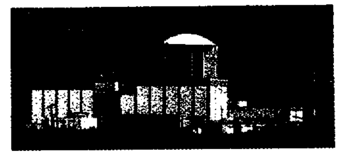
NRC-01-051

NMC
Committed to Nuclear Excellence

Kewaunee Nuclear Power Plant
N490, State Highway 42
Kewaunee, WI 54216-9511
920-388-2560

Operated by
Nuclear Management Company, LLC



April 27, 2001

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Ladies/Gentlemen:

DOCKET 50-305
OPERATING LICENSE DPR-43
KEWAUNEE NUCLEAR POWER PLANT
NUCLEAR MANAGEMENT COMPANY, LLC. RESPONSE TO NRC'S REQUEST FOR ADDITIONAL INFORMATION ON WISCONSIN PUBLIC SERVICE CORPORATION RELOAD SAFETY EVALUATION METHODS TOPICAL REPORT, WPSRSEM-NP, REVISION 3

Reference: Letter from Mark E. Reddemann (NMC) to Document Control Desk (NRC), dated April 13, 2001, "Response to NRC' s Request for Additional Information on Wisconsin Public Service Corporation Reload Safety Evaluation Methods Topical Report, WPSRSEM-NP, Revision 3."

In the referenced letter, Nuclear Management Company, LLC, (NMC) committed to submitting Westinghouse WCAP-15427, Rev 1, "Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant," when received from Westinghouse. This submittal transmits that WCAP.

Enclosed are:

1. One copy of the Proprietary Class 2 WCAP 15427, Rev. 1, "Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant."

2. One copy of the Non-proprietary Class 3 WCAP 15667, "Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant."

Also enclosed are a Westinghouse authorization letter, CAW-01-1448, accompanying affidavit, Proprietary Information Notice, and Copyright Notice.

As item 1 contains information proprietary to Westinghouse Electric Company LLC ("Westinghouse"), it is accompanied by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.790 of the Commission's regulations.

Accordingly, it is respectfully requested that the information, which is proprietary to Westinghouse, be withheld from public disclosure in accordance with 10 CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse Affidavit should reference CAW-01-1448 and should be addressed to H. A. Sepp, Manager of Regulatory and Licensing Engineering, Westinghouse Electric Company LLC, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Please contact Mr. John Holly (920-388-8296) or Mr. Gerald Riste (920-388-8424) of my staff should you have any other questions.

Sincerely,

Mark E. Reddemann
Site Vice President

GOR

Attachments

cc - US NRC Region III - Attachment 2 only
US NRC Senior Resident Inspector - w/o Attachments
H.A. Sepp, Westinghouse Electric Company LLC – w/o Attachments

ATTACHMENT 2

Letter from Mark E. Reddemann (WPSC)

To

Document Control Desk (NRC)

Dated

April 27, 2001

WCAP-15667
"Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant."

– Non-Proprietary Class 3

Westinghouse Non-Proprietary Class 3

WCAP-15667

Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant

Westinghouse Electric Company LLC

WCAP-15667

Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant

R. Ofstun

April 2001

Westinghouse Electric Company LLC
P. O. Box 355
Pittsburgh, Pennsylvania 15230-0355

Table of Contents

1.0 Introduction

The GOTHIC code is rapidly becoming the industry standard for performing both inside and outside containment pressure and temperature design basis analyses. The code is being developed by Numerical Applications Incorporated (NAI) with funding by EPRI.

Wisconsin Public Service (WPS) approved a plan to develop a GOTHIC containment evaluation model for the Kewaunee Nuclear Power Plant. This work was done as part of the replacement steam generator program. The purpose of this work was to demonstrate the modeling capabilities with GOTHIC and to benchmark the GOTHIC model against both the existing CONTEMPT containment analysis model and the revised CONTEMPT and COCO containment analysis models created for the replacement SG program.

The GOTHIC model development program was done in two phases. The purpose of the first phase was to identify differences in modeling methodology between WPS and Westinghouse and to compare the GOTHIC model with the CONTEMPT model results for the LOCA and MSLB transients. Several modeling differences and discrepancies were discovered and a number of changes were made to create the final LOCA and MSLB containment evaluation models. The purpose of the second phase was to compare results from the revised GOTHIC model to results from the final LOCA and MSLB containment evaluation models.

This report documents the development and benchmark testing of the Kewaunee Nuclear Power Plant GOTHIC containment model. Transient results from the GOTHIC model are compared to results calculated by CONTEMPT and COCO.

2.0 Comparison of Modeling Assumptions for Containment Analyses

The current Kewaunee LOCA containment analysis model is based on the Westinghouse COCO code. WCAP-8327 (Ref. 1) describes the COCO code and containment design basis accident evaluation model. Key points are listed below:

1. The COCO code was submitted to the AEC for review on July 3, 1974 in Westinghouse Letter NS-RS-287. No SER for COCO has ever been received, therefore, the FSAR section for containment integrity for each plant contains text directly from the COCO WCAP. This text has been reviewed and approved by the NRC on a plant specific basis.
2. COCO is a 2 region model; gas (air/steam) and liquid.
3. The gas (air/steam) components are in thermal equilibrium, but the gas and liquid region may be at different temperatures.
4. Air is assumed to be an ideal gas.
5. All liquid break flow goes directly to the liquid region, all steam goes directly to the gas region. Two-phase break flow is separated assuming the liquid is saturated at the total system pressure and the steam is saturated at the steam partial pressure in the gas region. The liquid portion of the two-phase break flow enters the gas region as drops.
6. Drops from the ECCS containment spray are assumed to equilibrate with the vapor instantaneously (test data is referenced in WCAP-8327, Ref. 1).

7. Service water cooled fan cooler heat removal is input as a function of the steam temperature.
8. Sump heat is removed with RHR/CCW heat exchangers. The RHR/CCW heat exchangers are modeled with a fixed UA input. The sump, CCW, and service water flow rates are specified as functions of time.
9. Condensation heat and mass transfer between the sump and gas region is not modeled.
10. Heat sinks are modeled as vertical, layered plates with 1-D conduction.
11. The gap between the steel and concrete layers of a wall is modeled with a constant thermal conductance ([ ]^{a,c} BTU/hr-ft2-F); heat storage in the gap is neglected.
12. The Tagami maximum heat transfer coefficient, h_{Tagami} , is given below. A parabolic curve fit is used to model the transient Tagami condensation heat transfer coefficient during blowdown.

$$h_{Tagami} = 75\ (E/t_pV)^{0.60}$$

$$h = h_{Tagami}\ (t/t_p)^{1/2}$$

where:

E - Integrated energy release during blowdown (BTU)
V - Containment free volume (ft^3)
t_p - Time at end of blowdown (sec)

12. The Tagami condensation heat transfer coefficient for concrete surfaces is 40% of the value calculated for steel surfaces.
13. The condensation heat transfer coefficient is decreased exponentially to a value which is based on the steam/air weight ratio, x, after blowdown.

$$h_{stag} = 2 + 50x$$

$$h = h_{stag} + [h_{Tagami} - h_{stag}]\ e^{-0.05[t-tp]}$$

A technical description of the GOTHIC code is contained in Reference 2. The key differences between the GOTHIC and COCO modeling assumptions are listed below:

1. A linear curve fit is used in the GOTHIC Tagami heat transfer correlation during blowdown.

$$h_{Tagami} = 72.5\ (E/t_pV)^{0.62}$$

$h = h_i + [h_{Tagami} - h_i](t/t_p)$, where h_i is an initial heat transfer coefficient input value.

2. The transition from Tagami to the GOTHIC post-blowdown heat transfer correlation is done at a slower rate. The Uchida condensation correlation is one of two that can be used for condensation heat transfer after blowdown.

$$h_{Uchida} = 79.33[\rho_{vs}/\rho_{vg}]^{0.8}$$

$$h = h_{Uchida} + [\max(h_{Tagami}, h_{Uchida}) - h_{Uchida}]\ e^{-0.025(t-tp)}$$

where:

ρ_{vs} - density of the steam component (lbm/ft^3)
ρ_{vg} - density of the non-condensable gas component (lbm/ft^3)

3. GOTHIC models the drop phase and does not instantaneously equilibrate the drops to the gas temperature. Larger drops take longer to equilibrate than an equivalent mass of smaller drops due to the large difference in surface area. The GOTHIC spray drop diameter input value can be made very small to allow the drops to quickly equilibrate with the gas.

4. GOTHIC models the thickness, and properties of each layer in a thermal conductor; the gap is not modeled with a fixed conductance as it is in COCO. The air gap thickness input value can be adjusted to yield the same thermal conductance as COCO uses given a fixed set of air properties.

5. GOTHIC normally models heat transfer between the liquid in the sump and the gas phase. Sump heat and mass transfer can be eliminated by setting the interface area to 0.0 ft^2.

The current Kewaunee MSLB containment analysis model is based on the CONTEMPT code. The CONTEMPT code and input are described in Reference 3. The GOTHIC and CONTEMPT code features and modeling techniques are compared in Reference 4. The key differences are summarized below.

1. GOTHIC was designed as a general purpose thermal hydraulic transient analysis code; CONTEMPT was specifically designed for containment analyses and contains four special hard-wired volume types for this purpose.

2. GOTHIC performs mass and energy balances for the droplet phase; the spray efficiency is a user input in CONTEMPT. Similarly, GOTHIC performs mass and energy balances for steam/air bubbles rising through a pool; CONTEMPT assumes 100% condensation efficiency.

3. For interface heat and mass transfer, CONTEMPT assumes the interface is always at saturation, GOTHIC calculates the interface temperature from first principles.

4. CONTEMPT uses a user specified phase separation model for blowdown (pressure flash or temperature flash); GOTHIC determines the blowdown phase separation based on fundamental models for interface heat and mass transfer at the containment conditions.

5. GOTHIC models momentum balanced, multi-phase flow between compartments and to the atmosphere. GOTHIC uses break flow tables or correlations for choked flow. CONTEMPT only models the vapor phase flow between compartments and to the atmosphere.

6. GOTHIC calculates the tube and shell heat transfer coefficients for heat exchangers; the overall heat transfer coefficient is a user input for CONTEMPT heat exchangers.

7. Each version of GOTHIC is qualified against a wide range of tests (both experimental and analytical) and the results are documented in the Qualification Report (Ref. 5). Although CONTEMPT results from various versions have been compared with various experimental and analytical tests, there is no corresponding documentation to demonstrate the Qualification of each version of CONTEMPT.

As described above, some of the differences between the code modeling assumptions can be eliminated by input changes in the GOTHIC model. The comparison of transient results from the GOTHIC model with results from the COCO and CONTEMPT models should highlight those differences that cannot be eliminated by GOTHIC input changes.

3.0 Phase 1 GOTHIC Containment Model Input Development

A GOTHIC containment model of the Kewaunee Nuclear Power Plant was constructed for benchmark test comparison with the current CONTEMPT LOCA and MSLB containment models. The GOTHIC input description for the model follows.

A method for creating the GOTHIC containment DBA evaluation models based on COCO input decks was developed and documented in Reference 6. This same method was applied to create the Kewaunee GOTHIC model based on the CONTEMPT input deck for the Phase 1 LOCA and MSLB transient benchmark comparisons.

GOTHIC Containment Volume

The containment volume input value from the Kewaunee CONTEMPT input deck (Ref. 7) was used in the GOTHIC containment evaluation model. The bottom elevation was arbitrarily set to 0.0 ft; the height was arbitrarily set to 100 ft and the hydraulic diameter was arbitrarily set to 10 ft. The GOTHIC pool area input value was intentionally set to 0.0 ft^2 to prevent condensation on the water that settles to the bottom of the volume (similar to the conservative assumption in the CONTEMPT model). The containment volume initial conditions for the LOCA cases were set to match the CONTEMPT input (air filled at 16.85 psia, 120 F, and 17.7% RH).

GOTHIC Model Boundary Conditions

Three flow boundary conditions and their associated flow paths were added to the GOTHIC containment evaluation model to provide the LOCA mass and energy releases and containment spray. One flow boundary condition was used to represent the two-phase blowdown mass and energy release, as well as the post-blowdown steam mass and energy release. A second flow boundary condition was used to represent the post-blowdown liquid mass and energy release. The third flow boundary condition was used to represent the spray flow.

The mass and energy release input data was taken from the Kewaunee CONTEMPT input deck. The CONTEMPT energy releases were converted into enthalpy input values (required for GOTHIC input) by dividing the energy release rate by the mass flow rate at each point in time. These mass flow rate and enthalpy input values were copied into four separate GOTHIC function tables (two mass flow rate and two enthalpy tables). Each of the three flow boundary conditions

were assigned the appropriate mass and enthalpy functions as multipliers on the flow rate and temperature inputs in GOTHIC.

The upstream pressure for the mass and energy release boundary conditions is used to determine the fluid density at the boundary. The fluid density is used to calculate the boundary flow velocity. Since the source momentum is dissipated within the lumped parameter containment volume, this input value is not very important. The upstream pressure was set to 60 psia in this model. This is in the range of the expected peak containment pressure following blowdown.

The liquid portion of the two-phase LOCA blowdown mass and energy release was injected into the containment vapor phase as small droplets. The spray drop diameter input was set to a small value (0.00394-in) as recommended by NAI (Ref. 9). A forcing function was used to turn off the droplets at the end of blowdown. The liquid portion of the post-blowdown mass and energy release was released directly into the liquid phase; no drop diameter was input.

The elevation of each of the two break flow paths coming from the boundary conditions was set to 30 ft. This places them in the vapor region of the containment model. The flow path area, hydraulic diameter and length input values were arbitrarily set to 1.0 ft^2, 1.0 ft and 1.0 ft respectively.

The spray flow rate was also input as a function in GOTHIC. The spray flow rate and temperature input data was taken from the Kewaunee CONTEMPT input deck. The spray flow rate starts at a specified time (135 seconds) and stops at the recirculation switchover time in the LOCA case (3775 seconds). The spray drop diameter input was set to a very small value (0.0005-in) to simulate the 100% spray efficiency input value that is used in the CONTEMPT model. The spray temperature (RWST water) was set to 100 F to match the CONTEMPT model input value.

GOTHIC Fan Cooler Model

A GOTHIC cooler component was added to the containment volume to simulate the service water cooled fan coolers. The heat removal rate is specified as a function of the containment vapor temperature in the Kewaunee CONTEMPT model. This same function was input to the GOTHIC model. A multiplier (for the number of operating fan coolers) was applied to the heat removal function. The cooler component was started at a specified time (85 seconds) to match the CONTEMPT model for the LOCA case.

GOTHIC Thermal Conductors

The Kewaunee CONTEMPT model heat sinks were incorporated into the GOTHIC containment model. The CONTEMPT material thickness input values were converted from feet to inches for input to GOTHIC. The thickness input values for the various materials in each GOTHIC conductor type are tabulated below.

Kewaunee CONTEMPT Model Heat Sinks - LOCA

Conductor	Area (ft^2)	Paint (ft)	Steel (ft)	Concrete (ft)	Total (in)	Paint (in)	Steel (in)	Concrete (in)
1	41300	0.001	0.125		1.512	0.012	1.5	0
2	17300	0.001	0.0625		0.762	0.012	0.75	0
3	47925	0.001	0.0208		0.2616	0.012	0.2496	0
4	69300	0.001		0.5	6.012	0.012	0	6

The CONTEMPT MSLB model used more heat sinks than the LOCA model. The MSLB model heat sink thickness values from Reference 8 are tabulated below.

Kewaunee CONTEMPT Model Heat Sinks - MSLB

Conductor	Area (ft^2)	Paint (ft)	Steel (ft)	Concrete (ft)	Total (in)	Paint (in)	Steel (in)	Concrete (in)
1	41300	0.001	0.125		1.512	0.012	1.5	0
2	17300	0.001	0.0625		0.762	0.012	0.75	0
3	1260	0.001	0.0208	1	12.2616	0.012	0.2496	12
4	1100		0.0156	1	12.1872	0	0.1872	12
5	5500		0.0208	1	12.2496	0	0.2496	12
6	4055	0.001	0.014		0.18	0.012	0.168	0
7	16925	0.001	0.0208		0.2616	0.012	0.2496	0
8	28500	0.001	0.03125		0.387	0.012	0.375	0
9	2000	0.001	0.0625		0.762	0.012	0.75	0
10	500	0.001	0.083		1.008	0.012	0.996	0
11	1695	0.001	0.0061		0.0852	0.012	0.0732	0
12	12400	0.001	0.00375		0.057	0.012	0.045	0
13	2000	0.001	0.00415		0.0618	0.012	0.0498	0
14	18000	0.001	0.00291		0.04692	0.012	0.03492	0
15	2200	0.001	0.06		0.732	0.012	0.72	0
16	50292	0.001		0.5	6.012	0.012	0	6
17	19009	0.001		0.5	6.012	0.012	0	6
18	1785	0.001		0.333	4.008	0.012	0	3.996

Note, the gap between the steel and concrete was not modeled in the CONTEMPT model or the benchmark GOTHIC model. This will be addressed in the final evaluation model.

GOTHIC requires input for the density, thermal conductivity and specific heat of each material in a conductor. The material properties for the paint, steel and concrete were taken from the CONTEMPT input values. The GOTHIC thermal conductivity input values were taken directly from the CONTEMPT input deck. The CONTEMPT volumetric heat capacity input values were converted to the required density and specific heat input values. The density input values for concrete, carbon steel and stainless steel were taken from Kreith (Ref. 10); a density of 1.0 lbm/ft^3 was assumed for the paint. The GOTHIC specific heat input values for these materials were

calculated by dividing the CONTEMPT volumetric heat capacity input values by the appropriate density. Though not used, the material property input values for air were also taken from Reference 9 (at a temperature of 32 F). All of the material property input values were entered independent of temperature (similar to the CONTEMPT model).

Material	Density (lbm/ft^3)	Conductivity (BTU/hr-ft-F)	Specific Heat (BTU/lbm-F)
Paint	1	0.25	32.4
Carbon Steel	490	26	0.115
Stainless Steel	488	8	0.116
Concrete	140	0.8	0.206
Air	0.08	0.014	0.24

The conductor initial temperature input values were taken from the Kewaunee CONTEMPT input deck.

The Tagami heat transfer coefficient was used for blowdown and the Uchida heat transfer coefficient was used for post-blowdown condensation. The outside "B" surface of each conductor was modeled as adiabatic. Note, GOTHIC calculates the transient Tagami and Uchida heat transfer coefficient values differently, so this may have an impact on the transient results.

GOTHIC Sump Recirculation Modeling

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

A noding diagram and listing of the Phase 1 GOTHIC containment model input tables for the DEPS min-SI LOCA case are included in Appendix A.

4.0 Phase 1 Transient Comparison

As described earlier, the comparison testing was done in two phases. The first phase compares the GOTHIC model results to the CONTEMPT LOCA and MSLB model results.

4.1 LOCA Case

The GOTHIC LOCA benchmark model described in Section 3 was run out 10000 seconds for comparison with the data presented in Table 9 of Reference 11. The comparison plots are shown in Figures 4.1-1 through 4.1-3.

The GOTHIC pressure and vapor temperature transients match to the CONTEMPT model results reasonably well. The CONTEMPT peak pressure and temperature are 59.67 psia and 265.65 F at 168 seconds; the GOTHIC peak pressure and temperature are 59.99 psia and 266.06 F at 169

seconds. The first CONTEMPT data point is at 5 seconds; this accounts for the difference in the early part of the transient (between 1 and 5 seconds on the log plot).

The sump liquid temperature response calculated by GOTHIC is different than CONTEMPT. GOTHIC predicts an initially slower increase in the sump temperature, however, by the end of blowdown, the sump temperature calculated by GOTHIC exceeds the value calculated by CONTEMPT. The GOTHIC sump temperature remains higher than CONTEMPT until the start of recirculation, then both decrease at approximately the same rate.

The difference in the sump liquid temperature response is a result of the better method for modeling drops and interfacial heat and mass transfer in GOTHIC. Heat and mass transfer between the atmosphere to the droplet portion of the break liquid allows for more energy deposition in the sump. While this raises the sump temperature, it also helps maintain the atmosphere temperature at saturation.

The results of this comparison are similar to other GOTHIC/CONTEMPT LOCA transient comparisons performed by other utilities, i.e. the pressure and vapor temperature match very well and the GOTHIC sump liquid temperature is higher.

