Docket No. 50-336
B14315

Attachment 1
Millstone Nuclear Power Station, Unit No. 2

Proposed Revision to Technical Specifications
Main Steam Line Break Design Limits
Response to Request for Additional Information

Previously Transmitted Information

December 1992

1.0 Core Response to a MSLB

1.1 Event Description

A steam line piping failure event, or main steam line break (MSLB), is initiated by a rupture of a main steam line pipe upstream of the MSIV's causing an uncontrolled steam release from the secondary system. As a result of the uncontrolled release of steam, the heat extraction rate from the primary side is no longer equal to the core heat generation rate. This power mismatch increases the primary-to-secondary side heat transfer and, consequently, reduces the primary side temperatures. When this overcooling on the primary side is coupled with a negative moderator temperature coefficient, the shutdown margin after scram can potentially be eroded. Such an erosion of shutdown margin may result in a return-to-power which, in turn, challenges thermal margin. The consequences of this event are governed by the steam flow rate out of the ruptured steam line, the primary pump operating assumptions (i.e., with or without offsite power), the magnitude of the moderator coefficient, and the initial primary side operating state.

1.2 Event Disposition and Justification

Four cases were analyzed: Hot Zero Power (HZP) with offsite power available, HZP with loss of offsite power, Hot Full Power (HFP) with offsite power available, and HFP with loss of offsite power. The changes from Table 1 that could impact the MSLB are the change in delay times for the HPSI and Feedline Isolation. The reduction in the delay times of the HPSI and Feedline Isolation are beneficial and, thus, the analysis remains bounding.

2.0 Core Response to a LOCA

2.1 Event Description

The loss-of-coolant accident (LOCA) is initiated by a breach in the Primary Coolant System pressure boundary. A range of break sizes, from small leaks up to a complete double-ended severance of the Primary Coolant System pipe, must be considered. Typically, these breaks are classified as large and small breaks.

The purpose of the LOCA analyses is to demonstrate that the criteria stated in 10CFR50.46(b) are met, namely:

(1) The calculated peak fuel element cladding temperature does not exceed the 2200°F limit.

(2) The amount of fuel element cladding which reacts chemically with water or steam does not exceed 1 percent of the total amount of zircaloy in the core.

(3) The cladding temperature transient is terminated at a time when the core geometry is still amenable to cooling. The peak local cladding oxidation limit of 17 percent is not exceeded during or after quenching.

(4) The core temperature is reduced and decay heat is removed for an extended period of time, as required by the long-lived radioactivity remaining in the core.

2.2 Event Disposition and Justification

2.2.1 Small Break LOCA (SBLOCA):

The only plant change from those listed on Table 1, that might affect the SBLOCA analysis of record is the reduced HPSI delay time. However, the change in HPSI delay time represents a negligible amount of additional SI water injected into the primary system over a very long transient.

The reduced LPSI delay time does not affect the SBLOCA event because the primary pressure never becomes low enough to initiate the LPSI system.

Plant changes from Table 1 that might affect containment pressure, such as a reduced fan cooler delay time, do not affect the SBLOCA analysis because the primary system pressure remains high and the break flow remains choked for the duration of the event.

The conclusion for the SBLOCA event is that the analysis of record is unaffected by the plant changes of Table 1 and the SBLOCA event does not require reanalysis.

2.2.2 Large Break LOCA (LBLOCA):

Of the plant changes from Table 1, only the following have the potential of influencing the LBLOCA analysis of record:

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	Old Value	Value Used In Analysis	New Value
HPSI delay time (sec)	45	45*	25
LPSI delay time (sec)	65	65*	45
Containment spray delay time (sec)	35.6	26	35.6
Containment fan coolers delay time (sec)	31	31	26
Containment High-High Pressure Setpoint (psig)	27	4.75	9.48

*The original analysis used 30 and 50 seconds; in Cycle 10 the acceptability of 45 and 65 seconds was demonstrated.

Note: The feedwater flow in the analysis of record is assumed to be ramped to zero within 1.43 seconds of transient initiation. This is a much faster and more conservative feedwater isolation time than the new feedline isolation time of 14 seconds.

Note: The values used in the LBLOCA analysis are consistent with the assumption of loss of offsite power.

(1) The reduced HPSI delay time will result in a negligible additional amount of SI flow to the downcomer prior to beginning-of-reflood (BOCREC) time since the HPSI flow rate is very small compared to the flow from the Safety Injection Tanks (SITs) and the change in delay time is only 5 seconds. A negligible change in BOCREC time will occur, but what does occur will be in a favorable direction.

