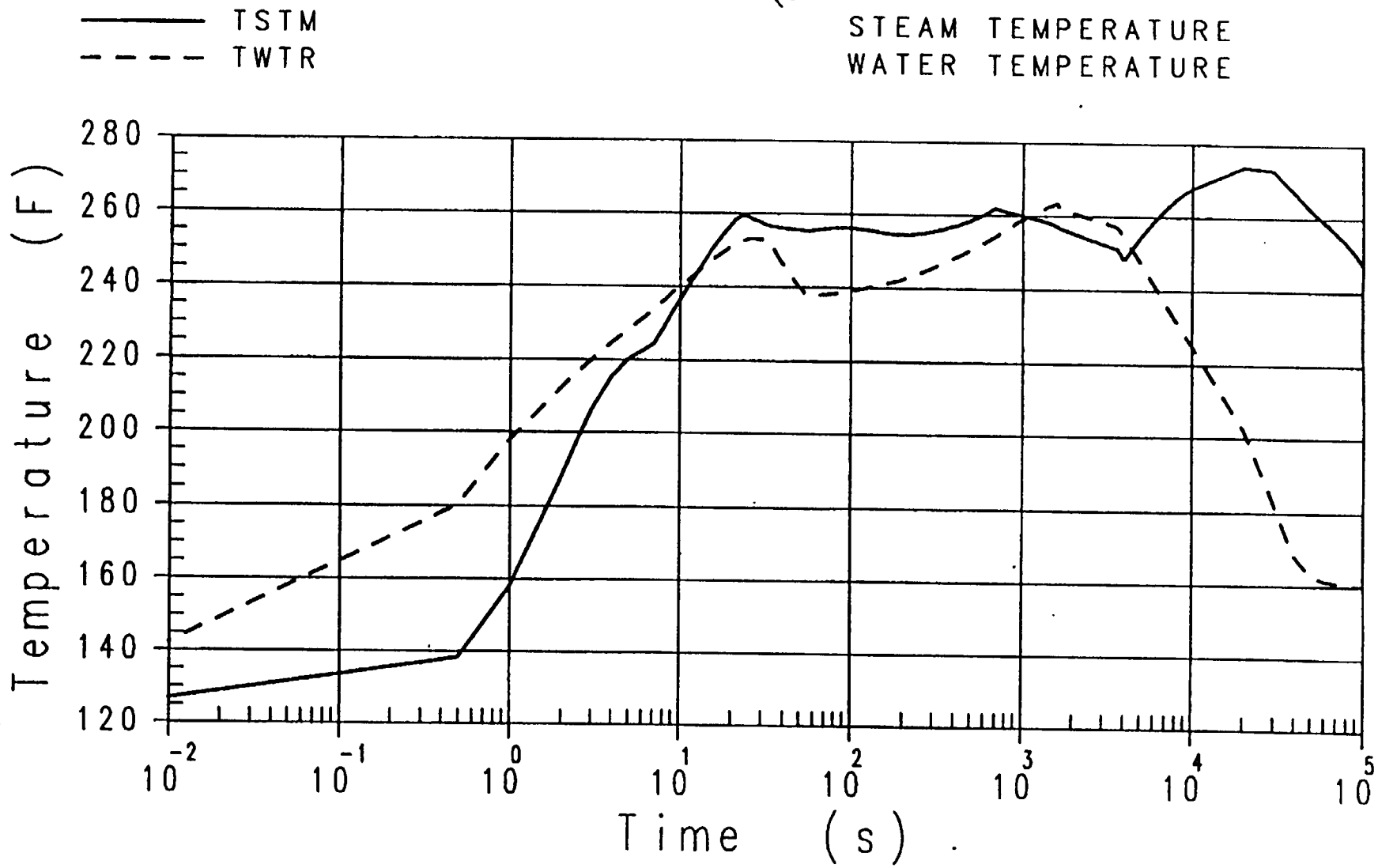

FIGURE 3-14

CONTAINMENT TEMPERATURE vs. TIME

DEPS – MIN ECCS

NO CFCU SENSITIVITY

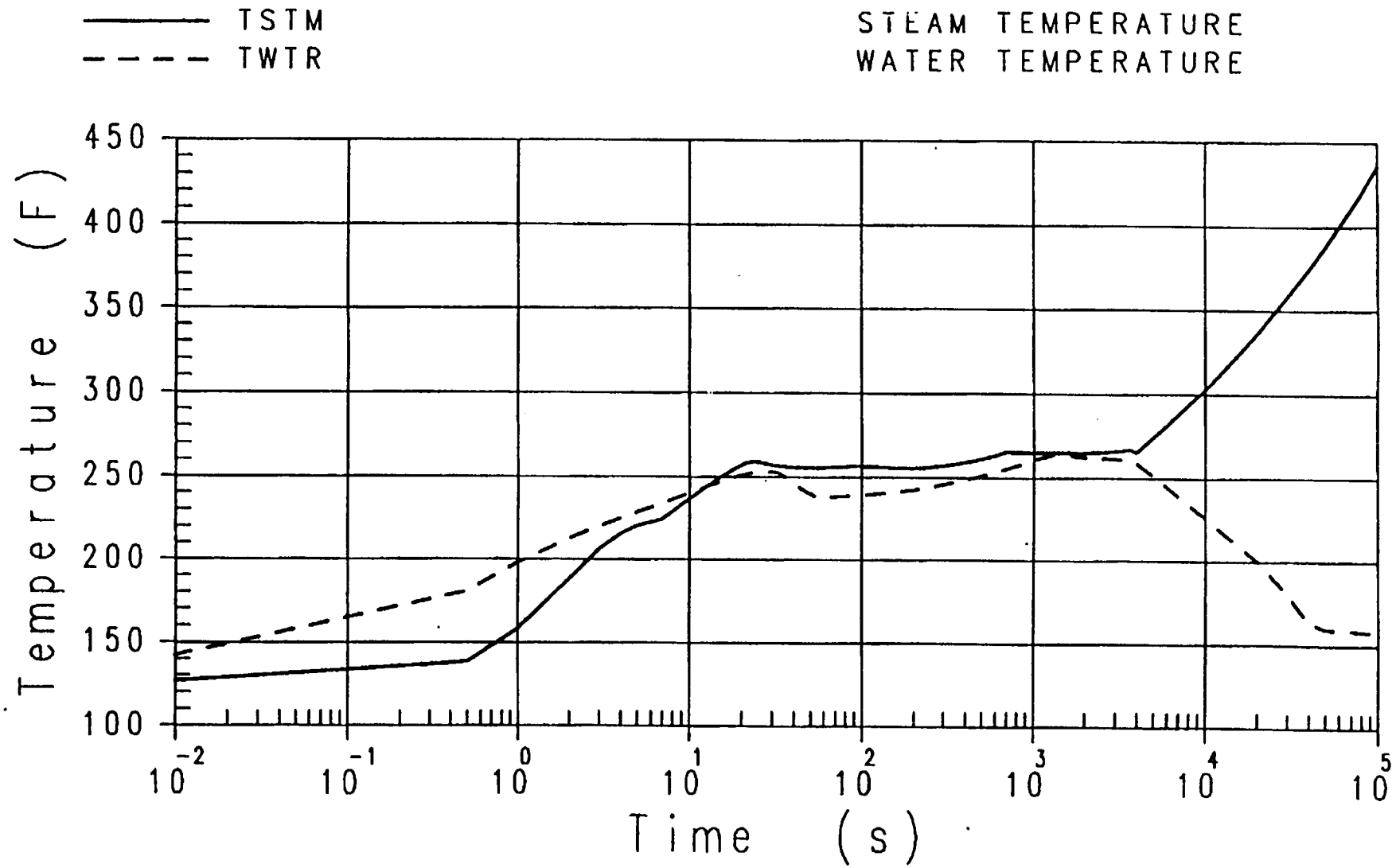

TABLE 3-3

CHRONOLOGY OF EVENTS FOR LOCA - DEPS MIN ECCS

Time (Seconds)	Event
0.0	Start of Accident
23.5	Peak Pressure Reached
25.8	End of Blowdown Phase
28.2	Pumped Emergency Core Cooling Starts
48.8	Containment Fan Coolers Start
55.9	Accumulators Emptied
88.3	Containment Sprays Start
192.6	End of Reflood Phase
692.7	Broken Loop Steam Generator Equilibrates
1610.0	Intact Loop Steam Generator Equilibrates
1680.0	Sump Recirculation Starts
3900.0	Containment Spray Shut Off

TABLE 3-5

CHRONOLOGY OF EVENTS FOR LOCA - DEPS MAX ECCS - CSP FAILURE

Time (Seconds)	Event
0.0	Start of Accident
23.5	Peak Pressure Reached
25.8	End of Blowdown Phase
25.8	Pumped Emergency Core Cooling Starts
48.8	Containment Fan Coolers Start
56.9	Accumulators Emptied