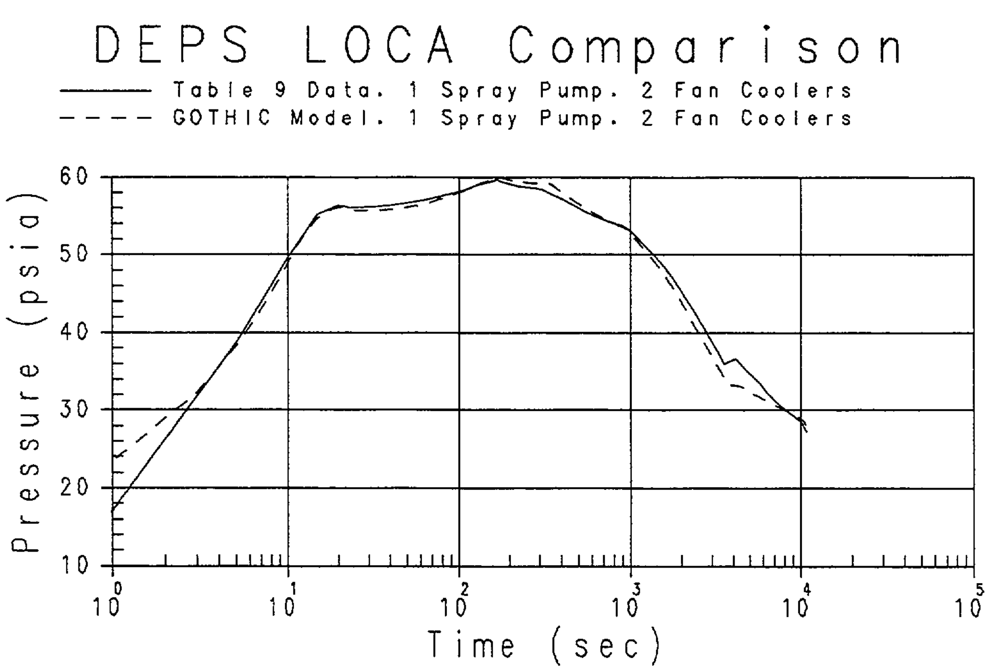


Figure 4.1-1 DEPS LOCA Pressure Comparison

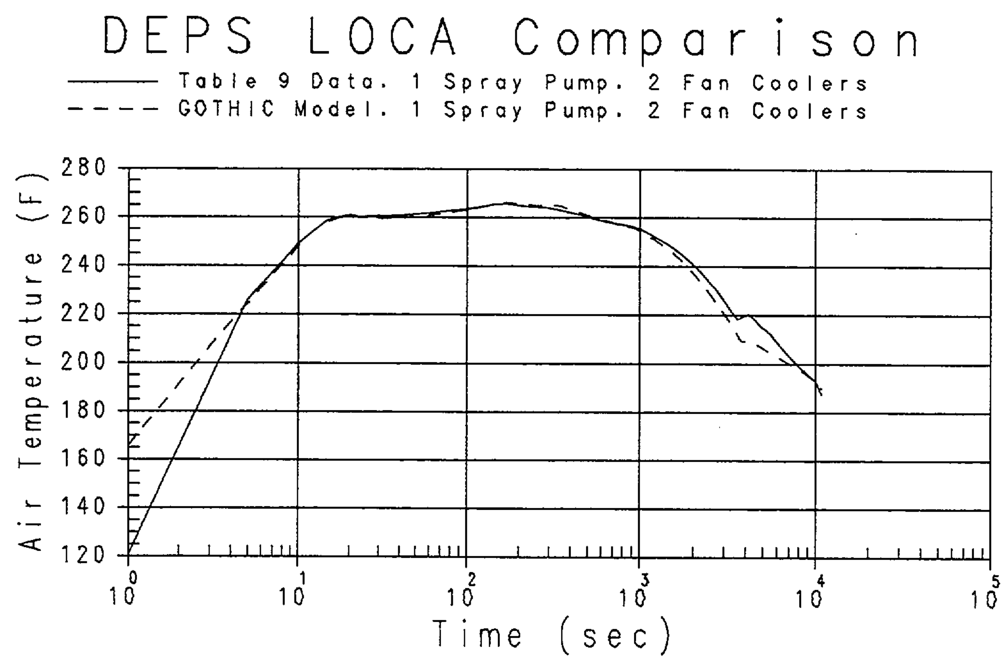


Figure 4.1-2 DEPS LOCA Vapor Temperature Comparison

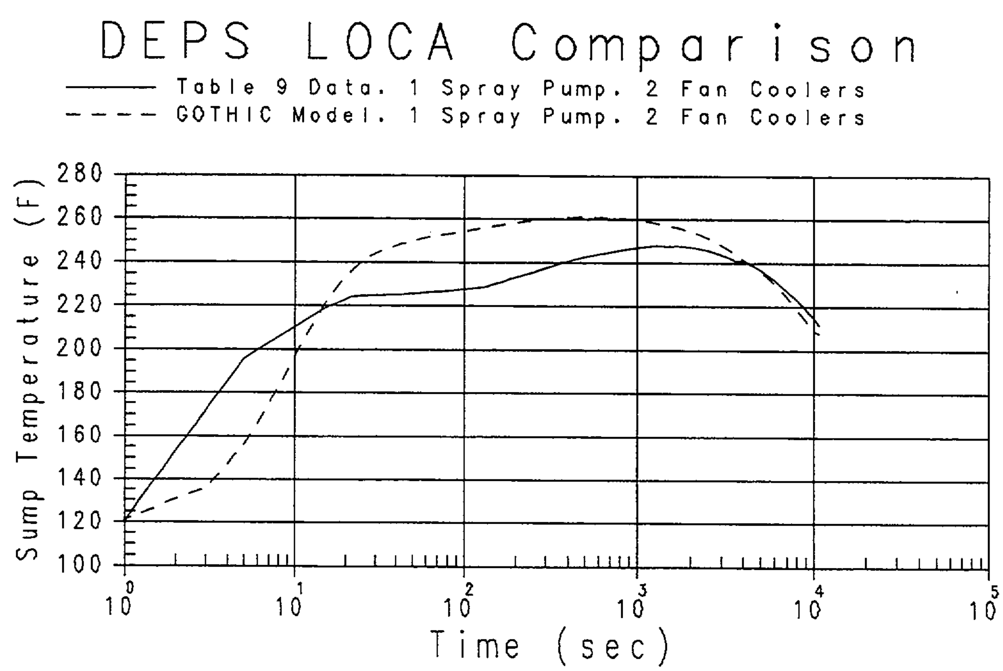


Figure 4.1-3 DEPS LOCA Sump Liquid Temperature Comparison

4.2 MSLB Cases

The GOTHIC LOCA containment model input described in Section 3 and shown in Appendix A was modified to run both the MSLB peak pressure and peak temperature cases. The additional MSLB heat sinks described in Section 3 were added to the model. The recirculation volumes, [ ]^{a,c} were eliminated since these items are not required for design basis MSLB analyses. The MSLB steam mass and energy releases, representing blowdown from the steam generators, were input into the LOCA two-phase mass flow rate and enthalpy function tables. The MSLB steam mass and energy releases, representing reverse flow from the turbine prior to MSIV closure, were input into the LOCA liquid mass flow rate and enthalpy function tables. Other changes that were made included revising the Tagami peak time and energy, revising the setpoints for fan cooler and spray actuation, revising the initial conditions, and setting the revaporization fraction to 8% to match the CONTEMPT model input.

The MSLB peak pressure transient is based on the mass and energy releases from a full double-ended rupture of a main steam line, including a failure of the feedwater isolation valve, while operating at 102% power. Comparisons of the GOTHIC and CONTEMPT calculated MSLB peak pressure transient pressure, gas temperature, sump temperature, and fan cooler heat removal are shown in Figures 4.2-1 through 4.2-4.

The GOTHIC pressure and vapor temperature transients match the CONTEMPT model results reasonably well. The GOTHIC calculated peak pressure is 60.7 psia (right at design, 46 psig); the CONTEMPT peak pressure is 60.2 psia.

The sump liquid temperature response calculated by GOTHIC is different than CONTEMPT. The GOTHIC sump liquid temperature increases more quickly, then remains a little higher than CONTEMPT for the remainder of the transient. As explained in the LOCA results comparison, this difference is a result of the better method for modeling drops and interfacial heat and mass transfer in GOTHIC.

The MSLB peak temperature transient is based on the mass and energy releases from a 1.0 ft^2 break in the main steam line, including a loss of offsite power and failure of the MSIV, while operating at 102% power. Comparisons of the GOTHIC and CONTEMPT calculated MSLB peak temperature transient pressure, gas temperature, sump temperature, and fan cooler heat removal are shown in Figures 4.2-5 through 4.2-8.

GOTHIC predicts a lower pressure (37 psia at 546 seconds vs. 39.3 psia at 540 seconds) and vapor temperature (268.7 F at 340.1 seconds vs. 297 F at 540 seconds) than CONTEMPT for the MSLB peak temperature case. CONTEMPT predicts containment pressure to reach the spray setpoint at about 440 seconds, and spray begins to inject at about 540 seconds; GOTHIC does not reach the spray setpoint.

Comparisons with various test data simulating steam line breaks inside containment indicate that the GOTHIC code/model predicts higher than measured vapor temperatures (Ref. 5). This suggests that the CONTEMPT code results are overly conservative.