(2) The reduced LPSI delay time will have no effect on BOCREC time since the delay time is satisfied after BOCREC has already occurred. However, LPSI flow beginning 5 seconds earlier will tend to fill the downcomer slightly faster, which will cause a slight increase in the reflood rate, which is in a favorable direction. The difference in reflood rate will be very small and will have no effect on the calculated PCT since the effective reflood rate is already well above the FCTF correlation limit of 1.77 in/sec prior to the time of PCT.

above the FCTF correlation limit of 1.77 in/sec prior to the time of PCT.

(3) The containment spray delay time, used in the analysis of record (26 sec), is conservative relative to the delay time indicated in Table 1 (35.6 sec). A shorter delay time will tend to decrease the containment pressure and reflood rate; however, the difference in delay time of 9.6 sec has a very minor effect on containment pressure and reflood rate and no effect on the PCT, since the effective reflood rate is well above the FCTF correlation limit of 1.77 in/sec.

(4) The reduction in fan cooler delay time will tend to reduce the containment pressure, which tends to reduce the reflood rate. However, the containment pressure is dominated by the mass and energy release from the primary system, and a reduction in the fan cooler delay time from 31 to 26 seconds will have a negligible effect on the containment pressure. Although the reduced fan cooler delay time acts in an adverse direction, it will have no effect on the calculated PCTs.

(5) The analysis of record conservatively uses a Containment High Pressure Setpoint of 4.75 psig to initiate containment sprays. Therefore, a change in the Containment High-High Pressure Setpoint from 27 to 9.48 psig has no affect on the analysis of record.

The conclusion of this disposition is that the LBLOCA analysis of record is unaffected by the plant changes of Table 1 and does not require reanalysis.

Table 1

Item	Old Value/Condition	New Value/Condition
HPSI Delay Time*	45 sec.	25 sec.
LPSI Delay Time*	65 sec.	45 sec.
Charging Pump Delay Time	55 sec.	35 sec.
Containment Spray Delay Time		
With Offsite Power	35.6 sec.	16.0 sec.
Without Offsite Power	35.6 sec.	35.6 sec.
Containment Fan Coolers Delay Time		
With Offsite Power	31.0 sec.	15.0 sec.
Without Offsite Power	31.0 sec.	26.0 sec.
Feedline Isolation Time	22 sec.	14 sec.
Feedwater Valve Closure Time	30 sec.	14 sec.
Containment Hi-Hi Pressure Setpoint	27 psig	9.48 psig

* Without Offsite Power

In addition to the above changes, the Technical Specifications have been changed to add Main Steam Isolation and Feedwater Isolation based on a Containment Pressure-High signal.

EQ Review for PDCR 2-114-92 Integrated Safety Evaluation

EVALUATION OF EQ EQUIPMENT THERMAL RESPONSE TO THE POSTULATED MSLB AND LOCA IN THE MILLSTONE UNIT 2 CONTAINMENT

1.0 Introduction

The purpose of this evaluation is to demonstrate that the limiting accident in containment is enveloped by equipment qualification testing for the applicable equipment in containment. The two elements of the worst case accident is the Loss of Coolant Accident (LOCA) and the Main Steam Line Break accident (MSLB). The new postulated MSLB analysis for containment (Reference 6.13) includes a 427°F temperature peak at 53 seconds which reduces to below 289°F at 96 seconds into the accident . Since this temperature peak represents a short duration at superheated conditions the surface temperature of safety related equipment will not exceed the saturated temperature of the steam pressure in containment during the event. This approach has been presented by the NRC in NUREG 0588 paragraph 1.2 and NUREG 0510 which recognizes the relatively low heat transfer rate in superheated steam, the heat capacity of the affected safety related equipment and the short duration of the superheated peak temperature of the MSLB. Furthermore analysis in NUREG 1511 "Containment Main Steam Line Break Analysis For Equipment Qualification" shows that there exist a condensate-vapor-air boundary layer up to 3 ft. thick surrounding component surfaces which will maintain the surfaces at saturated steam temperature.

The new containment accident response for a LOCA (Reference 6.14) and the MSLB is shown in Figure 1 along with the corresponding T_{Sat} curves for MSLB pressure profile. The composite curve is provided which envelopes the LOCA, MSLB (except the superheated peak) and T_{Sat} curve for the maximum steam pressure[1] during the event. The following discussions summarizes the analysis for using saturated steam temperature in leu of the actual superheated peak temperature.

2.0 Thermal Response

The 427°F superheated steam will not heat equipment beyond their qualified temperature because of the short time period at the superheated conditions. The temperature a component will reach is dependent upon the rate of heat transfer[2] from the environment to the surface of the component. The rate of heat transfer will depend on the thermal barriers between the superheated steam and the component surface.