88.3	Containment Sprays Start
207.1	End of Reflood Phase
960.0	Sump Recirculation Starts
1127.1	Broken Loop Steam Generator Equilibrates
1588.5	Intact Loop Steam Generator Equilibrates
2820.0	Containment Spray Shut Off

TABLE 3-6

CHRONOLOGY OF EVENTS FOR LOCA - DEPS MAX ECCS - CFCU FAILURE

Time (Seconds)	Event
0.0	Start of Accident
23.9	Peak Pressure Reached
25.8	End of Blowdown Phase
25.8	Pumped Emergency Core Cooling Starts
48.8	Containment Fan Coolers Start
56.9	Accumulators Emptied
88.3	Containment Sprays Start
207.1	End of Reflood Phase
780.0	Sump Recirculation Starts
862.1	Broken Loop Steam Generator Equilibrates
1588.5	Intact Loop Steam Generator Equilibrates
1680.0	Containment Spray Shut Off

TABLE 3-7

COMPOSITE CONTAINMENT TEMPERARTURE vs. TIME

Time (sec)	Temperature (°F)
0	120
5	225.0
6	230.18
7	233.89
8	235.68
9	237.95
10	240.47
11	242.99
12	245.51
13	248.04
14	250.56
15	253.08
16	256.60
17	258.12
18	258.56
19	259.01
20	259.44
21	259.89
22	260.33
23	260.77
24	262.21
25	261.65
26	261.37
27	261.08
28	260.80
29	257.76
30	257.48
31	257.22
32	256.97
33	256.79
34	256.70
35	256.62
36	256.55
37	256.49
38	256.43
39	256.37
40	256.32
41	256.27
42	256.23
43	256.18
44	256.15
45	256.11
46	256.08
47	256.05
48	256.02
49	256.00
50	255.96
51	255.92

TABLE 3-7

COMPOSITE CONTAINMENT TEMPERARTURE vs. TIME

Time (sec)	Temperature (°F)
52	255.89
53	255.85
54	255.82
55	255.79
56	255.77
57	255.72
58	255.62
59	255.52
60	255.53
61	255.57
62	255.60
63	255.64
64	255.67
65	255.71
66	255.74
67	255.77
68	255.80
69	255.83
70	255.85
71	255.87
72	255.90
73	255.92
74	255.94
75	255.96
76	255.98
77	256.00
78	256.02
79	256.03
80	256.05
81	256.06
82	256.07
83	256.08
84	256.09
85	256.10
86	256.11
87	256.12
88	256.13
89	256.12
90	256.11
91	256.10
92	256.08
93	256.07
94	256.05
95	256.04
96	256.02
97	256.00
98	255.98
99	255.96