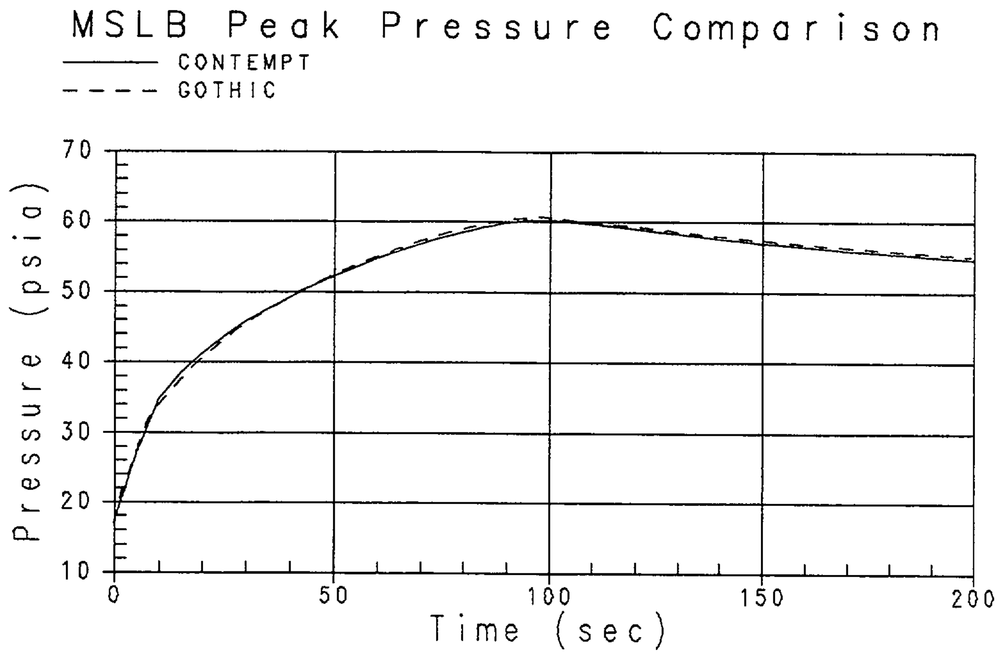


Figure 4.2-1 Containment Pressure Comparison for MSLB Peak Pressure Case

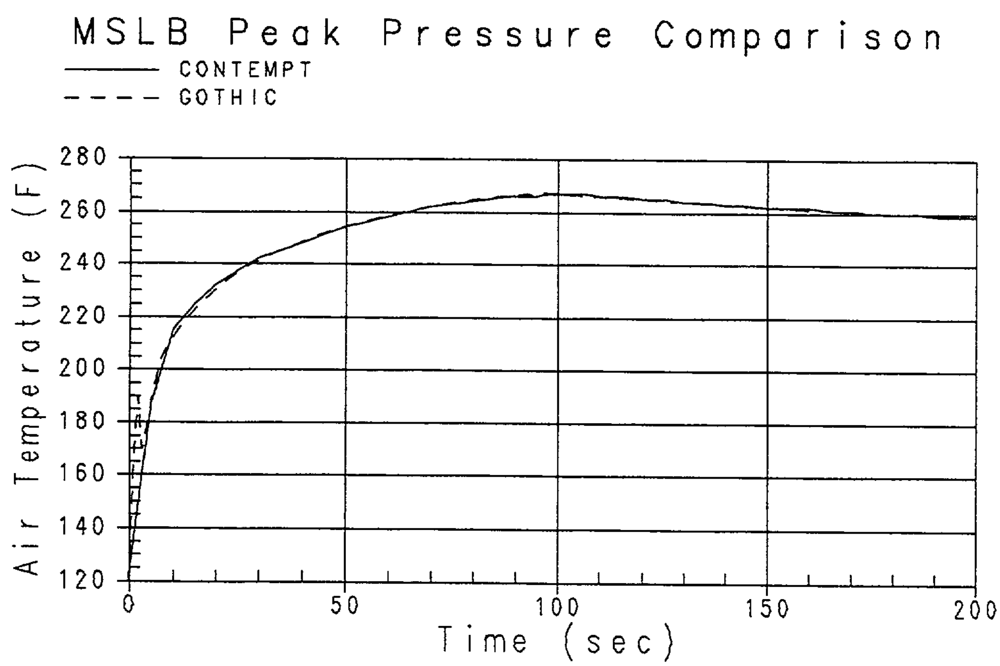


Figure 4.2-2 Containment Temperature Comparison for MSLB Peak Pressure Case

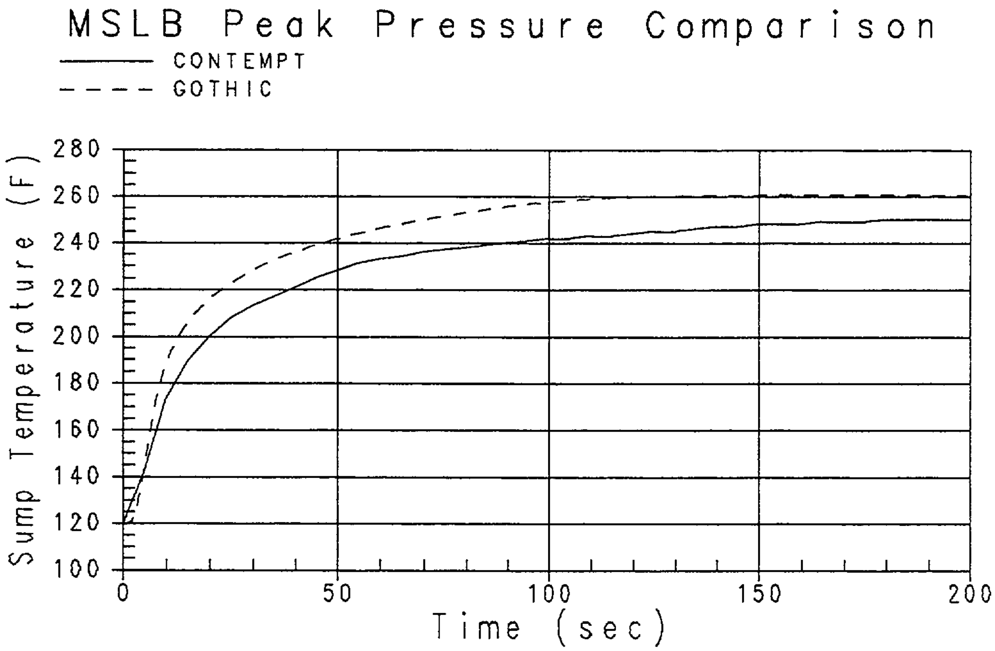


Figure 4.2-3 Containment Sump Temperature Comparison for MSLB Peak Pressure Case

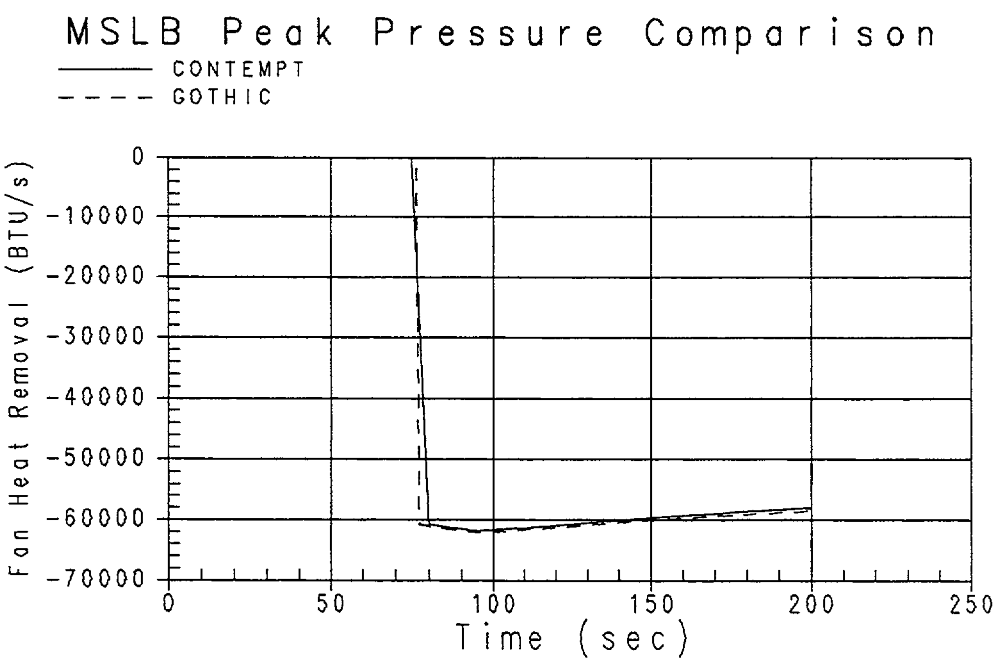


Figure 4.2-4 Fan Cooler Heat Removal Comparison for MSLB Peak Pressure Case

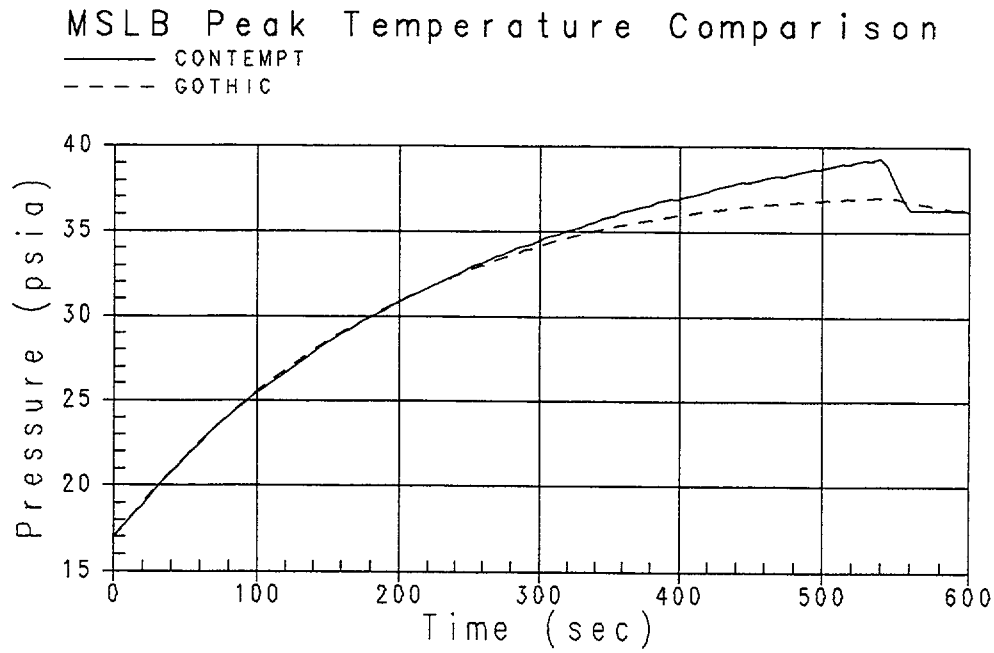


Figure 4.2-5 Containment Pressure Comparison for MSLB Peak Temperature Case

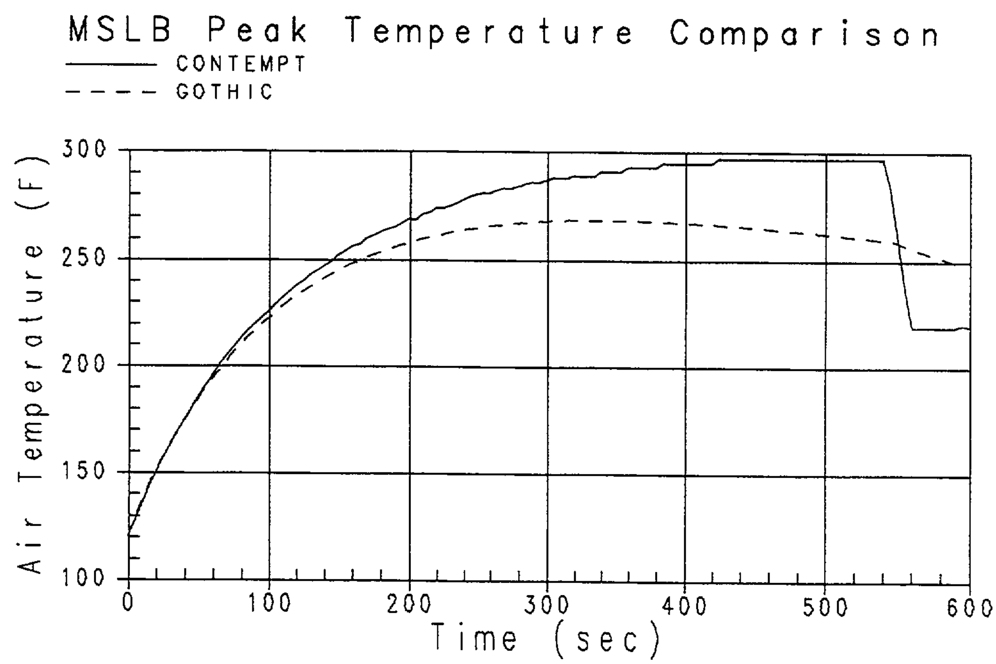


Figure 4.2-6 Containment Temperature Comparison for MSLB Peak Temperature Case

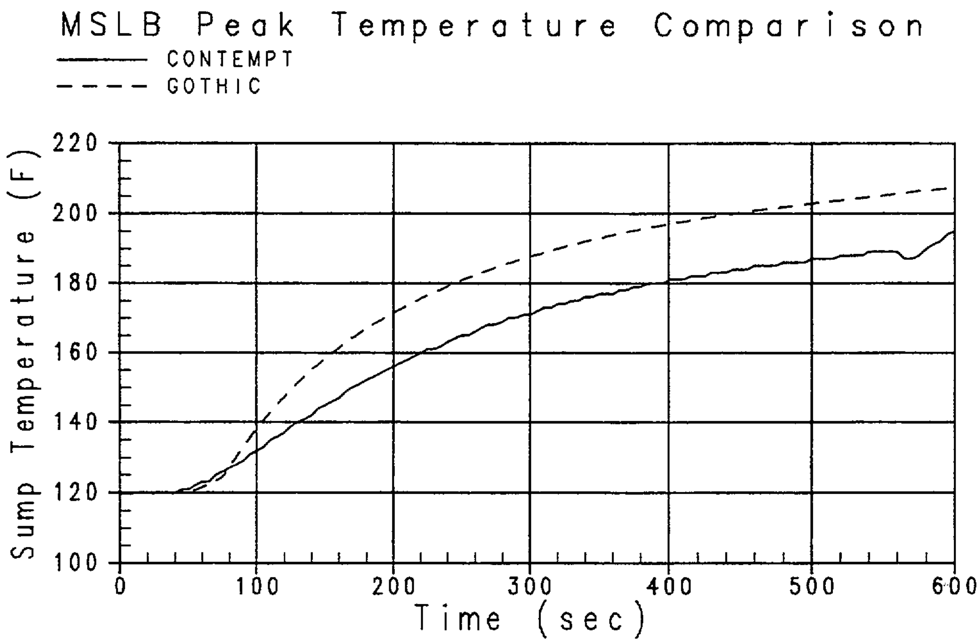


Figure 4.2-7 Sump Temperature Comparison for MSLB Peak Temperature Case

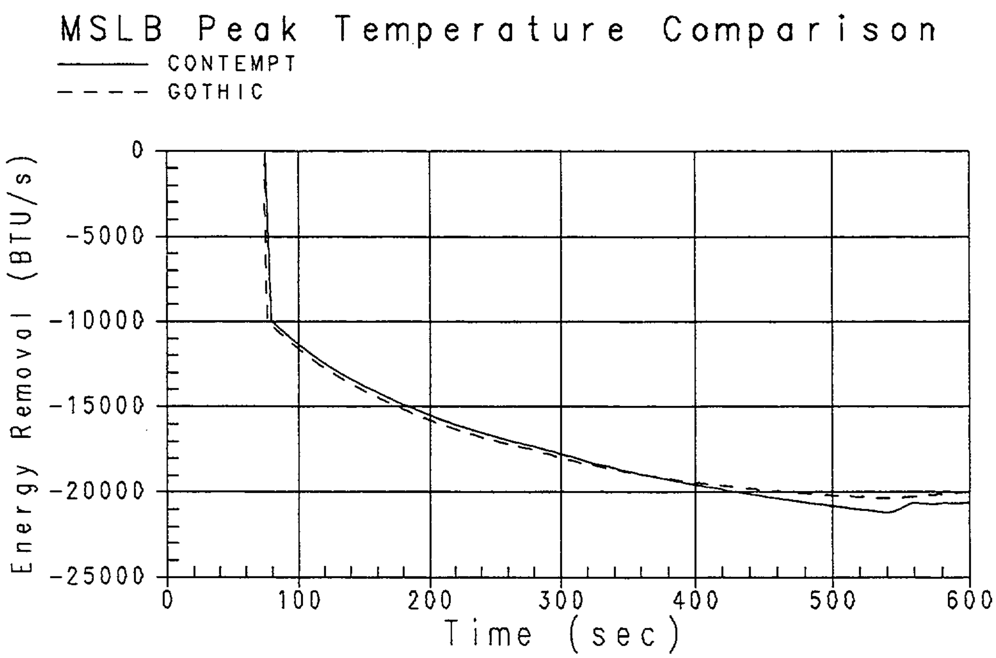


Figure 4.2-8 Fan Cooler Heat Removal Comparison for MSLB Peak Temperature Case

5.0 Phase 2 GOTHIC Containment Model Changes

The CONTEMPT and COCO model input decks were compared to determine differences between the WPS and Westinghouse modeling methodology. Several modeling differences were noted and changes were made to both the CONTEMPT and COCO models to generate more consistent Kewaunee containment models for the LOCA and MSLB transients. In particular, the heat sink data in both models was revised and the LOCA and MSLB mass and energy release input was recalculated to account for the effect of the replacement steam generators.

The Phase 2 GOTHIC LOCA containment model was updated to incorporate the new heat sink data and mass and energy releases from Reference 12. The new heat sink input for the LOCA containment model is listed in the table below.

Kewaunee - Revised Heat
Sinks for LOCA Model

Conductor	Area (ft^2)	Paint (in)	Primer (in)	Steel (in)	Air Gap (in)	Concrete (in)	Total (in)
1	41300	0.008	0.003	1.500	0.000	0.0	1.511
2	17300	0.008	0.003	0.750	0.000	0.0	0.761
3	1260	0.008	0.003	0.250	[ ] a,c	12.0	[ ] a,c
4	1100	0.000	0	0.187	[ ] a,c	12.0	[ ] a,c
5	5500	0.000	0	0.250	[ ] a,c	12.0	[ ] a,c
6	4055	0.008	0.003	0.168	0.000	0.0	0.179
7	16925	0.008	0.003	0.250	0.000	0.0	0.261
8	28500	0.008	0.003	0.375	0.000	0.0	0.386
9	2000	0.000	0.003	0.750	0.000	0.0	0.753
10	500	0.000	0.003	0.996	0.000	0.0	0.999
11	1695	0.008	0.003	0.072	0.000	0.0	0.083
12	12400	0.008	0.003	0.045	0.000	0.0	0.056
13	2000	0.008	0.003	0.050	0.000	0.0	0.061
14	18000	0.008	0.003	0.035	0.000	0.0	0.046
15	2806	0.014	0	0.000	0.000	6.0	6.014
16	12896	0.014	0	0.000	0.000	12.0	12.014
17	18588	0.014	0	0.000	0.000	24.0	24.014
18	1088	0.014	0	0.000	0.000	12.0	12.014
19	28898	0.014	0	0.000	0.000	12.0	12.014
20	6810	0.014	0	0.000	0.000	4.0	4.014

In addition, some of the thermal conductor properties were also changed in the COCO LOCA model to provide more bounding values. These changes were not made in the CONTEMPT MSLB model. The new GOTHIC LOCA model thermal property input values from Reference 12 are listed below:

Material	Density	Conductivity	Specific Heat
Paint	1	0.083	28.8
Primer	1	0.9	28.8
Carbon Steel	490	26	0.115
Stainless Steel	488	8	0.116
Concrete	144	0.8	0.2
Air	0.08	0.014	0.24

A listing of the Phase 2 GOTHIC DEPS input deck is provided in Appendix B.

6.0 Phase 2 Transient Comparison

As described earlier, the comparison testing was done in two phases. The second phase compares the GOTHIC model results to the COCO LOCA (Ref. 12) and CONTEMPT MSLB model results (Ref. 14) for the replacement steam generators.

6.1 LOCA Cases

The first case assumes a DEPS LOCA with a loss of 1 train of safeguards (2 fan coolers @ 5 psig + 85 sec delay, 1 spray pump @ 37.7 psia + 135 sec delay). The GOTHIC LOCA benchmark model with changes as described in Section 5 was run out to 100000 seconds for comparison with the COCO results presented in Reference 12. The comparison plots are shown in Figures 6.1-1 through 6.1-4. The transient event-history is summarized below:

Time	Event
0.0	Large DEPS LOCA Occurs
85.2	Fan Coolers Start
137.8	Spray Injection Begins
3802.0	Transfer to Recirculation Cooling Occurs

GOTHIC predicted a peak pressure of 56.9 psia at 13 seconds; COCO predicted a peak pressure of 57.7 psia at about 60 seconds. GOTHIC also predicted a slightly lower vapor temperature and higher sump temperature after blowdown.

As described previously, GOTHIC contains better interfacial heat and mass transfer models and is able to model the 2-phase break flow phase separation better than COCO. More of the break energy is deposited in the sump with GOTHIC. This results in a higher sump temperature and a lower vapor temperature and pressure.

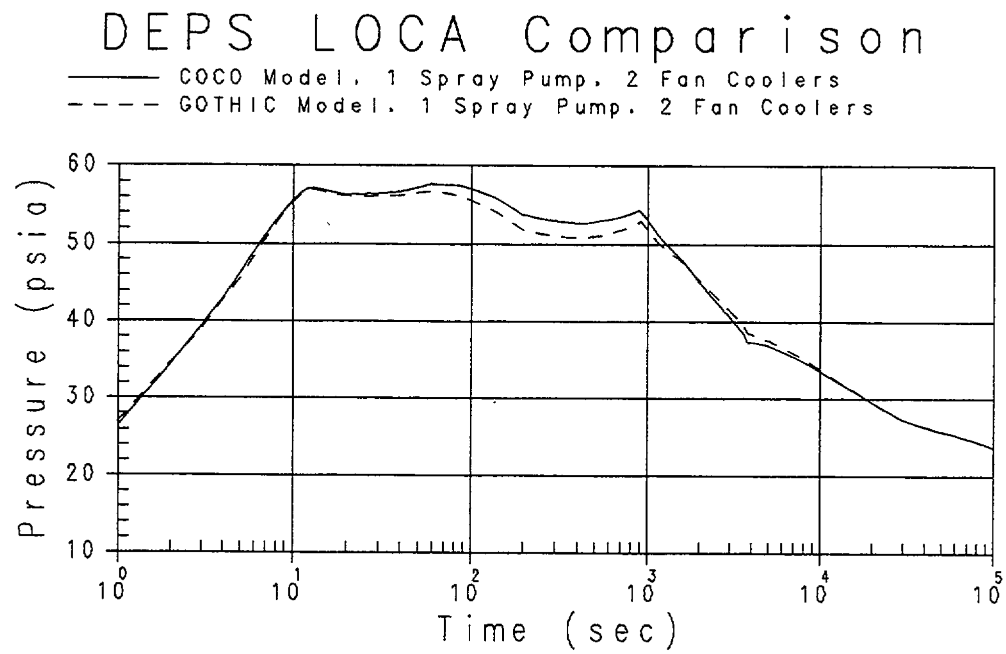


Figure 6.1-1 - DEPS LOCA Pressure

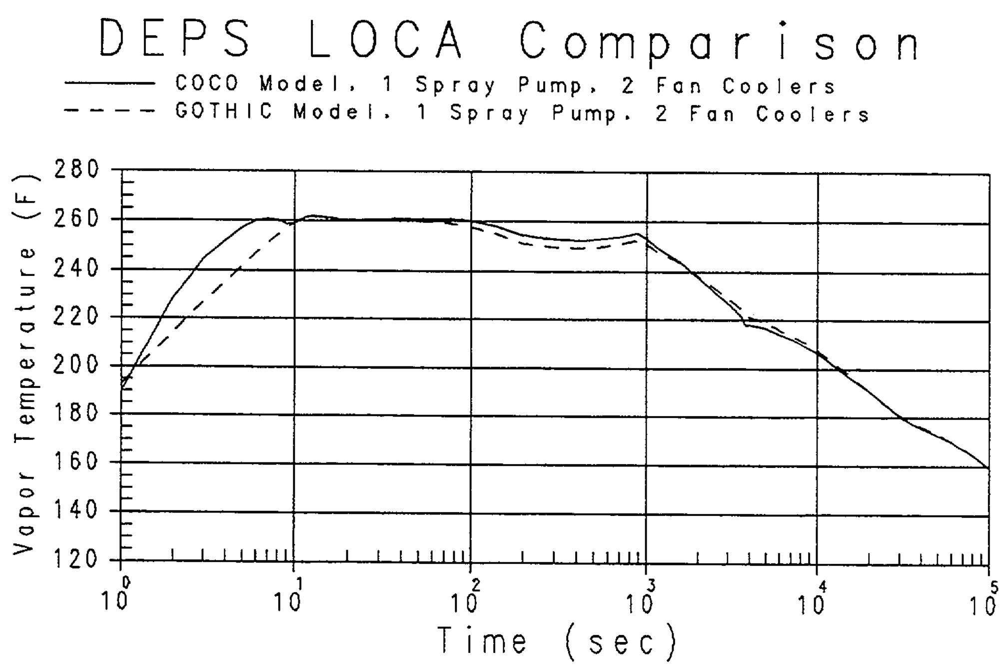


Figure 6.1-2 - DEPS LOCA Vapor Temperature

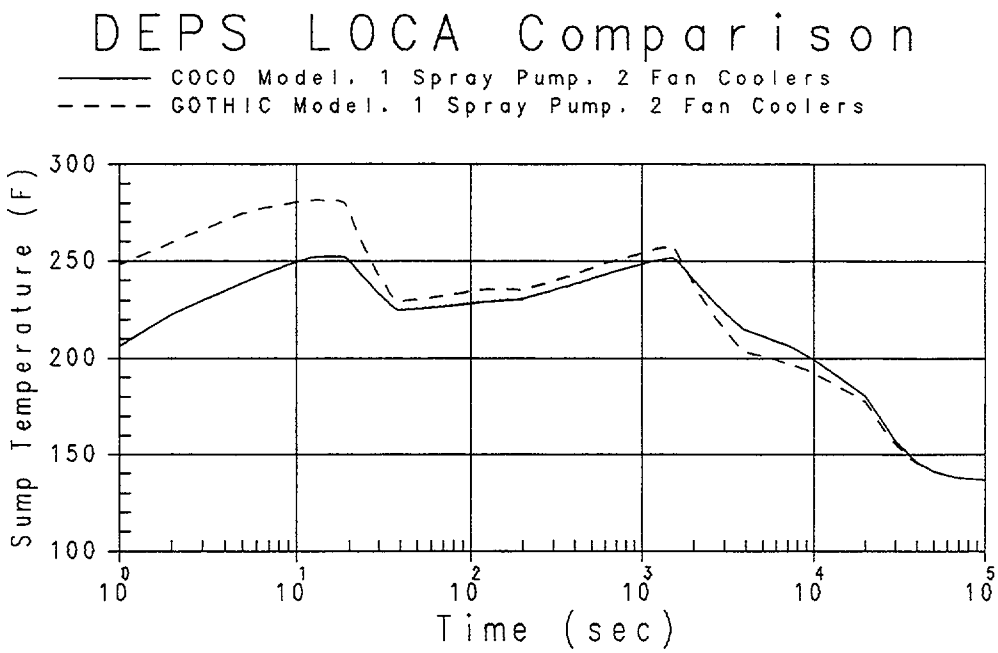


Figure 6.1-3 - DEPS LOCA Sump Temperature

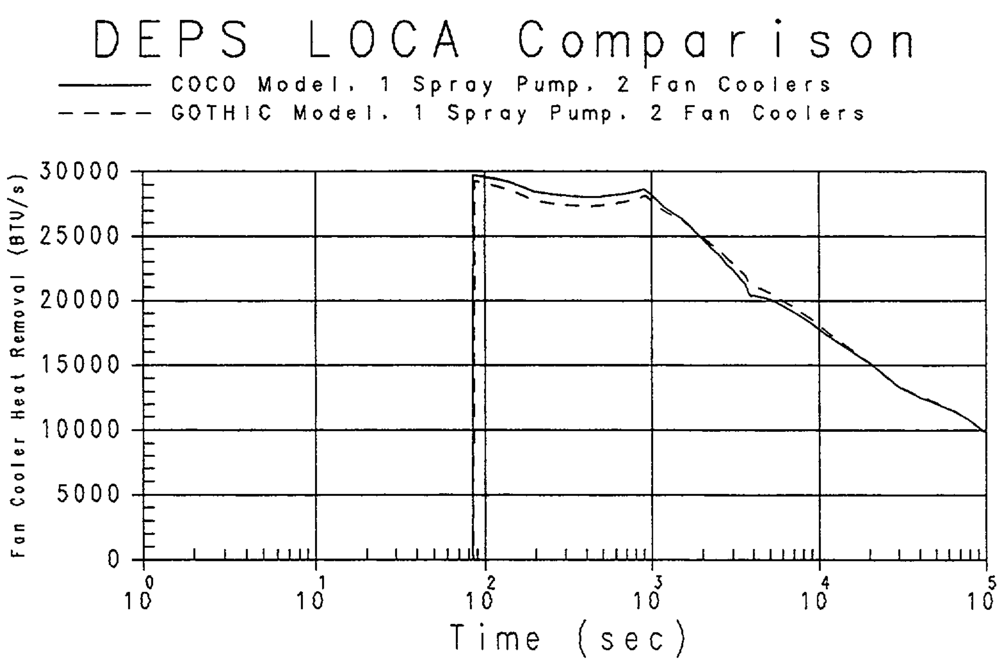


Figure 6.1-4 - DEPS LOCA Fan Heat Removal

A second DEPS LOCA case was run to examine the sensitivity of the GOTHIC phase separation model to the break drop diameter input value. The recommended GOTHIC break drop diameter input value was increased by a factor of 10 (to 0.0394-in).

The comparison with COCO transient results is shown in Figures 6.1-5 through 6.1-8. Increasing the break drop diameter input value resulted in a higher initial calculated pressure and vapor temperature. The GOTHIC calculated peak pressure increased to 57.6 psia (vs. 57.7 psia for COCO), but the time of peak pressure remained unchanged. The GOTHIC sump liquid temperature was slightly lower than the original case, but still remained higher than COCO.

The third case assumes a DEHL LOCA. The DEPS LOCA mass and energy release input tables were replaced with DEHL LOCA mass and energy release input tables (Ref. 12). Since the peak pressure for this case occurs during the blowdown phase (prior to fan cooler or spray actuation), the case is run for only 50 seconds.

The comparison with COCO transient results is shown in Figures 6.1-9 through 6.1-11. Although the pressure response is nearly identical (the GOTHIC peak pressure is 59.5 psia vs. 59.4 psia for COCO), COCO predicts a higher initial vapor temperature and lower sump temperature.

The recommended GOTHIC break drop diameter input value was increased by a factor of 10 and the case was re-run. The comparison with COCO transient results is shown in Figures 6.1-12 through 6.1-14. The larger drop diameter caused the vapor temperature to increase more rapidly and resulted in only a small increase in the GOTHIC peak pressure. The GOTHIC sump liquid temperature was slightly lower than the original case, but still remained higher than COCO.