A condensate layer will form on component surfaces during the initial phase of the accident which will act as a thermal blanket. The temperature of this condensate layer will range from the sub-saturated temperature of the component near the surface of the component to the super-saturated temperature associated with containment pressure at the outer edges. The temperature at the surface of the component will remain equal to or less than the saturated temperature while this condensate layer exists. The condensate layer will thin out as the temperature of the component surface increases to the saturation temperature. Since the rate of heat transfer through this condensate layer is slow, depending on the mass of the component, there will be a substanstial thermal lag for the superheated steam to directly impinge on the component surface.

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[1]The steam pressure in containment is determined by subtracting the partial pressure of air from the total pressure to result with the partial pressure of steam. To estimate the partial steam pressure we have subtracted 14.7 psi, i.e. the atmospheric pressure of containment prior to the accident, from the gauge pressure calculated in the analysis to determine the saturation temperature.

[2] See Reference 6.3

In the case of the MSLB in containment, since the superheated condition peaks within 60 seconds, the condensate layer would remain on component surfaces throughout this phase of the accident maintaining a temperature at or below the saturated temperature.

3.0 Equipment Review

A review was performed on the EQ master list equipment in containment to determine if they are qualifiable under the MSLB superheat conditions. The qualified test pressure[3] represents the qualifiable saturated steam temperature during the test. As long as the peak test pressure is greater than the peak containment accident pressure and both are at or above saturated conditions then it is evident that the tested conditions are more severe, with a higher saturated temperature, than the accident conditions.

The CAR fans are important for containment heat removal during the MSLB. The motors associated with these fans are enclosed, and have an internal cooling system. These motors were tested up to 80 psig. With an internal cooling system they would be capable of reducing the superheated steam to a saturated condition for a fairly long period of time. Another item of particular interest for this event are the containment penetrations. These have been tested to 70 psig which is more severe than the postulated accident conditions.

4.0 Verification by Test

There have been several superheated steam tests which demonstrate that surface temperatures remain at saturated conditions for several hours even for low mass components (i.e. Namco Limit Switch). Temperature probes were placed directly on component surfaces during these high temperature steam tests to monitor the actual temperatures of the component. The test results are included in References 6.5, 6.6, 6.7, 6.8, 6.9 and 6.10. As an observation, the Sandia High Temperature Cable Testing has shown that cable performance is maintained well above the 427°F temperatures of the MSLB accident.

5.0 Conclusion

The superheated transient peak of the MSLB in containment is of short duration and will not cause any EQ equipment to exceed their qualification temperature. The LOCA profile and the MSLB profile is used for the composite profile in containment.

The revised LOCA and MSLB temperature profiles (excluding the superheated peak) have been superimposed in Figure 1 to produce a profile which envelopes all postulated accident transients in the containment. Figure 2 provide the test curves from all the equipment in containment and show how they envelop the composite profile[4].

Based on this evaluation the new LOCA and MSLB temperature profiles will have no adverse affect on the EQ program

Prepared By RE Depat 10/16/92 ~~10/17/92~~ RD

R.E.Depatie
E/I&C Programs

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[3]The steam pressure in a test chamber is determined by the actual recorded pressure of the chamber. There would not be a contribution of partial air pressure since test chambers are normally vented to ensure that the required temperature spikes are achieved. Any affect of the atmospheric pressure is eliminated during the venting process.

[4]The lack of enveloping between the test profiles and the composite profile within the first 100 seconds of the accident is considered insignificant for qualifying the equipment.

6.0 References (for this Attachment only)

6.1 NUREG/CR-1511, Containment Main Steam Line Break Analysis for Equipment Qualification, 6/80

6.2 NUREG-0588, Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment

6.3 "Heat Transmission", 3rd Edition, William H. McAdams, McGraw-Hill Book Co.

6.4 ET-2069, Generic Evaluation Report for SCE SONGS 1, Evaluation of the Thermal Response of Typical Environmental Qualification Related Equipment to a Transient Superheated Steam Environment, EchoTech/RAM-Q

6.5 RMT Report 108220A, Rosemount, Analysis of the Model 1153 Series D Transmitters to 420°F for Three Minutes, dated 11/5/82

6.6 QR-52600-5940-2, Valcor Engineering Corp., Qualification Test Report for IEEE Class IE Solenoid Valves, dated 7/11/79

6.7 Report #B-0027, Limitorque Corp. Test Lab, Limitorque Valve Actuator Temperature Related to High Ambient Temperatures, dated 10/18/78