TABLE 3-7

COMPOSITE CONTAINMENT TEMPERARTURE vs. TIME

Time (sec)	Temperature (°F)
100	255.94
101	255.92
102	255.90
103	255.87
104	255.85
105	255.83
106	255.80
107	255.78
108	255.75
109	255.73
110	255.70
111	255.68
112	255.65
113	255.62
114	255.60
115	255.57
116	255.54
117	255.51
118	255.49
119	255.46
120	255.43
121	255.40
122	255.38
123	255.35
124	255.32
125	255.30
126	255.27
127	255.24
128	255.21
129	255.19
130	255.16
131	255.13
132	255.11
133	255.08
134	255.08
135	255.03
136	255.00
137	254.97
138	254.94
139	254.92
140	254.89
141	254.86
142	254.84
143	254.81
144	254.78
145	254.76
146	254.73
147	254.70

TABLE 3-7

COMPOSITE CONTAINMENT TEMPERARTURE vs. TIME

Time (sec)	Temperature (°F)
148	254.67
149	254.65
150	254.62
151	254.60
152	254.57
153	254.54
154	254.52
155	254.49
156	254.47
157	254.44
158	254.42
159	254.39
160	254.37
161	254.35
162	254.32
163	254.30
164	254.28
165	254.25
166	254.23
167	254.21
168	254.18
169	254.16
170	254.14
171	254.12
172	254.10
173	254.08
174	254.06
175	254.04
176	254.02
177	254.00
178	253.98
179	253.96
180	253.94
181	253.92
182	253.90
183	253.88
184	253.86
185	253.85
186	253.83
187	253.82
188	253.80
189	253.78
190	253.76
191	253.75
192	253.73
193	253.72
194	253.72
195	253.71

TABLE 3-7

COMPOSITE CONTAINMENT TEMPERARTURE vs. TIME

Time (sec)	Temperature (°F)
196	253.71
197	253.71
198	253.71
199	253.71
209	253.71
219	253.72
229	253.75
239	253.78
249	253.83
259	253.88
269	253.94
279	254.01
289	254.09
299	254.17
309	254.25
319	254.34
329	254.44
339	254.53
349	254.63
359	254.73
369	254.84
379	254.94
389	255.04
399	255.15
409	255.25
419	255.36
429	255.46
439	255.57
449	255.67
459	255.78
469	255.88
479	255.98
489	256.09
499	256.19
599	257.46
699	258.96
799	256.00
899	255.00
999	254.12
1099	253.23
1199	252.42
1299	251.67
1399	250.87
1499	250.05
1599	249.49
1699	248.34
1799	247.51
1899	246.80

4.0 CONCLUSIONS

Based upon the information provided in this report, it is demonstrated that the containment safeguards system are fully capable of mitigating the consequences of a hypothetical loss-of-coolant accident. This analysis, based on current operating conditions, resulted in an overall peak containment pressure of 41.53 psig for the DEHLG break. The peak post blowdown containment pressure was also demonstrated to be 39.83 psig for the DEPS break.

The calculated containment margin is 5.47 psig to a containment design pressure of 47.0 psig. Thus, the most limiting LOCA cases have been considered and have been demonstrated to yield acceptable results. The containment pressure and temperature response is determined for both loss of coolant and main steamline break accidents. Hence, the main steamline break accident may bound the LOCA results.

The composite temperature curve [Figure 3-9 and Table 3-7] has been compared to the Reference 13 DEPS LOCA temperature curve. Reference 13 curve is bounding for the post-blowdown period. The new composite curve yields slightly higher temperatures during the blowdown phase due to the inclusion of the hot leg break. The reference 13 curve was for the pump suction break only, and did not included the hot leg break. The hot leg break has been shown to bound the pump suction break during the blowdown period.

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BREAK	Peak Pressure (psig)
Double-ended hot leg 3423 MWt	41.53
Double-ended Pump Suction 3433 MWt Revised RHR, CCP, and SI Flows Reduced Containment Spray Setpoint	
Min ECCS	39.83
Max ECCS - CSP Failure	39.83
Max ECCS - CFCU Failure	39.83