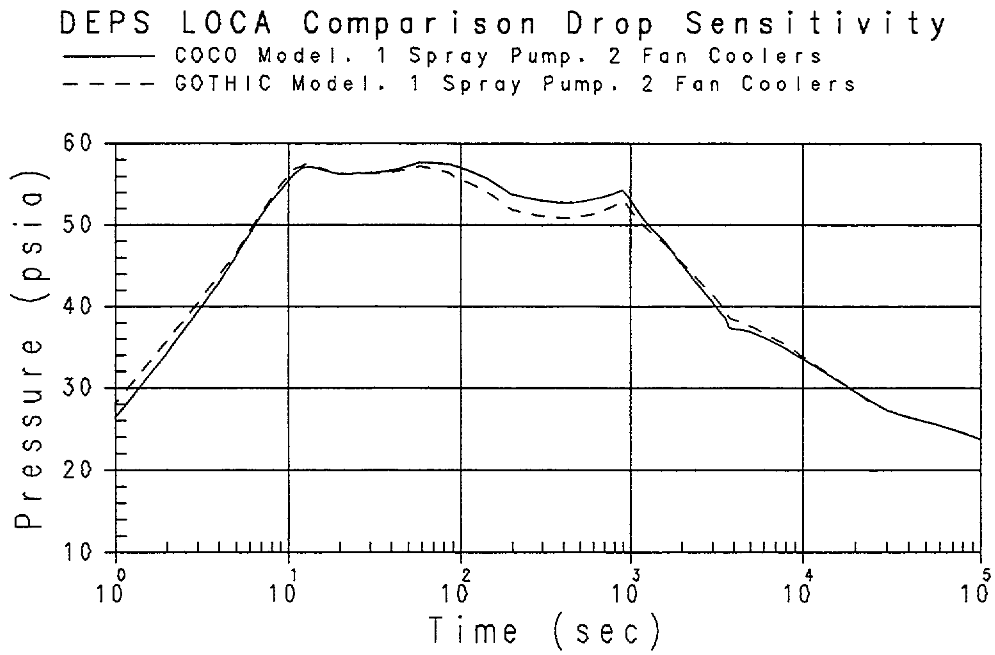


Figure 6.1-5 - Drop Sensitivity Pressure

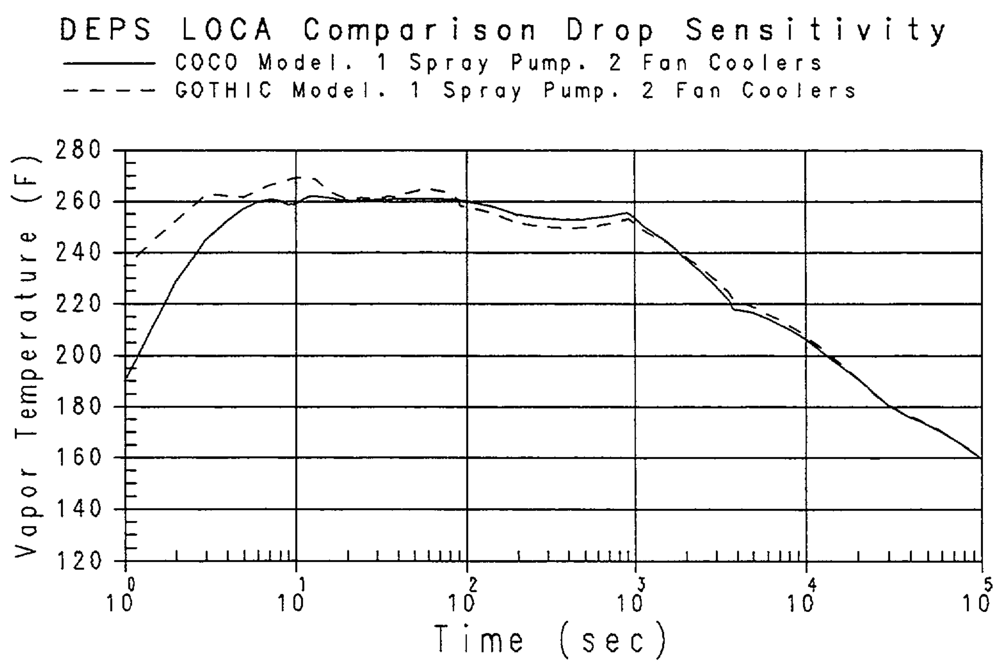


Figure 6.1-6 - Drop Sensitivity Vapor Temperature

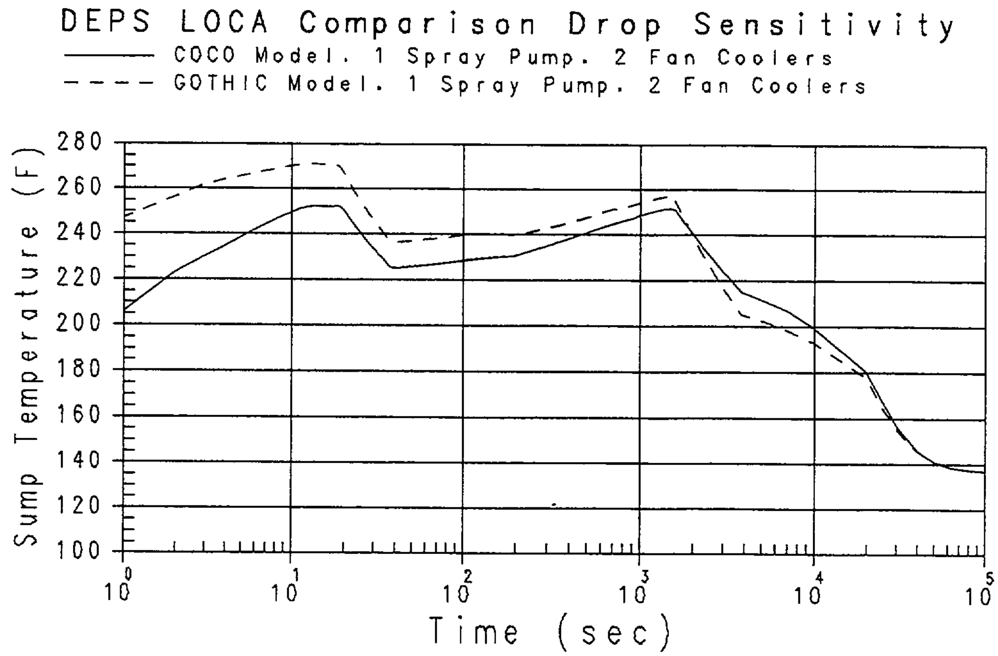


Figure 6.1-7 - Drop Sensitivity Sump Temperature

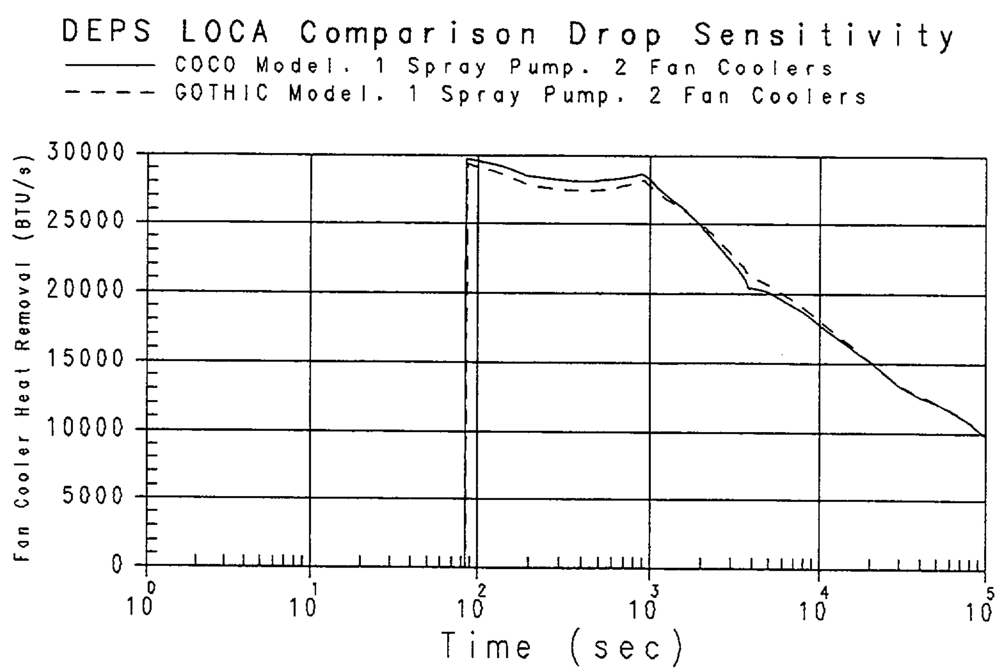


Figure 6.1-8 - Drop Sensitivity Fan Cooler Heat Removal

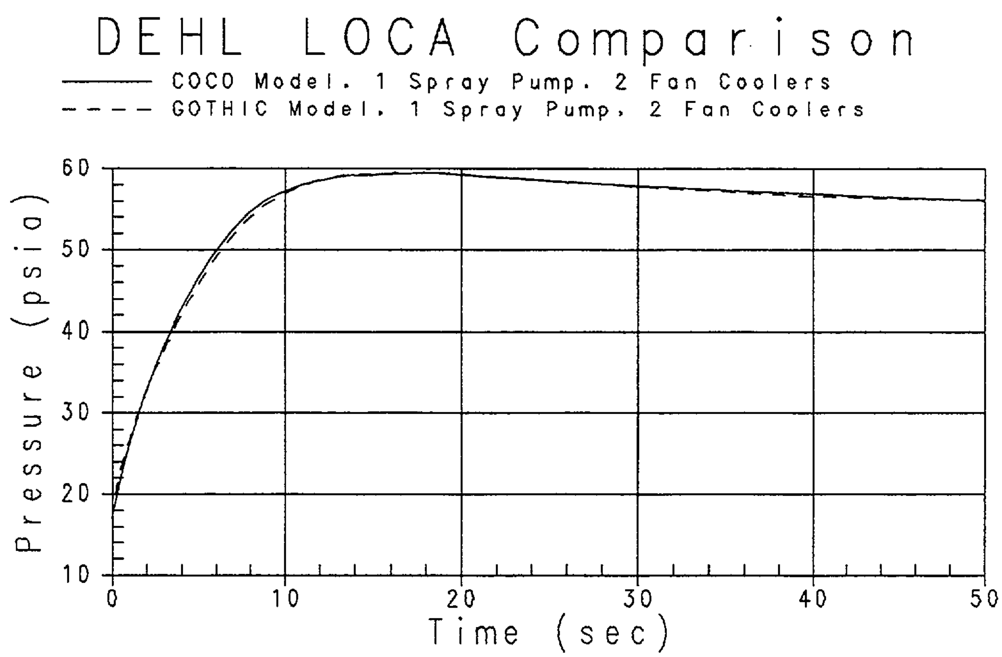


Figure 6.1-9 DEHL LOCA Pressure Comparison

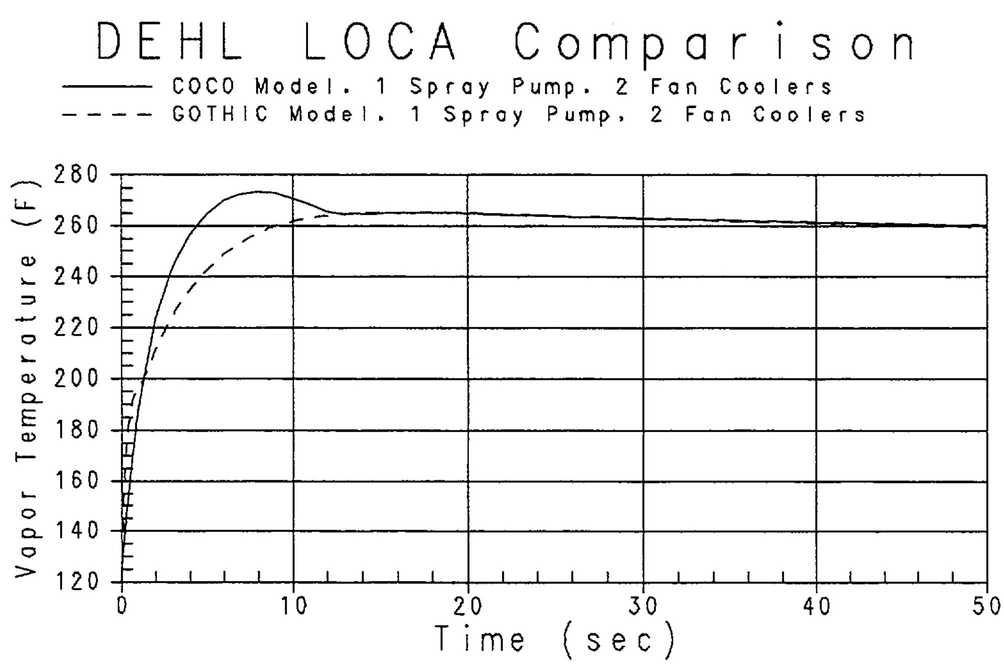


Figure 6.1-10 DEHL LOCA Vapor Temperature Comparison

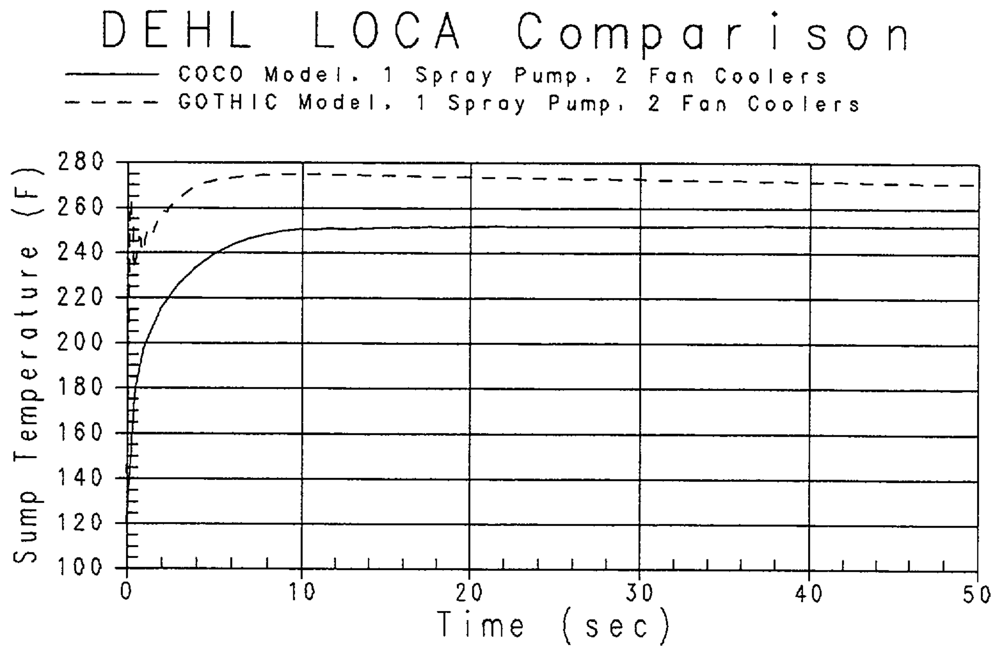


Figure 6.1-11 DEHL LOCA Sump Temperature Comparison

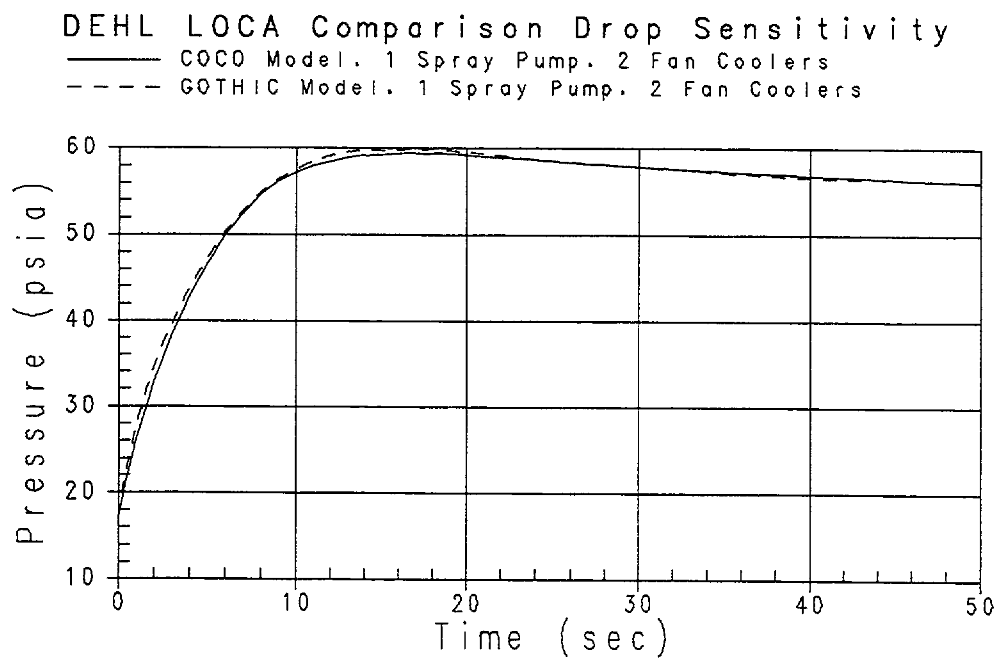


Figure 6.1-12 DEHL LOCA Drop Sensitivity Pressure Comparison

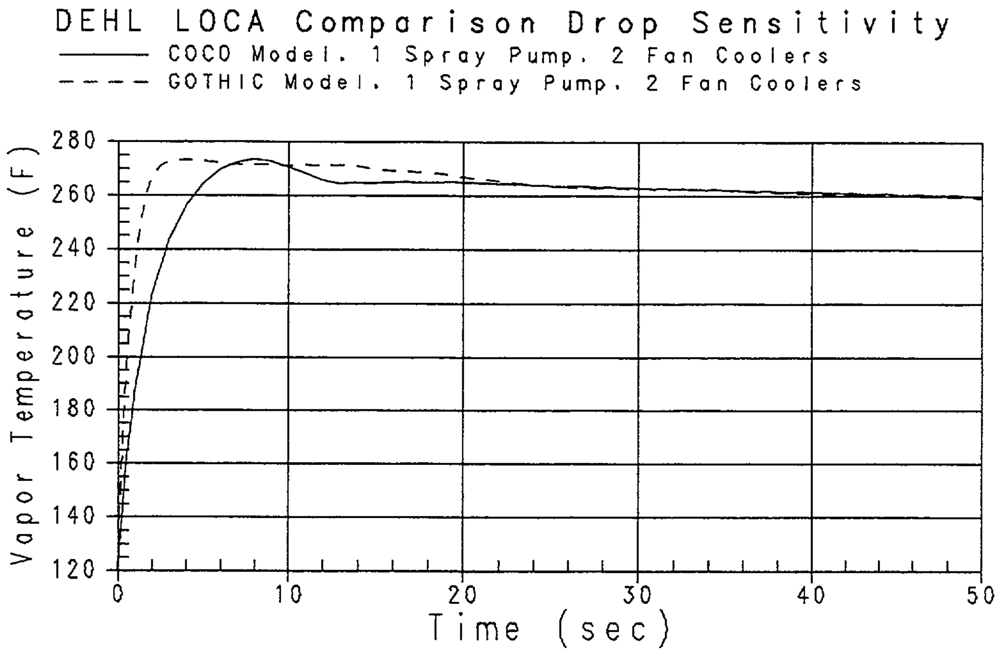


Figure 6.1-13 DEHL LOCA Drop Sensitivity Vapor Temperature Comparison

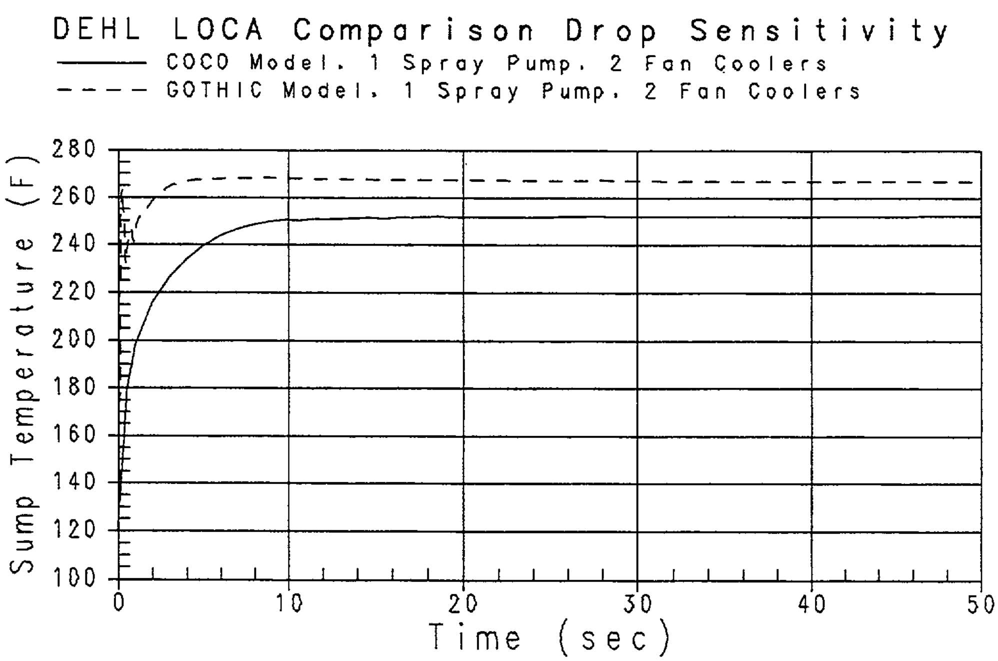


Figure 6.1-14 DEHL LOCA Drop Sensitivity Sump Temperature Comparison

6.2 MSLB Cases

The GOTHIC LOCA containment model input shown in Appendix B was modified to run both the MSLB peak pressure and peak temperature cases. The MSLB heat sinks and conductor properties were revised to match the CONTEMPT model (Ref. 13). The recirculation volumes, [ ] a,c were eliminated since these items are not required for design basis MSLB analyses. The MSLB steam mass and energy releases, representing blowdown from the replacement steam generators (Ref. 13), were input into the LOCA two-phase mass flow rate and enthalpy function tables. The MSLB steam mass and energy releases, representing reverse flow from the turbine prior to MSIV closure (Ref. 13), were input into the LOCA liquid mass flow rate and enthalpy function tables. Other changes that were made included revising the setpoints for fan cooler and spray actuation, revising the initial conditions, and setting the revaporization fraction to 8% to match the CONTEMPT model input (Ref. 13). A listing of the Phase 2 GOTHIC MSLB input deck is provided in Appendix C. Note, the MSLB break mass and enthalpy release data tables (Functions 1 and 2) provided in Appendix C are incomplete. Both of these tables were truncated for printing due to the extraordinarily large quantity of data points.