6.8 QTR-155, Namco Controls, Generic Qualification of EA180 Series Limit Switches for use in Nuclear Power Plant Class 1E Applications in Compliance with IEEE 323-1974, 382-1972, and 344-1975, 10/5/87

6.9 Temperature Gradients within an Insulated Cable during a Main Steam Line Break, James R. Marth, The Rockbestos Co., 12/13/82

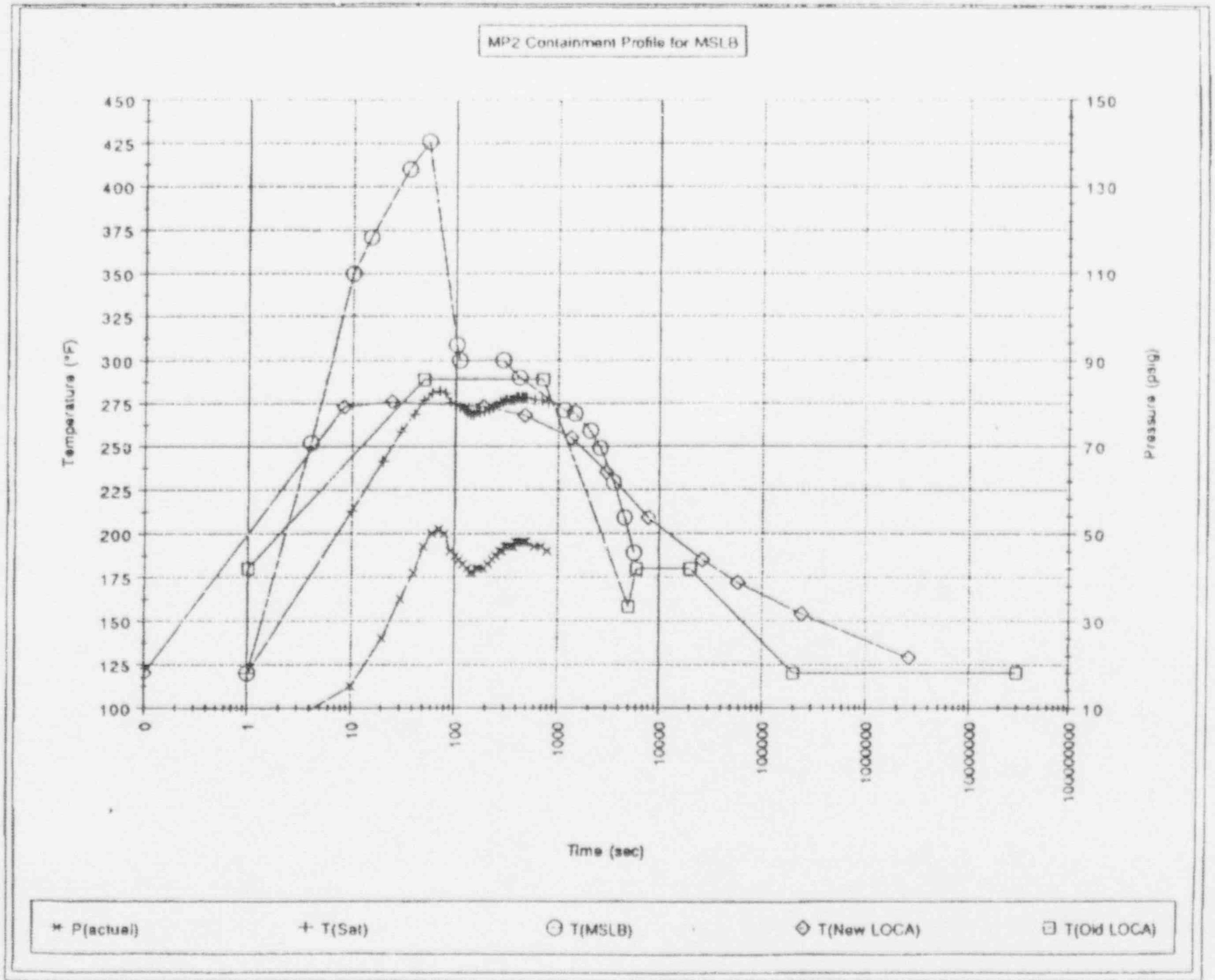
6.10 NUREG/CR-5655, SAND90-2629, Submergence and High Temperature Steam Testing of Class 1E Electrical Cables