The MSLB peak pressure transient is based on the mass and energy releases from a 1.4 square foot rupture of a main steam line, including a failure of the feedwater regulating valve, while operating at 102% power. The MSLB peak pressure case was run with full safeguards (4 fan coolers @ 75 sec, 2 spray pumps @ 37.7 psia + 106 sec delay).

Comparisons of the GOTHIC and CONTEMPT calculated MSLB peak pressure transient pressure, gas temperature, sump temperature, sump mass, drop mass, and fan cooler heat removal are shown in Figures 6.2-1 through 6.2-6. GOTHIC predicts nearly the same vapor pressure, temperature and fan cooler heat removal response as CONTEMPT. The GOTHIC calculated peak pressure is 60.9 psia; the CONTEMPT peak pressure is 60.5 psia.

There are differences in the sump temperature and mass; these are related the drop size input value. GOTHIC holds much more liquid in the atmosphere than CONTEMPT. This keeps the atmosphere at saturation, but reduces the sump mass/level.

The break drop diameter input value was increased by a factor of 10 (to 0.0394-in) in a sensitivity case; the comparison is shown in Figures 6.2-7 through 6.2-12. This change resulted in a noticeable improvement in the comparison of the calculated sump and drop mass distribution prior to spray injection. This change also caused an increase in the calculated vapor temperature response prior to spray injection. The change did not noticeably affect the calculated pressure response or fan cooler heat removal.

After the spray starts (at about 130 seconds), the sump mass predictions begin to diverge again. The small spray drop diameter input value that is used in the GOTHIC model to simulate the high spray efficiency input value in CONTEMPT allows a mist to buildup and to remain in the atmosphere instead of falling into the sump. The use of a larger spray drop diameter input for GOTHIC would improve the sump mass comparison after spray initiation.

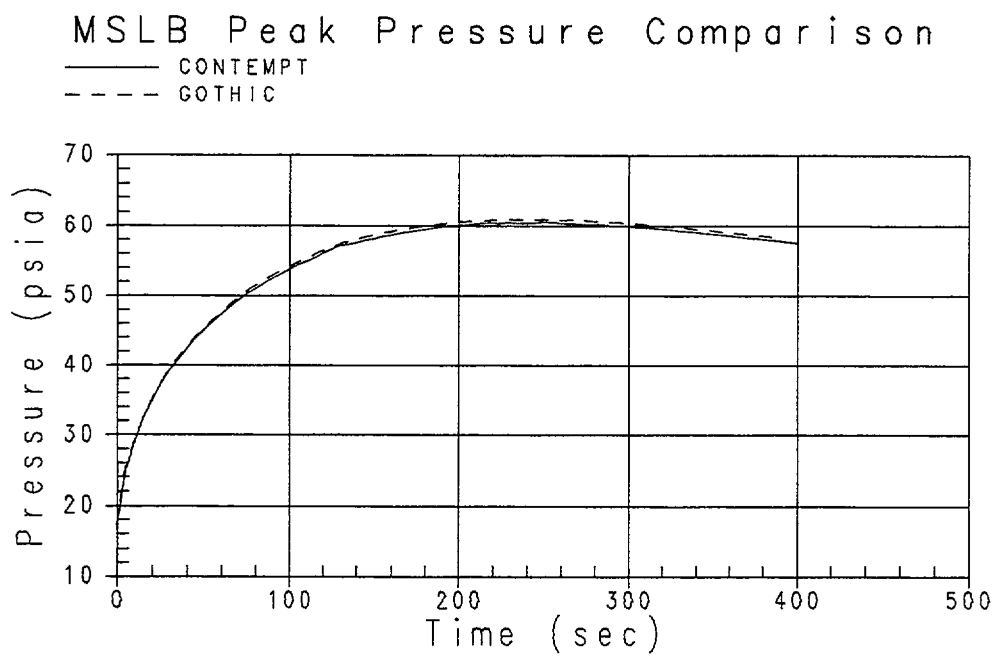


Figure 6.2-1 Containment Pressure Comparison for MSLB Peak Pressure Case

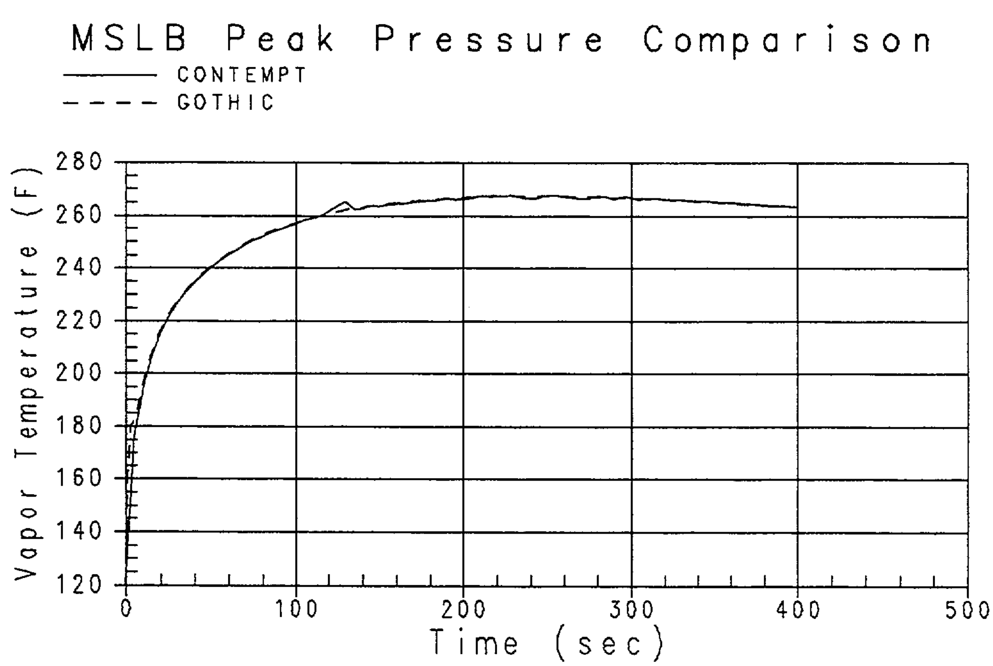


Figure 6.2-2 Containment Vapor Temperature Comparison for MSLB Peak Pressure Case

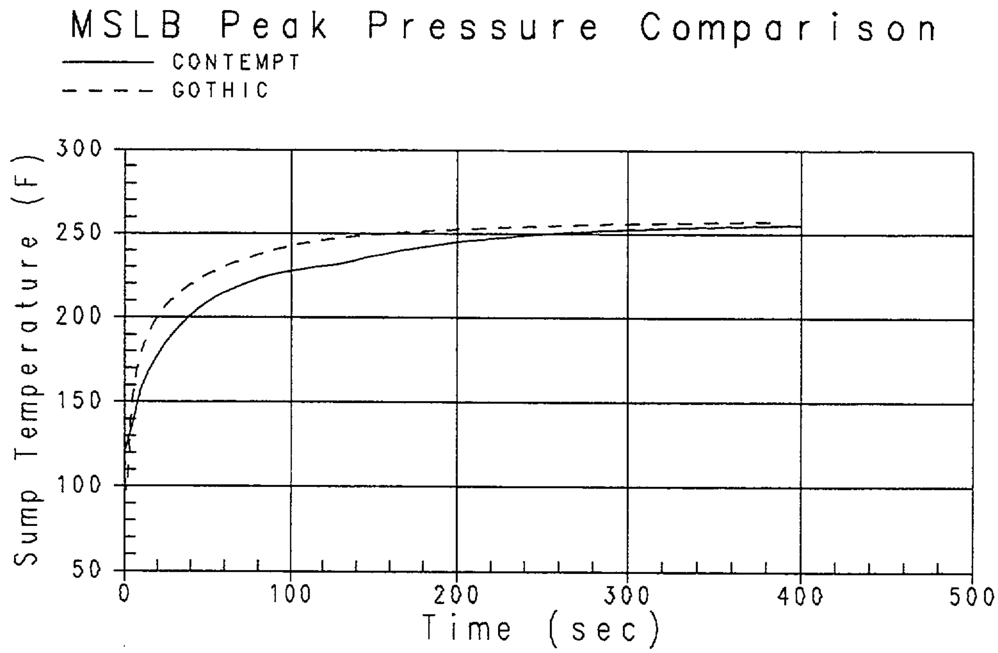


Figure 6.2-3 Sump Temperature Comparison for MSLB Peak Pressure Case

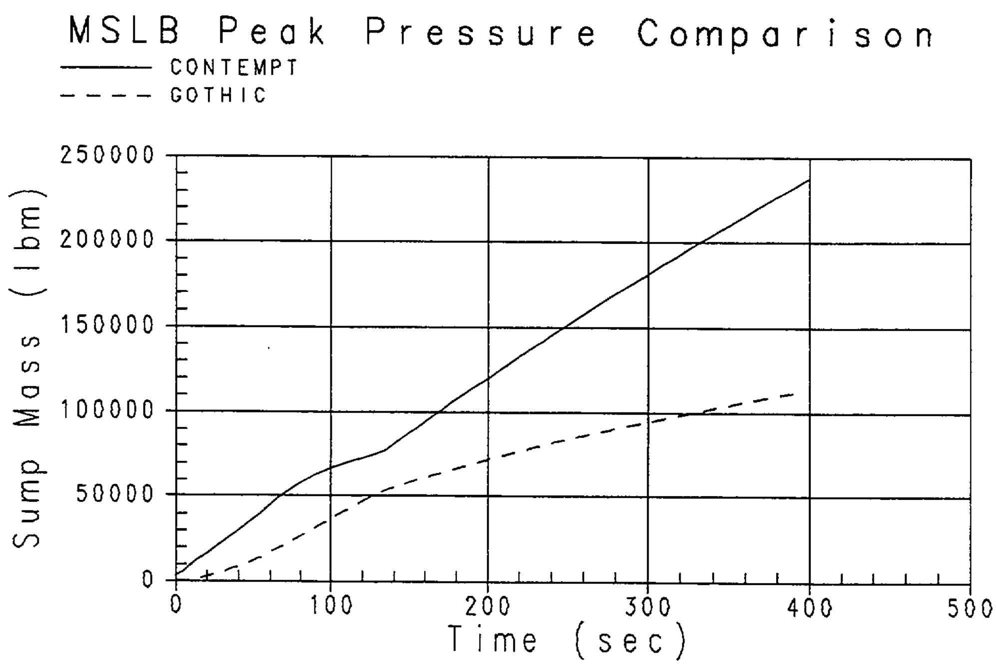


Figure 6.3-4 Sump Mass Comparison for MSLB Peak Pressure Case

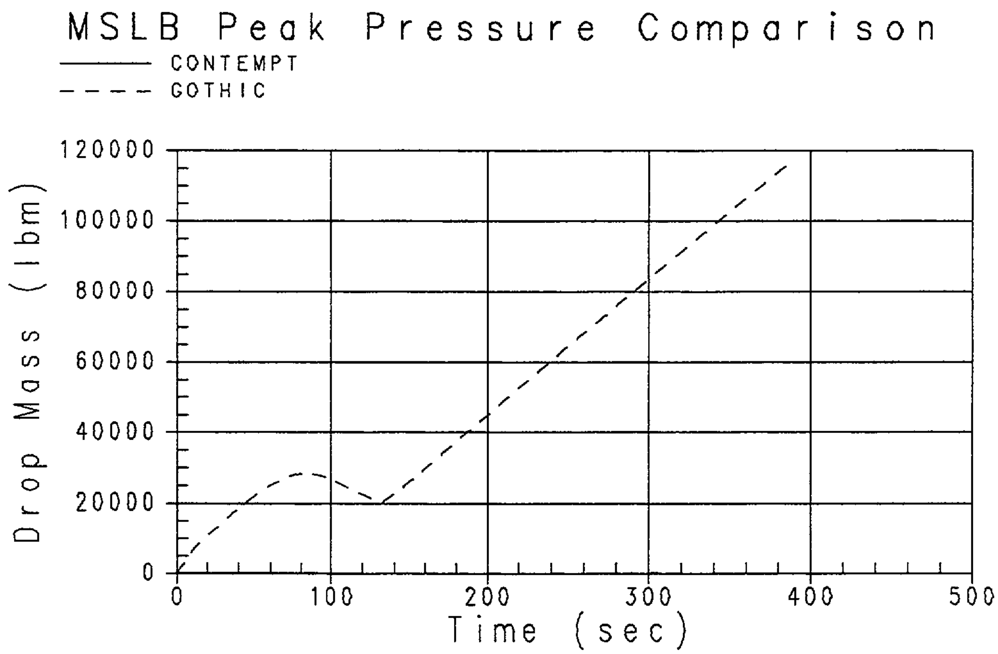


Figure 6.2-5 Drop Mass Comparison for MSLB Peak Pressure Case

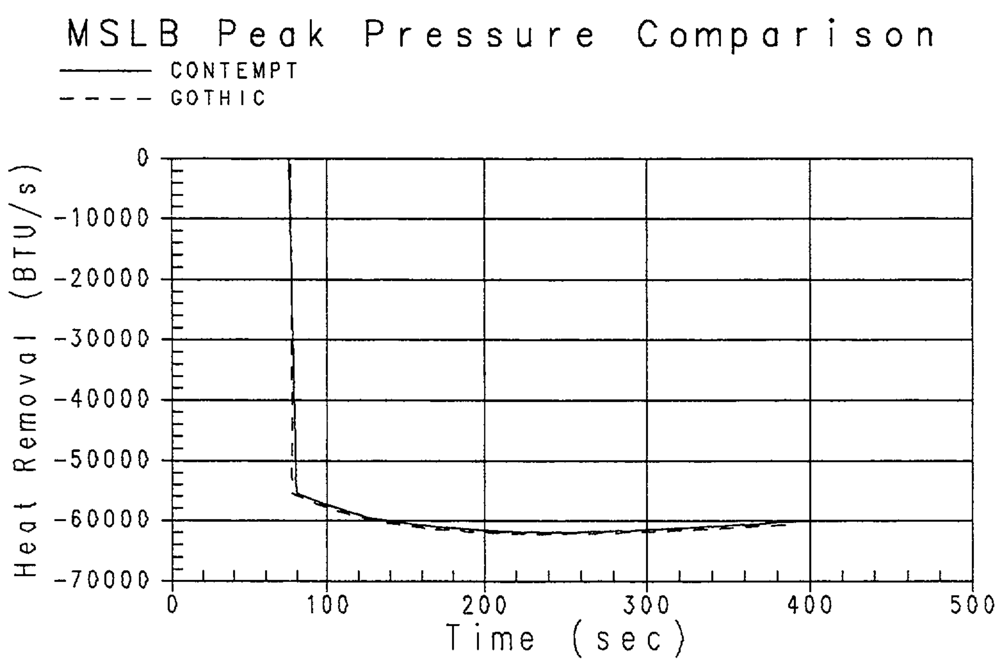


Figure 6.2-6 Fan Cooler Heat Removal Comparison for MSLB Peak Pressure Case

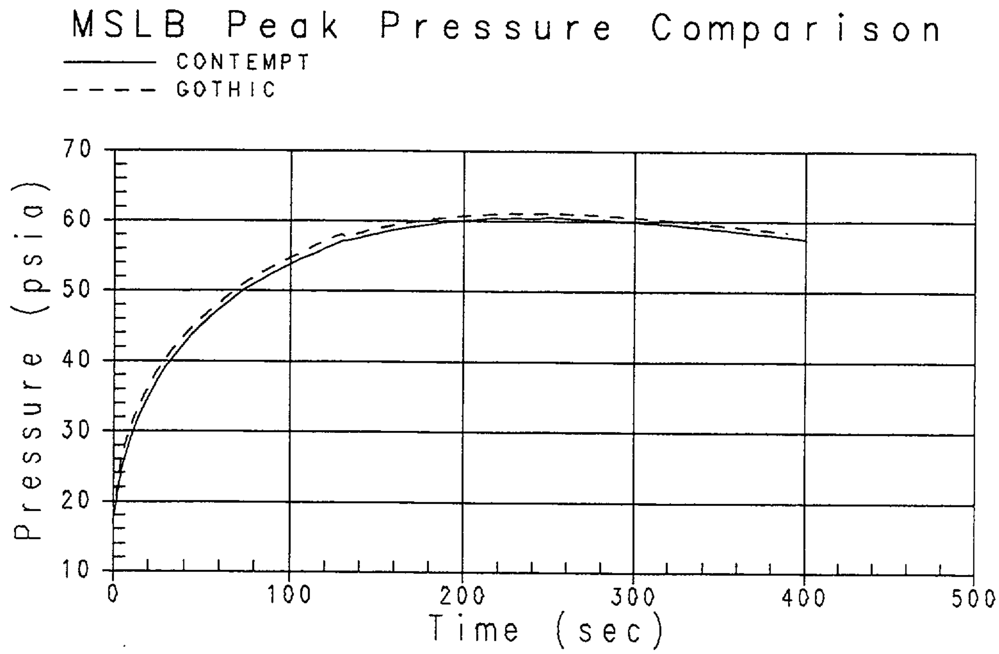


Figure 6.2-7 Drop Sensitivity Pressure Comparison for MSLB Peak Pressure Case

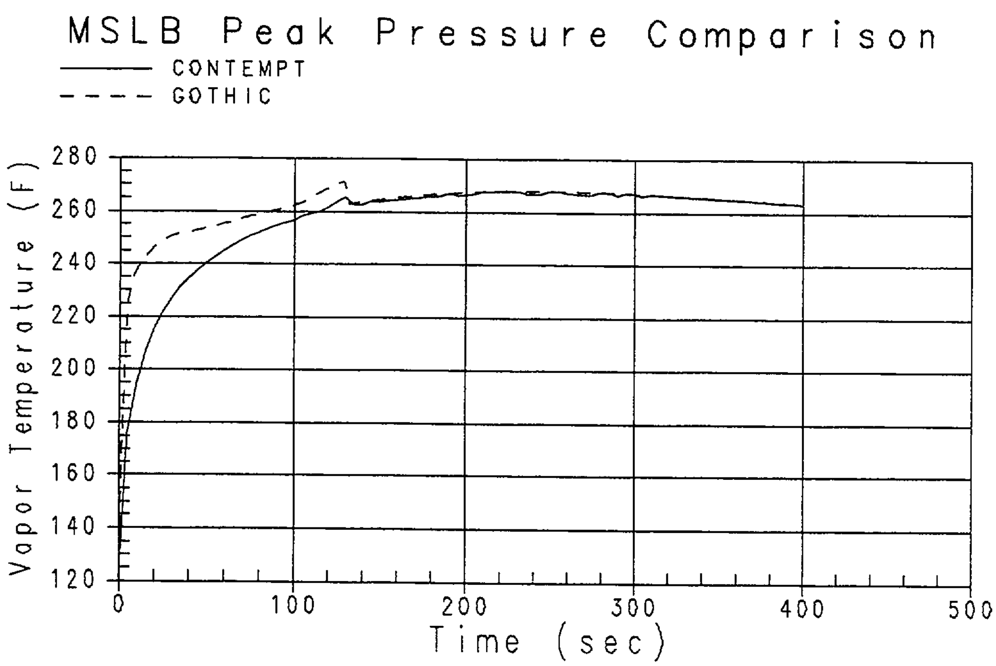


Figure 6.2-8 Drop Sensitivity Temperature Comparison for MSLB Peak Pressure Case

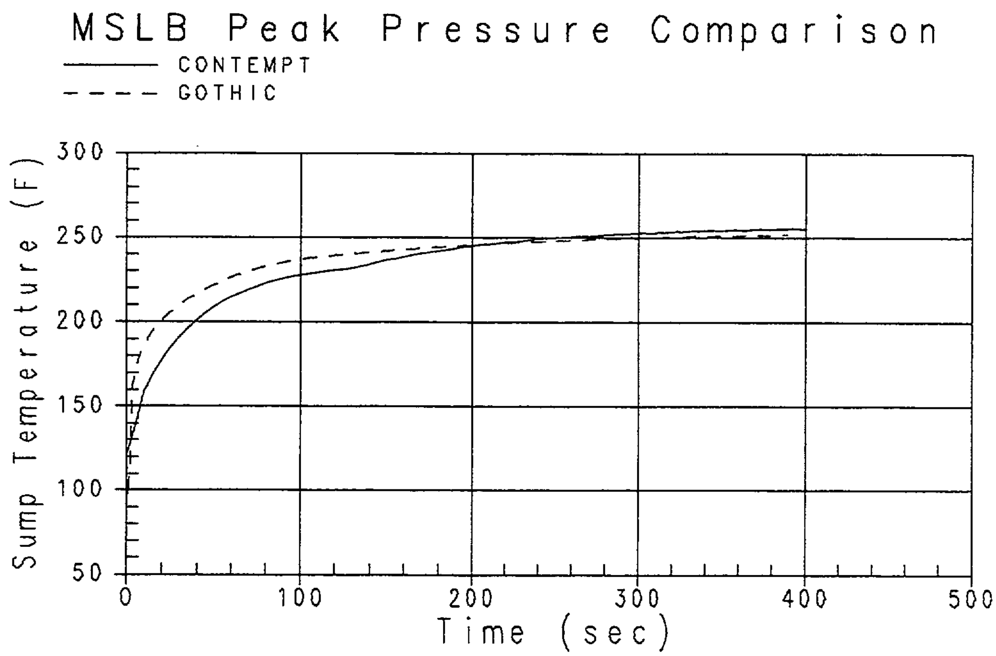


Figure 6.2-9 Drop Sensitivity Sump Temperature Comparison for MSLB Peak Pressure Case

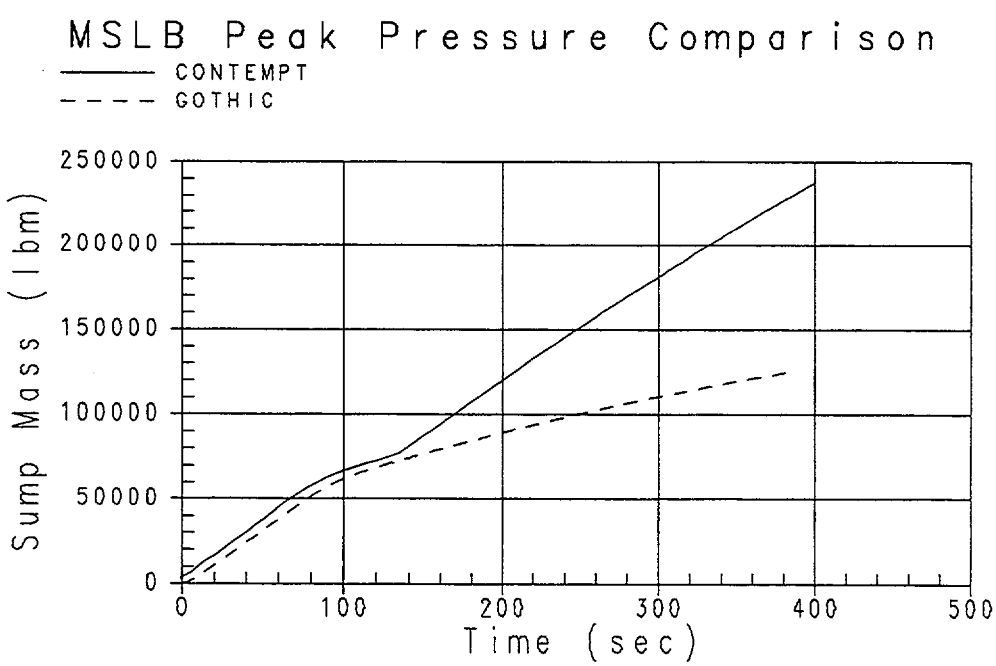


Figure 6.2-10 Drop Sensitivity Sump Mass Comparison for MSLB Peak Pressure Case

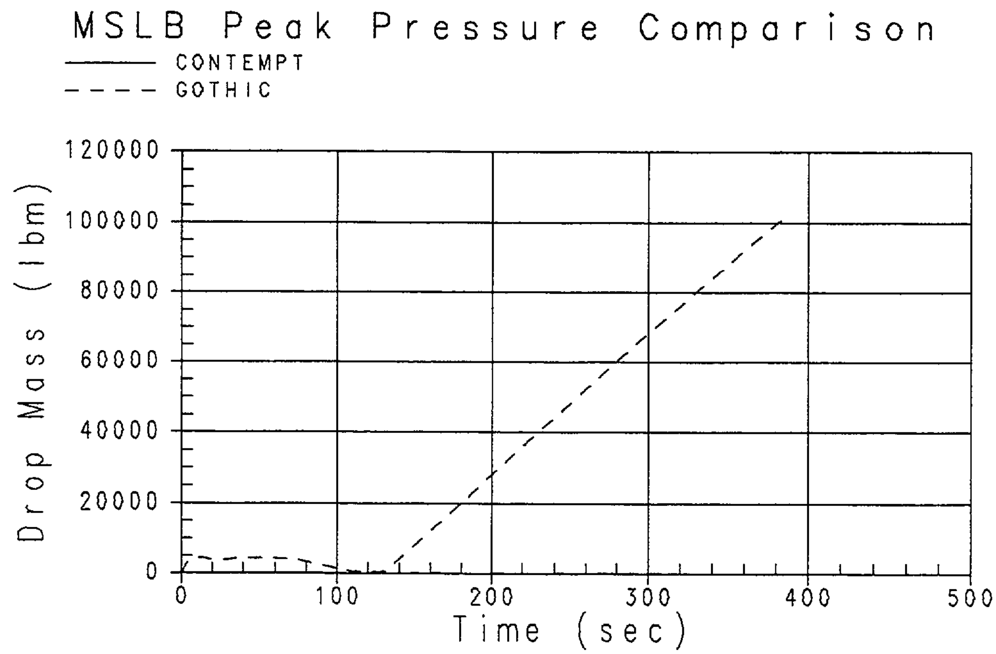


Figure 6.2-11 Drop Sensitivity Drop Mass Comparison for MSLB Peak Pressure Case

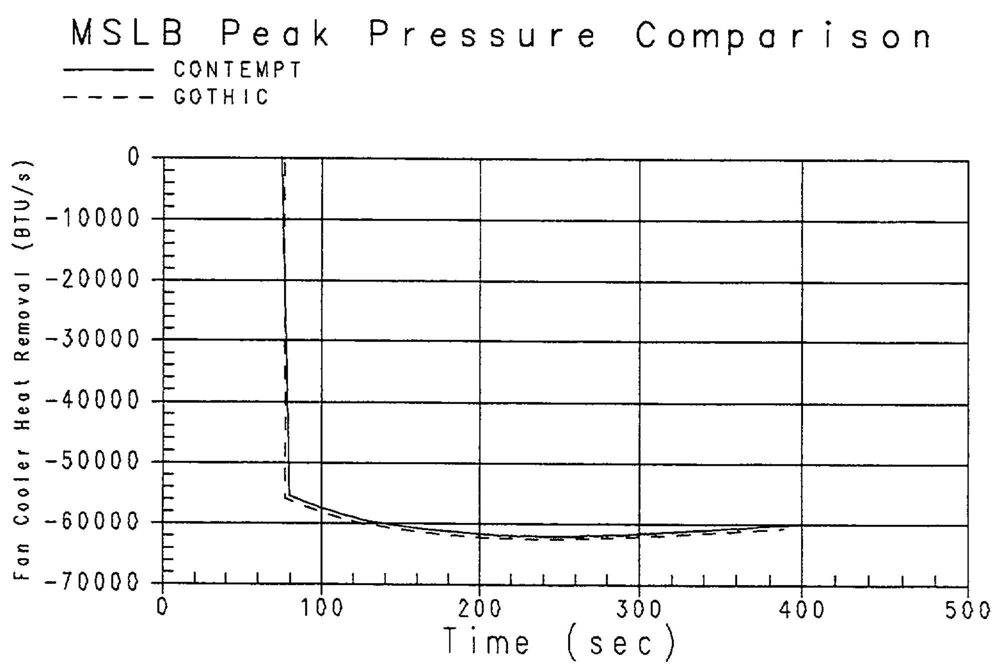


Figure 6.2-12 Drop Sensitivity Fan Cooler Heat Removal Comparison for MSLB Peak Pressure

The MSLB peak temperature transient is based on the mass and energy releases from a 1.1 square foot rupture of a main steam line while operating at 0% power. The MSLB peak temperature case was run assuming a loss of 1 train of safeguards (2 fan coolers, 1 spray pump).

Comparisons of the GOTHIC and CONTEMPT calculated MSLB peak temperature transient pressure, gas temperature, sump temperature, sump mass, drop mass, and fan cooler heat removal are shown in Figures 6.2-13 through 6.2-18. GOTHIC predicts nearly the same vapor pressure and fan cooler heat removal response as CONTEMPT, however, it underpredicts the vapor temperature between 50 seconds and when the spray starts at 130 seconds. There are also differences in the sump temperature and mass; these are related to the drop size input value. GOTHIC holds much more liquid in the atmosphere than CONTEMPT. This keeps the atmosphere at saturation, but reduces the sump mass/level.

The break drop diameter input value was increased by a factor of 10 (to 0.0394-in) in a sensitivity case; the comparison is shown in Figures 6.2-19 through 6.2-24. This change resulted in a noticeable improvement in the comparison of the calculated sump mass distribution prior to spray injection. This change also improved the comparison of the calculated vapor temperature response. GOTHIC predicted a peak temperature of 278.2 F; CONTEMPT predicted a peak temperature of 274.7 F. The change did not noticeably affect the calculated pressure response or fan cooler heat removal.

After the spray starts, the sump mass predictions begin to diverge again. The small spray drop diameter input value that is used in the GOTHIC model to simulate the high spray efficiency input value in CONTEMPT allows a mist to buildup and to remain in the atmosphere instead of falling into the sump. The use of a larger spray drop diameter input for GOTHIC would improve the sump mass comparison after spray initiation.