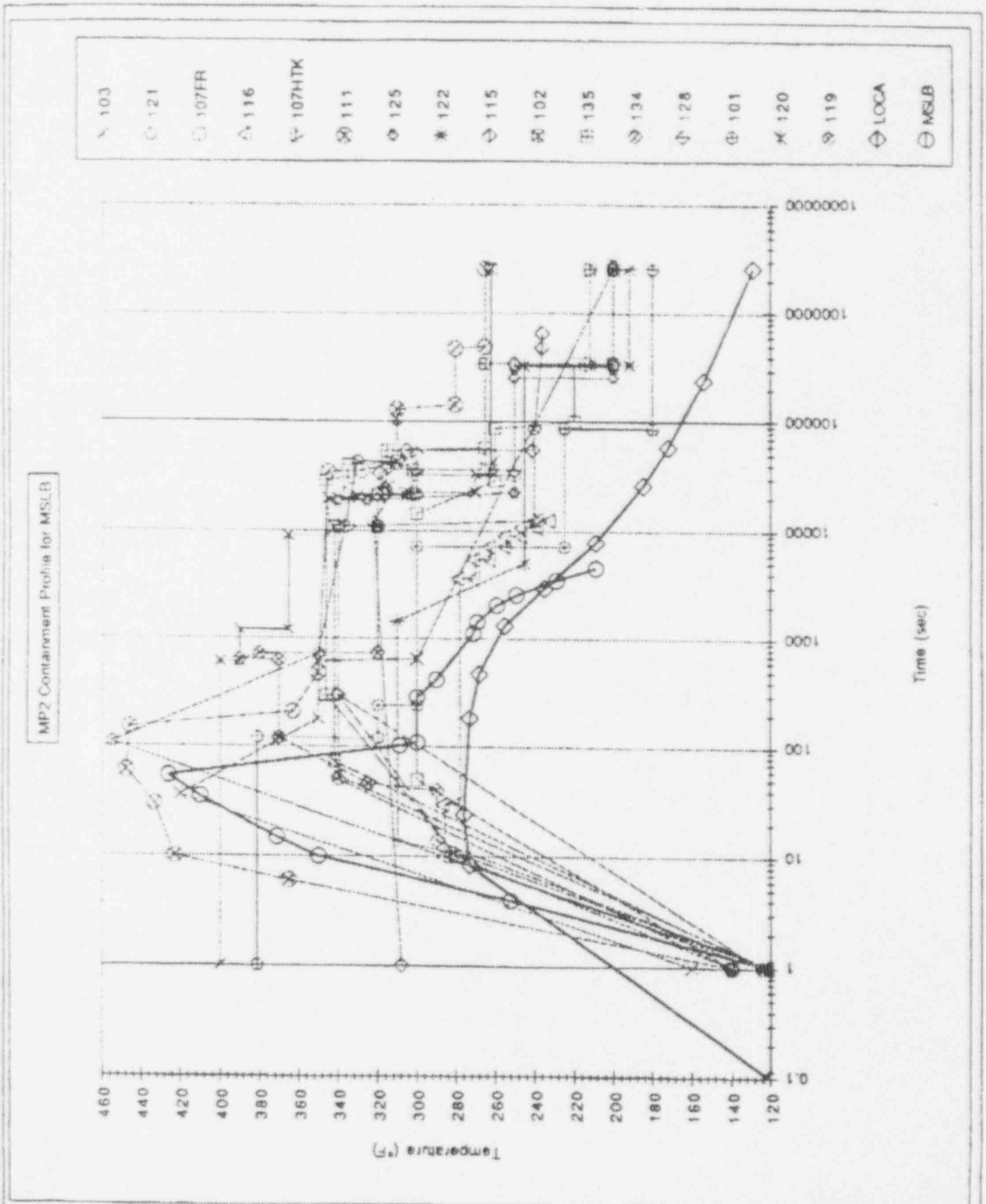
6.11 NUREG 0510, Identification of Unresolved Safety Issues Relating to Nuclear Power Plants, 1/1/79

6.12 NUREG 0458, Short Term Safety Assesment on Environmental Qualification of Safety Related Electrical Equipment of SEP Operating Reactors, 05/1/78

6.13 Draft ABB Memo P.W.Wielhouwer to J.A.Camp dated 10/9/92

6.14 Fax Memo R.C. Wipple to Bob Depatie dated 10/16/92 (11:35)


MP2 Containment Profile for MSLB
Temperature (°F)
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
Pressure (psig)
150
130
110
90
70
50
30
10
0
1
10
100
1000
10000
100000
1000000
10000000
100000000
Time (sec)
P(actual)
T(Sat)
T(MSLB)
T(New LOCA)
T(Old LOCA)



MP2 Containment Profile for MSLB
Temperature (°F)
Time (sec)
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
0.1
1
10
100
1000
10000
100000
1000000
10000000
103
121
107FR
116
107HTK
111
125
122
115
102
135
134
128
101
120
119
LOCA
MSLB