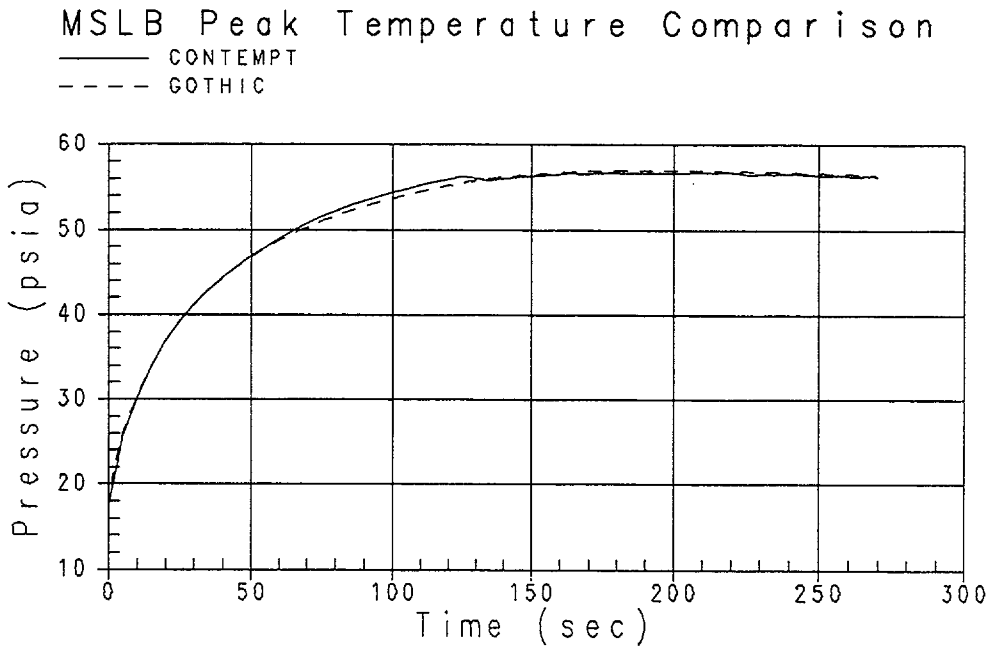


Figure 6.2-13 Containment Pressure

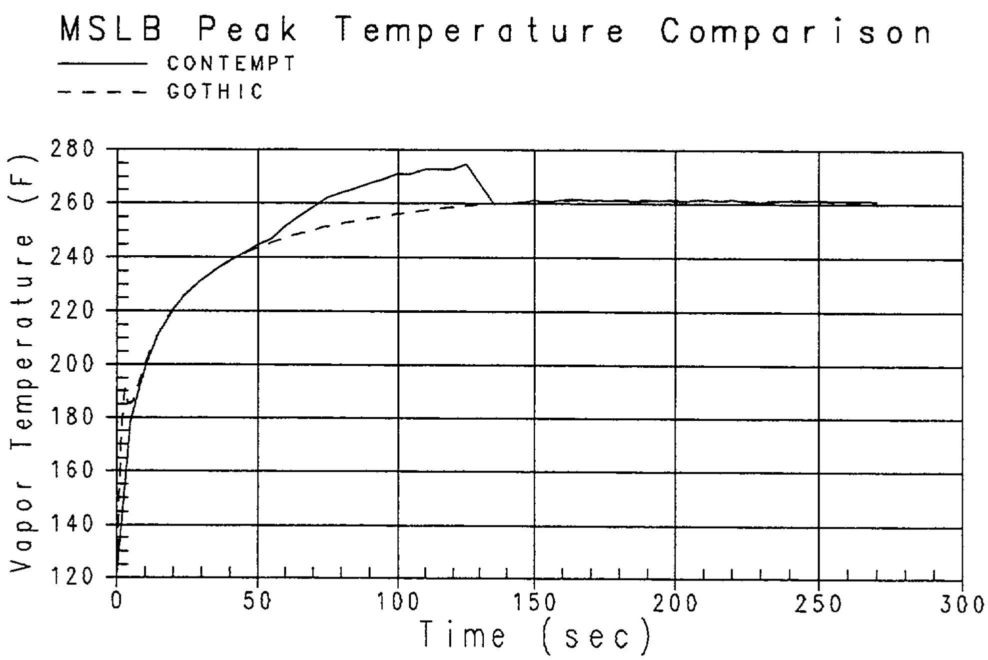


Figure 6.2-14 Vapor Temperature

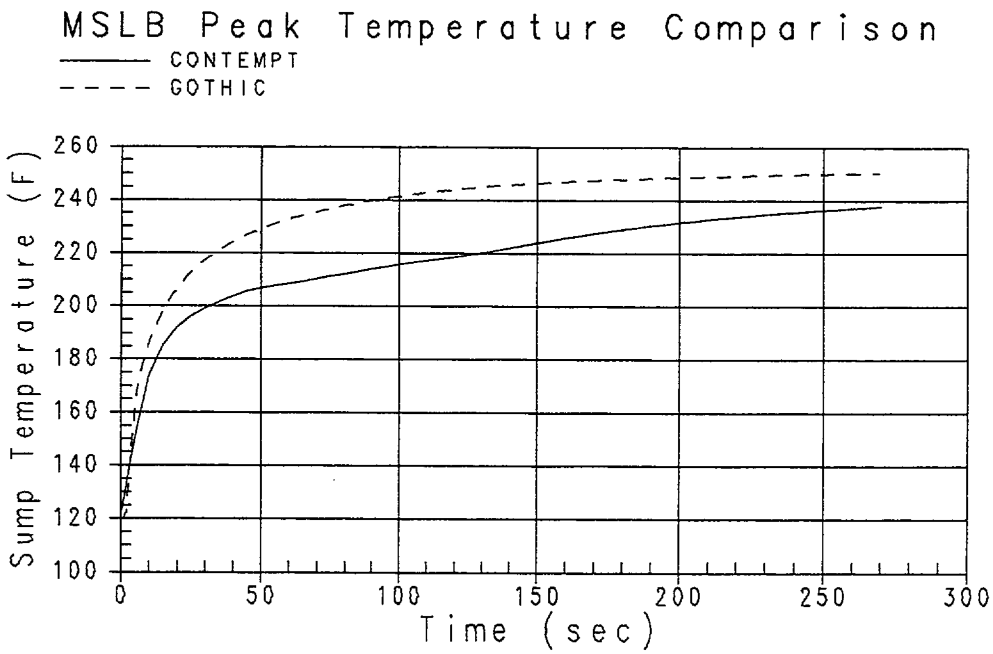


Figure 6.2-15 Sump Temperature

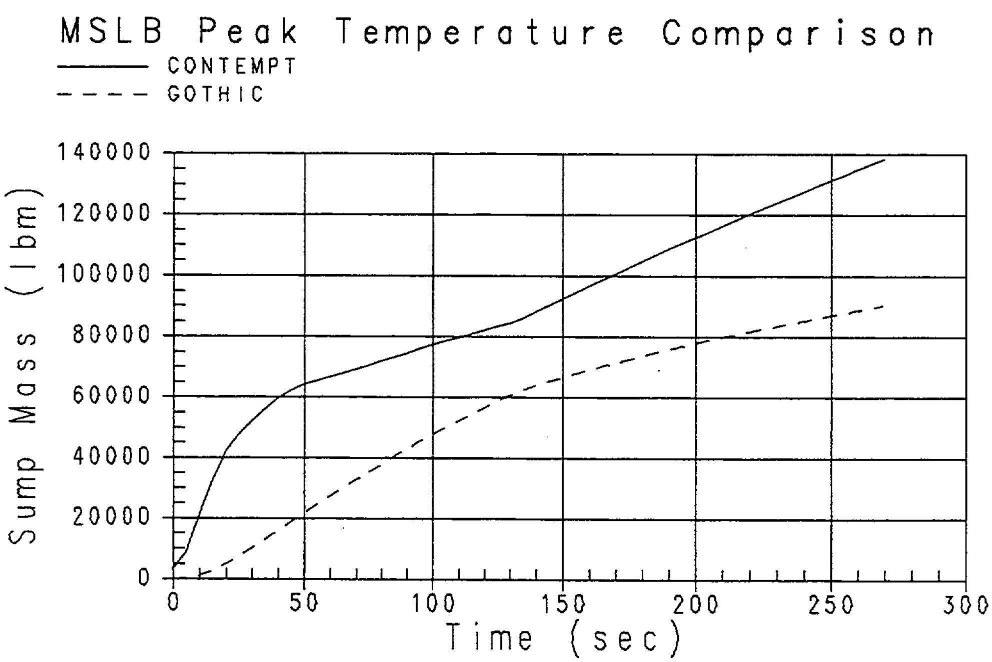


Figure 6.2-16 Sump Mass

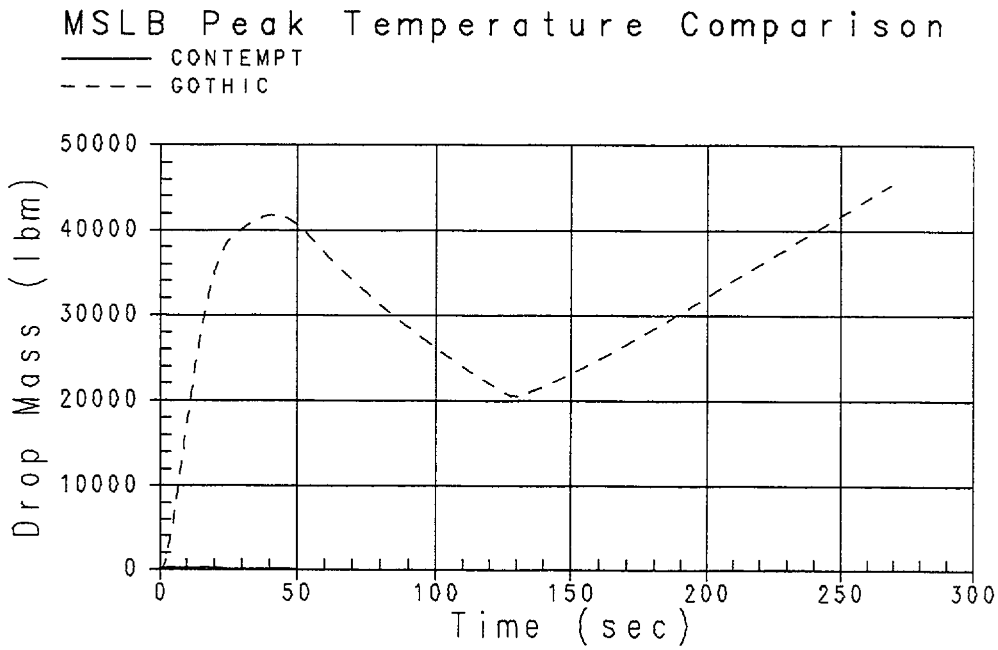


Figure 6.2-17 Drop Mass

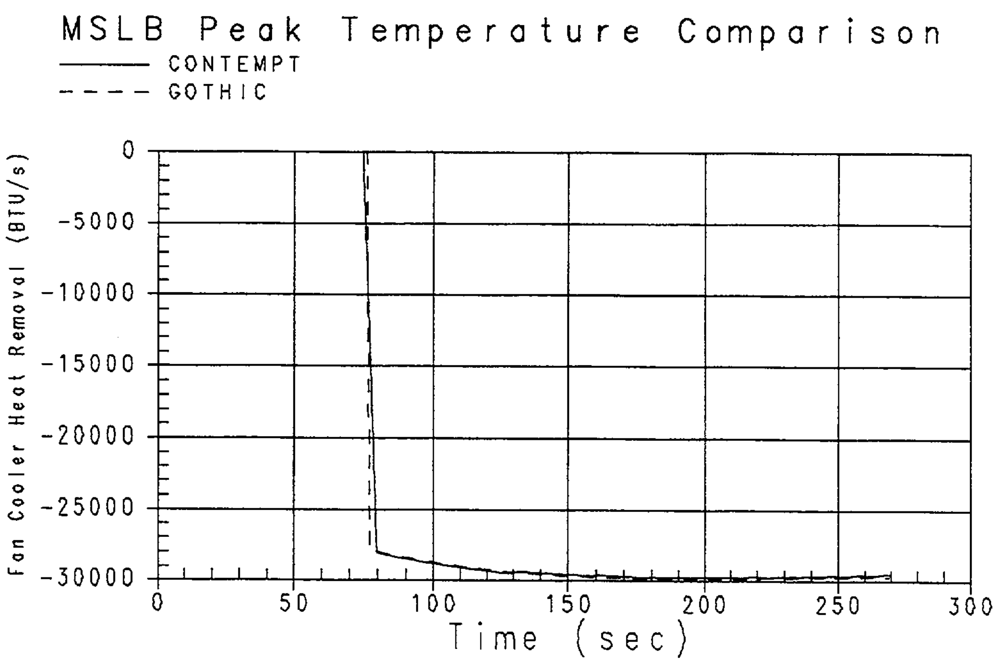


Figure 6.2-18 Fan Cooler Heat Removal

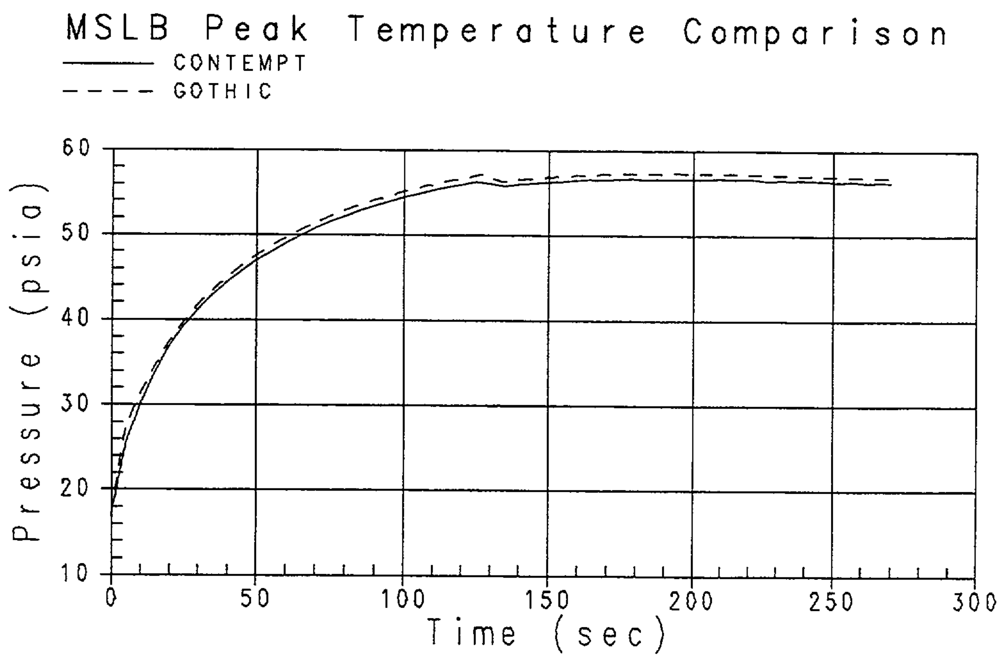


Figure 6.2-19 Drop Sensitivity Containment Pressure

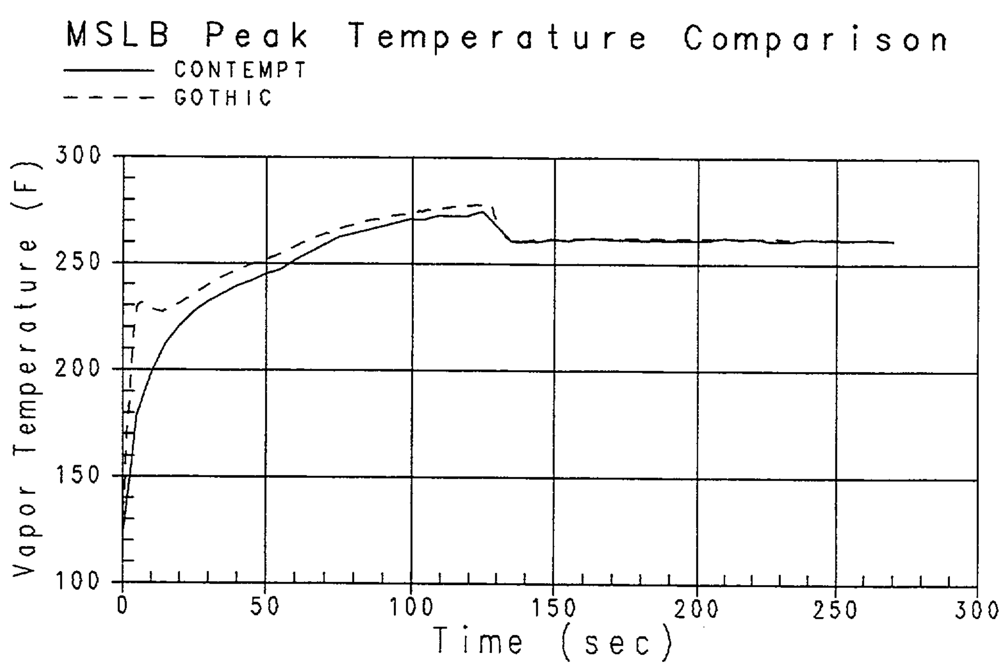


Figure 6.2-20 Drop Sensitivity Vapor Temperature

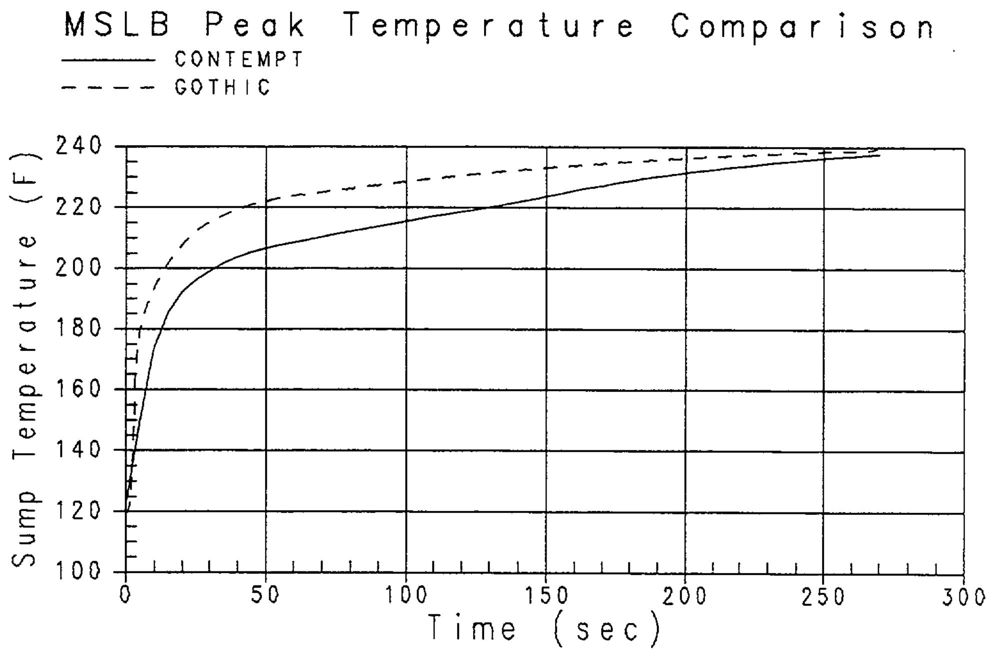


Figure 6.2-21 Drop Sensitivity Sump Temperature

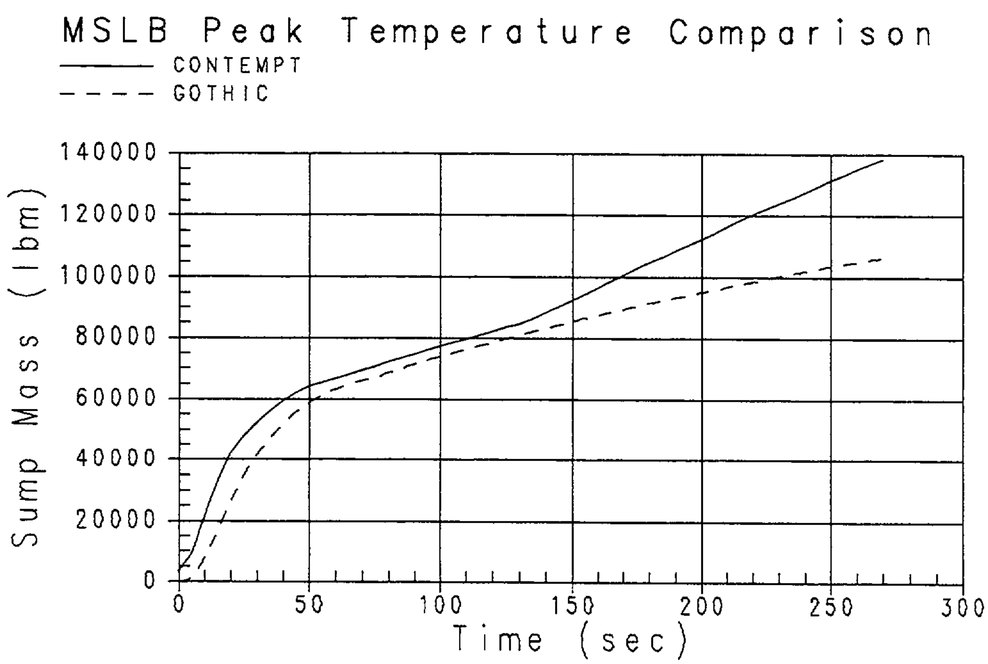


Figure 6.2-22 Drop Sensitivity Sump Mass

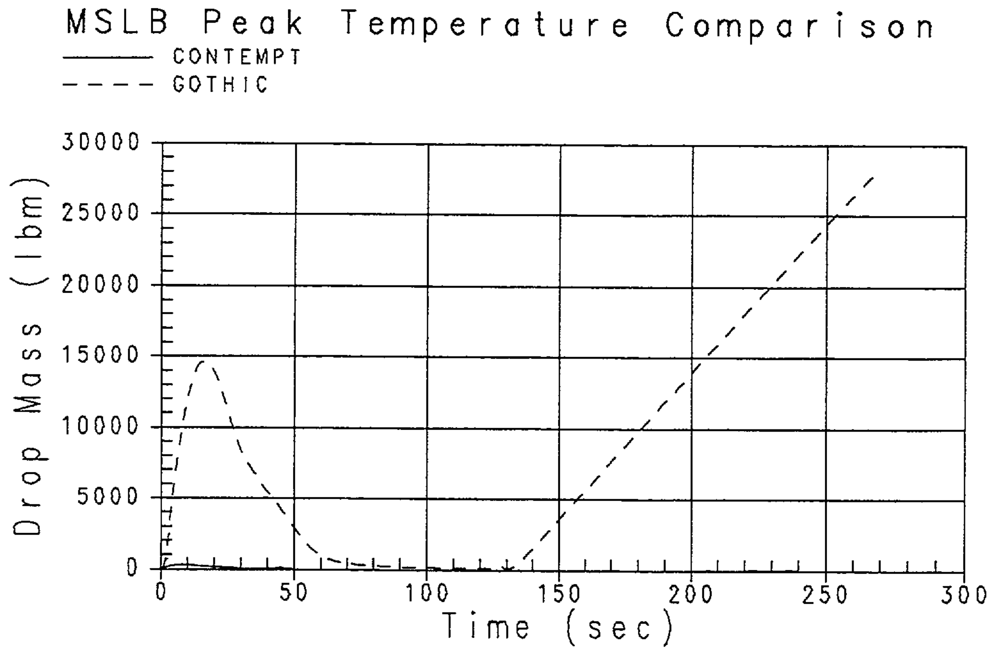


Figure 6.2-23 Drop Sensitivity Drop Mass

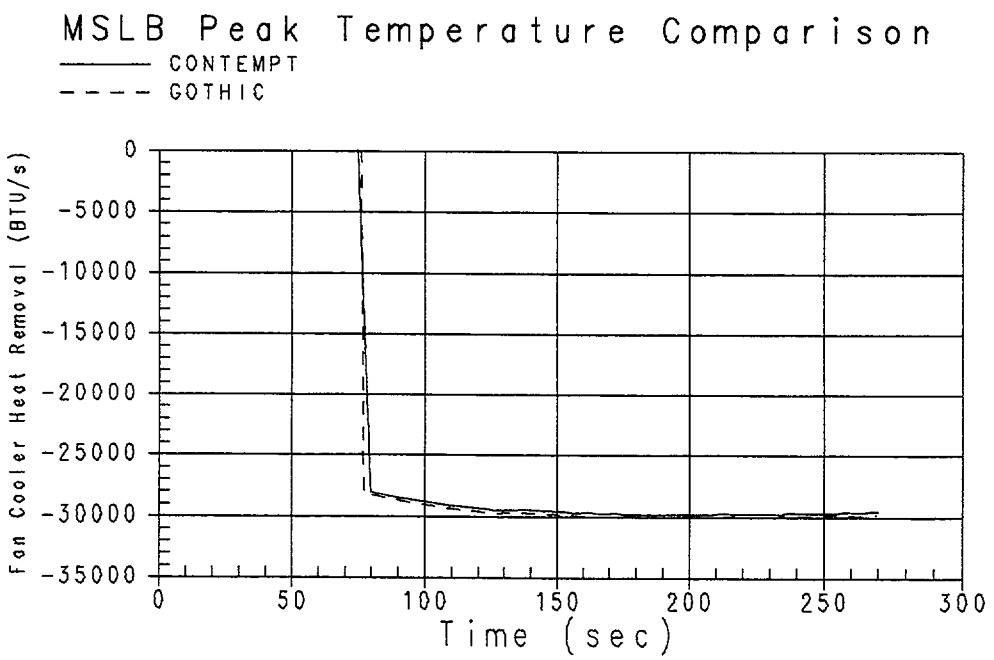


Figure 6.2-24 Drop Sensitivity Fan Cooler Heat Removal

7.0 Summary of Results and Conclusions

A GOTHIC containment model was created to provide a benchmark comparison with COCO results for LOCA and CONTEMPT for MSLB transients. The GOTHIC containment model input is based on input data from the Kewaunee CONTEMPT and COCO models. The LOCA containment model contains input for service water cooled fan coolers, the containment spray, major heat sinks, and recirculation cooling. The MSLB containment model does not include the recirculation cooling models.

GOTHIC does a good job of matching the trends in both the LOCA and MSLB transient response as predicted by the COCO and CONTEMPT codes. Some specific results of the benchmark comparison for the Kewaunee containment models are summarized below:

1. GOTHIC predicts a slightly higher (approximately 0.5 psi) peak pressure than CONTEMPT for the MSLB transients.
2. GOTHIC predicts lower peak temperatures for the MSLB transients. The large mass of liquid drops in the atmosphere predicted by GOTHIC prevents the atmosphere from becoming superheated.
3. GOTHIC predicts a slightly higher (approximately 0.1 psi) DEHL LOCA blowdown peak pressure than COCO.
4. GOTHIC predicts a lower (approximately 0.8 psi) DEPS LOCA peak pressure than COCO. The time of peak pressure is also different. GOTHIC predicts the peak to occur during the blowdown phase (13 sec), while COCO predicts the peak to occur just before the fan coolers start (60 sec).
5. GOTHIC predicts higher sump liquid temperatures for both LOCA and MSLB transients.
6. The two-phase break flow drop diameter input value has an impact on the peak pressure and temperature calculation in GOTHIC. If larger drops are modeled (as in the sensitivity cases), some of the two-phase break energy that would have been deposited in the drop field (and subsequently the sump liquid region) gets left in the vapor region causing the calculated pressure and temperature to be higher.

8.0 References

1. WCAP-8327, "Containment Pressure Analysis Code (COCO)", F. M. Bordelon, July 1974 , Proprietary Class 2
2. Report NAI 8907-06 Rev. 5, "GOTHIC Containment Analysis Package Technical Manual", Version 5.0e, T. George, December 1995
3. NUREG/CR-0255, "CONTEMPT-LT/028 - A Computer Program for Predicting Containment Pressure-Temperature Response to a Loss of Coolant Accident", D. Hargroves, et. al. March, 1979
4. NAI 9301-05, "Comparison of Results from GOTHIC to Results from Other Codes", January, 1996
5. Report NAI 8907-09 Rev. 3, "GOTHIC Containment Analysis Package Qualification Report", Version 5.0e, T. George, December 1995
6. WCAP-15207, "Development and Comparison of a GOTHIC Containment Evaluation Model with the COCO Containment Evaluation Model for a Dry Containment", R. Ofstun, April 1999, Proprietary Class 2
7. Steam Generator Replacement (SGR) Project letter KLIC 99-008 from J. Holly to R. Owoc dated 1-27-99 transmitting the WPS CONTEMPT model input for LOCA.
8. Wisconsin Public Service Corp. 1998 Plant Safety Analysis for the Main Steam Line Break Accident.
9. Report NAI 8907-02 Rev. 6, "GOTHIC Containment Analysis Package User Manual", Version 5.0e, T. George, December 1995
10. *Principles of Heat Transfer*, 3rd Edition, Frank Kreith, 1973
11. Steam Generator Replacement (SGR) Project letter KLIC 99-008 from J. Holly to R. Owoc dated 1-27-99 transmitting calculation number SSFI 23-1 "Containment Pressure and Temperature Response to a Loss of Coolant Accident Feb. 3, 1989".
12. Westinghouse Calculation Note CN-CRA-00-31-R0, "Kewaunee LOCA Containment Analyses for Model 54F Steam Generators," July 2000, Proprietary Class 2C
13. "Kewaunee Nuclear Power Plant Steam Generator Replacement and Tave Operating window Program Licensing Report" dated October, 2000 Section 6.8 (Non LOCA safety analyses).

Appendix A

Phase 1 GOTHIC DEPS Input Deck and Noding Diagram

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Control Volumes							
Vol #	Description	Vol (ft3)	Elev (ft)	Ht (ft)	Hyd. D. (ft)	L/V IA (ft2)	Burn Opt
1	Containment Vol	1320000.	0.	100.	10.	0.	NONE

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Fluid Boundary Conditions - Table 1										
BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	ON Trip	OFF Trip
1F	Two Phase Break	60.		E1	2	1	1	0	0
2F	Liquid Break Fl	60.		E1	5	1	4	0	0
3F	Spray from RWST	14.7		100		1	6	0	0

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Fluid Boundary Conditions - Table 2													
BC#	Liq. V. Frac.	FF	Stm. P.R.	FF	Drop D. (in)	FF	Cpld BC#	Flow Frac.	FF	Heat (Btu/s)	FF	Outlet Quality	FF
1F	1.		1		5e-04	7						DEFAULT	
2F	1.		1		NONE							DEFAULT	
3F	1.		1		5e-04							DEFAULT	

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Fluid Boundary Conditions - Table 3 Gas Pressure Ratios								
BC#	Air Gas 1	FF	Gas 2	FF	Gas 3	FF	Gas 4	FF
1F	1.							
2F	1.							
3F	1.							

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Fluid Boundary Conditions - Table 4 Gas Pressure Ratios								
BC#	Gas 5	FF	Gas 6	FF	Gas 7	FF	Gas 8	FF
1F								
2F								
3F								
4F								

Flow Paths - Table 1							
F.P. #	Description	Vol A	Elev (ft)	Ht (ft)	Vol B	Elev (ft)	Ht (ft)
1	Two Phase Break	1	30.		1F	30.	
2	Liquid Break Fl	1	30.		2F	30.	
3	Spray Flow	1	90.		3F	90.	
[ ]							

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Flow Paths - Table 2						
Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	De-Entrmt Frac.	Mom Trn Opt
1	1.	1.	1.	1.		-
2	1.	1.	1.	1.		-
3	1.	1.	1.	1.		-
[ ]						

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Flow Paths - Table 3					
Flow Path #	Fwd. Loss Coeff.	Rev. Loss Coeff.	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.
1			OFF	OFF	0.0
2			OFF	OFF	0.0
3			OFF	OFF	0.0

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Thermal Conductors - Table 1									
Cond #	Description	Vol A	HT Co	Vol B	HT Co	Cond Type	S. A. (ft2)	Init. T. (F)	Or
1	Containment Cyl	1	1	1	2	1	41300.	120.	I
2	Containment Dom	1	1	1	2	2	17300.	120.	C
3	Structural Stee	1	1	1	2	3	47925.	120.	I
4	Heavy Floors	1	1	1	2	4	69300.	120.	F

Thermal Conductors - Table 2				
Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
1	No		No	
2	No		No	
3	No		No	
4	No		No	

Heat Transfer Coefficient Types - Table 1

Type #	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt	Rad Opt
1	Tagami			ADD	UCHI		VERT SURF	PIPE FLOW	OFF
2	Sp Heat	0.							
3	Sp Cond	1.	8	ADD			VERT SURF	PIPE FLOW	OFF
4	Sp Cond	0.4	8	ADD			VERT SURF	PIPE FLOW	OFF
5	Tagami		9	ADD	UCHI		VERT SURF	PIPE FLOW	OFF

Heat Transfer Coefficient Types - Table 2

Type #	Phase Opt	Min Liq Fract	Max Liq Fract	Convection Bulk Temp Model	Convection Bulk Temp FF	Condensation Bulk Temp Model	Condensation Bulk Temp FF
1	VAP			Tg-Tf		Tb-Tw	
2							
3	VAP			Tg-Tf		Tb-Tw	
4	VAP			Tg-Tf		Tb-Tw	
5	VAP			Tg-Tf		Tb-Tw	

Heat Transfer Coefficient Types - Table 3

Type #	Char. Length (ft)	Nat Conv Coef FF	Nat Conv Exp FF	For Conv Coef FF	For Conv Exp FF	Nom Vel (ft/s)	Vel FF	Minimum Conv HTC (B/h-f2-F)
1								-1.
2								
3								-1.
4								-1.
5								-1.

HTC Types - Table 4				
Type #	Total Heat (Btu)	Peak Time (sec)	Initial Value (B/h-f2-F)	Post-BD Direct FF
1	166896848.	22.2	0.	
2				
3				
4				
5	166896848.	22.2	0.	

Thermal Conductor Types							
Type #	Description	Geom	Thick. (in)	O.D. (in)	Regions	Heat (Btu/ft3-s)	Heat FF
1	Painted CS	WALL	1.512	0.	2	0.	
2	Painted CS	WALL	0.762	0.	2	0.	
3	Painted CS	WALL	0.262	0.	2	0.	
4	Concrete Floor	WALL	6.012	0.	2	0.	

Thermal Conductor Type 1 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.012	1	0.
2	2	0.012	1.5	15	0.

Thermal Conductor Type 2 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.012	1	0.

Thermal Conductor Type 2 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
2	2	0.012	0.75	8	0.

Thermal Conductor Type 3 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.012	1	0.
2	2	0.012	0.25	5	0.

Thermal Conductor Type 4 Concrete Floor					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.012	1	0.
2	4	0.012	6.	6	0.

Materials	
Type #	Description
1	Paint
2	Carbon Steel
3	Stainless Steel
4	Concrete
5	Gap

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Material Type 1 Paint			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	1.	0.25	32.4
500.	1.	0.25	32.4

Material Type 2 Carbon Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	490.	26.	0.115
500.	490.	26.	0.115

Material Type 3 Stainless Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	488.	8.	0.116

Material Type 3 Stainless Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
500.	488.	8.	0.116

Material Type 4 Concrete			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	144.	0.8	0.2
500.	144.	0.8	0.2

Material Type 5 Gap			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	0.08	0.014	0.24
500.	0.08	0.014	0.24

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Cooler/Heater											
Heater Cooler #	Description	Vol. #	On Trip #	Off Trip #	Flow Rate (CFM)	Flow Rate FF	Heat Rate (Btu/s)	Heat Rate FF	Phs Opt	Ctrlr Loc
1C	Fan Cooler 1	1	1				2.	3	VTS	1

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Component Trips									
Trip #	Sense Var.	Sensor 1 Loc.	Sensor 2 Loc.	Var. Limit	Set Point	Delay Time	Rset Trip	Cond Trip	Cond Type
1	TIME			UPPER	85.	0.			AND
2	TIME			UPPER	4375.	0.			AND

Functions				
FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1	Blowdown Mass R	Time (sec)	Flow Rate	30
2	Blowdown Enthal	Time (sec)	Enthalpy (	30
3	Fan Cooler Heat	Vapor Sat.	Heat Remov	6
4	Post-Blowdown M	Time (sec)	Flow Rate	43
5	Post-Blowdown E	Time (sec)	Enthalpy (	43
6	Spray Flow Rate	Time (sec)	Flow Rate	6
7	Break Drop Diam	Time (sec)	Multiplier	4
8	Wall Condensati	Ind. Var.	Dep. Var.	311
9	Blowdown Heat T	Time (sec)	Multiplier	4

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Function
1
Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	31872.	0.025	31872.
0.225	44557.	0.60001	41864.
1.1501	36687.	1.8501	29361.
2.7004	24544.	3.6505	20473.
4.5504	18729.	5.4504	16969.
6.3503	15599.	7.2513	14540.
8.2516	12982.	9.3508	12696.

Function 1 Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
10.402	12034.	11.402	10197.
12.301	8121.	13.201	7194.
14.101	6107.	14.95	5745.
15.851	4093.	16.7	3890.
17.6	4004.	18.5	3350.
19.3	3843.	20.15	4060.
21.05	2926.	21.85	3114.
22.2	0.	1000000.	0.

Function 2 Blowdown Enthalpy Release Ind. Var.: Time (sec) Dep. Var.: Enthalpy (BTU/lbm)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	547.72	0.025	547.72
0.225	550.22	0.60001	558.8
1.1501	573.73	1.8501	588.26
2.7004	599.95	3.6505	612.65
4.5504	614.03	5.4504	619.92
6.3503	625.25	7.2513	636.83
8.2516	650.42	9.3508	631.61
10.402	627.4	11.402	648.37
12.301	669.57	13.201	630.05
14.101	612.16	14.95	576.57
15.851	615.16	16.7	583.26

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
17.6	516.4	18.5	496.43
19.3	408.07	20.15	367.33
21.05	314.93	21.85	309.2
22.2	0.	1000000.	0.

Function
3
Fan Cooler Heat Removal vs. Vapor Temp.
Ind. Var.: Vapor Sat. Temp. (F)
Dep. Var.: Heat Removal (BTU/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
100.	866.67	136.	2944.44
205.	8750.	244.	13111.1
270.	15833.3	350.	15833.3

Function
4
Post-Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	21.996	0.
22.	150.	24.9984	230.
100.008	279.	150.012	248.
168.84	242.	169.992	149.5
180.	149.917	200.016	146.75
219.996	145.8	240.012	141.811
259.992	145.861	280.008	141.869
299.988	141.	320.004	137.972
339.984	137.061	360.	67.3389
380.16	75.3	399.96	74.8806
420.12	73.0194	460.08	72.3
479.88	71.9722	500.04	71.6611
540.	71.0694	579.96	70.5278
619.92	70.	659.88	69.55
699.84	69.15	720.	68.9444
740.16	68.7694	759.96	68.5806
799.92	68.2306	820.08	68.0611
839.88	67.9	860.04	67.6194
879.84	67.3611	1000.08	40.
2000.16	40.	2700.	40.
3600.	40.	10000.8	40.
10803.6	40.		

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	21.996	0.
22.	100.	24.9984	1804.35
100.008	1272.4	150.012	1258.06
168.84	1260.33	169.992	1224.56

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
180.	1224.72	200.016	1224.51
219.996	1224.51	240.012	1224.83
259.992	1224.49	280.008	1224.85
299.988	1224.78	320.004	1224.64
339.984	1224.62	360.	1198.54
380.16	1199.61	399.96	1199.43
420.12	1199.83	460.08	1199.55
479.88	1199.58	500.04	1199.47
540.	1199.37	579.96	1199.13
619.92	1199.25	659.88	1199.06
699.84	1198.88	720.	1199.07
740.16	1198.81	759.96	1198.87
799.92	1198.75	820.08	1198.72
839.88	1198.62	860.04	1198.66
879.84	1198.43	1000.08	1250.
2000.16	847.222	2700.	775.
3600.	694.444	10000.8	650.
10803.6	450.		

Function
6
Spray Flow Rate
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	134.	0.
135.	180.56	3775.	180.56
3776.	0.	1000000.	0.

Function
7
Break Drop Diameter Multiplier
Ind. Var.: Time (sec)
Dep. Var.: Multiplier

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	1.	22.	1.
22.1	0.	1000000.	0.

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.500001	31.0535
1.	43.9163	2.	62.107
3.	76.0652	4.	87.8325
5.00001	98.1997	6.00001	107.572
7.00001	116.191	8.00001	124.214
9.00001	131.749	10.	138.875
11.	145.654	12.	152.13
13.	158.342	14.	164.32
15.	170.087	16.	175.665
17.	181.071	18.	186.321
19.	191.426	20.	196.399
21.	201.249	22.	205.985
23.	198.704	24.	191.757
25.	185.136	26.	178.833
27.	172.839	28.	167.144
29.	161.738	30.	156.607
31.	151.744	32.	147.135
33.	142.766	34.	138.624
35.	134.695	36.	130.971
37.	127.439	38.	124.093
39.	120.921	40.	117.916
41.	115.068	42.	112.373
43.	109.821	44.	107.406
45.	105.122	46.	102.961

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
47.	100.918	48.	98.9866
49.	97.1614	50.	95.4373
51.0001	93.8087	52.0001	92.2711
53.0001	90.8193	54.0001	89.4495
55.0001	88.1571	56.0001	86.9384
57.0001	85.7895	58.0001	84.7071
59.0001	83.6873	60.0001	82.7271
61.0001	81.8233	62.0001	80.9732
63.0001	80.1737	64.0001	79.4224
65.0001	78.7166	66.0001	78.0377
67.0001	77.3995	68.0001	76.8003
69.0001	76.2375	70.0001	75.7096
71.0001	75.2145	72.0001	74.7506
73.0001	74.316	74.0001	73.9095
75.0001	73.5292	76.0001	73.1741
77.0001	72.8425	78.0001	72.5333
79.0001	72.2452	80.0001	71.9771
81.0001	71.7279	82.0001	71.4966
83.0001	71.2821	84.0001	71.0846
85.0001	70.9068	86.0001	70.7442
87.0001	70.5924	88.0001	70.4507
89.0001	70.3042	90.0001	70.1593
91.0001	70.0221	92.0001	69.8923
93.0001	69.7696	94.0001	69.6527
95.0001	69.5418	96.0001	69.4362
97.0001	69.3349	98.0001	69.2377
99.0001	69.1447	100.	69.0577
101.	68.9764	102.	68.9007
103.	68.8303	104.	68.7649
105.	68.7042	106.	68.6478
107.	68.5956	108.	68.5471
109.	68.5023	110.	68.4607
111.	68.4222	112.	68.3866
113.	68.3537	114.	68.3232
115.	68.2949	116.	68.2688
117.	68.2446	118.	68.2221
119.	68.2016	120.	68.1827

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
121.	68.1655	122.	68.1498
123.	68.1354	124.	68.1223
125.	68.1103	126.	68.0992
127.	68.0891	128.	68.0798
129.	68.0712	130.	68.0632
131.	68.0557	132.	68.0487
133.	68.0421	134.	68.0358
135.	68.0297	136.	68.0238
137.	68.018	138.	68.0121
139.	68.0062	140.	67.9985
141.	67.9582	142.	67.919
143.	67.8811	144.	67.8442
145.	67.8085	146.	67.7736
147.	67.7393	148.	67.7057
149.	67.6725	150.	67.64
151.	67.608	152.	67.5768
153.	67.5463	154.	67.5166
155.	67.4875	156.	67.4591
157.	67.4312	158.	67.404
159.	67.3774	160.	67.3513
161.	67.3258	162.	67.3007
163.	67.2761	164.	67.252
165.	67.2283	166.	67.2051
167.	67.1822	168.	67.1598
169.	67.1377	170.	67.1159
171.	67.0945	172.	67.0734
173.	67.0526	174.	67.0321
175.	67.0119	176.	66.9919
177.	66.9721	178.	66.9524
179.	66.9328	180.	66.9134
181.	66.8942	182.	66.8752
183.	66.8565	184.	66.8381
185.	66.8199	186.	66.802
187.	66.7842	188.	66.7665
189.	66.749	190.	66.7316
191.	66.7143	192.	66.6971
193.	66.68	194.	66.663

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
195.	66.646	196.	66.6291
197.	66.6123	198.	66.5955
199.	66.5788	209.	66.415
219.	66.2703	229.	66.1452
239.	66.0407	249.	65.9498
259.	65.8729	269.	65.8067
279.	65.7518	289.	65.7054
299.	65.6684	309.	65.6384
319.	65.4822	329.	65.332
339.	65.1873	349.	65.0457
359.	64.9072	369.	64.7693
379.	64.633	389.	64.4965
399.	64.3609	409.	64.2244
419.	64.0883	429.	63.9524
439.	63.8188	449.	63.6858
459.	63.5546	469.	63.4237
479.	63.2941	489.	63.1646
499.	63.0361	599.	61.7815
699.	60.5199	799.	59.2629
899.	57.973	999.	56.6961
1099.	55.3918	1199.	54.0459
1299.	52.6972	1399.	51.3745
1499.	50.1468	1599.	49.0052
1699.	48.0775	1799.	47.1675
1899.	46.2838	1999.	45.4242
2099.	44.5904	2199.	43.7787
2299.	42.9884	2399.	42.2188
2499.	41.4682	2599.	40.7352
2699.	40.0231	2799.	39.3252
2899.	38.6518	2999.	39.7282
3099.	40.593	3199.	41.3578
3299.	42.0341	3399.	42.6585
3499.	43.2326	3599.	43.759
3699.	44.2499	3799.	44.7052
3899.	45.1303	3999.	45.1248
4999.	42.5485	5999.	40.1068
6999.	37.6599	7999.	35.2619

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
8999.	32.9576	9999.	30.7671
19999.	21.3619	29999.	18.6501
39999.	17.1548	49999.	16.0192
59999.	14.9607	69999.	13.9801
79999.	13.0149	89999.	12.1094
99999.	11.2449	199999.	9.97442
299999.	9.44674	399999.	8.95265
499999.	8.49698	599999.	8.06067
699999.	7.66104	799999.	7.26935
899999.	6.9091	999999.	6.57074
1100000.	6.45591	1200000.	6.39476
1300000.	6.3115	1400000.	6.23837
1500000.	6.14982	1600000.	6.11368
1700000.	6.07941	1800000.	6.03757
1900000.	6.0035	2000000.	5.96926
2100000.	5.91277	2200000.	5.9026
2300000.	5.87032	2400000.	5.83614
2500000.	5.80421	2600000.	5.77205
2700000.	5.7403	2800000.	5.71281
2900000.	5.67726	3000000.	5.66197
3000000.	5.66191		

Function
9
Blowdown Heat Transfer Multiplier
Ind. Var.: Time (sec)
Dep. Var.: Multiplier

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.4	22.	0.4
23.	1.	1000000.	1.

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Volume Initial Conditions							
Vol #	Pressure (psia)	Vapor Temp. (F)	Liquid Temp. F	Relative Humidity (%)	Liquid Volume Fraction	Ice Volume Fract.	Ice Surf.A. (ft2)
def	16.85	120.	120.	17.	1e-05	0.	0.
[ ]							

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Initial Gas Pressure Ratios								
Vol #	Air Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7	Gas 8
def	1.	0.	0.	0.	0.	0.	0.	0.
[ ]								

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Run Control Parameters (Seconds)								
Time Int	DT Min	DT Max	DT Ratio	End Time	Print Int	Graph Int	Max CPU	Dump Int
1	0.001	0.05	1.	1.	1.	0.1	600.	0.
2	0.001	0.05	1.	600.	50.	2.	600.	0.
3	0.001	0.05	1.	5000.	200.	20.	600.	0.
4	0.001	1.	1.	10800.	600.	100.	600.	0.

Run Parameters Menu	
Parameter	Value
Restart Time (sec)	0
Restart Time Step #	0
Restart Time Control	NEW
Revap. Fraction	0
Hetero. Nucleation?	YES
Min. NC HT Coeff. (Btu/ft2-hr-F)	0
Reference Pressure (psia)	0
Forced Ent. Drop Dia. (ft)	0.00833
Vaper Phase Head Cor.?	NO
Solution Method	DIRECT
Include Kinetic Energy?	NO

Ice Condenser Parameters			
Initial Temp. (F)	Bulk Density (lbm/ft3)	Surface Area Multiplier Function	Heat Transfer Option
15.	33.43		UCHIDA

Graphs							
Graph #	Title	Mon	Curve Number 1	2	3	4	5
1	Containment Pre		PR1				
2	Containment Tem		TV1				
3	Sump Water Temp		TL1	TL2			
4	Sump Level		LL1				
5	Fan Cooler Heat		CQ1C				
6	Spray Flow Rate		FD3	FD7	FL7		
7	Metal and Concr		HA1	HA4			
8			TL3				
9			LL3	LL2			
10			FL4				

Noncondensing Gases						
Gas No.	Description	Symbol	Type	Mol. Weight	Lennard-Jones Diameter (Ang)	Parameters e/K (K)
1	Air	Air	POLY	28.97	3.617	97.

Noncondensing Gases - Cp/Visc. Equations						
Gas No.	Cp Equation (Required) Tmin (R)	Tmax (R)	Cp (Btu/lbm-R)	Visc. Equation (Optional) Tmin (R)	Tmax (R)	Viscosity (lbm/ft-hr)
1	360.	2280.	0.238534-6.2006			

Appendix B

Phase 2 GOTHIC DEPS Input Deck and Noding Diagram

ewaunee Containment DBA Model - DEPS MIN
/11/00 13:10:14
OTHIC Version 5.0(QA)-e - October 1996

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Control Volumes							
Vol #	Description	Vol (ft3)	Elev (ft)	Ht (ft)	Hyd. D. (ft)	L/V IA (ft2)	Burn Opt
1	Containment Vol	1320000.	0.	100.	10.	0.	NONE

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Fluid Boundary Conditions - Table 1									
BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	ON Trip	OFF Trip
1F	Two Phase Break	60.		E1	2	1	1	0	0
2F	Liquid Break Fl	60.		E1	5	1	4	0	0
3F	Spray from RWST	14.7		120		1	6	3	4
5F	Accumulator Nit	14.7		300		1	13		

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Fluid Boundary Conditions - Table 2													
BC#	Liq. V. Frac.	FF	Stm. P.R.	FF	Drop D. (in)	FF	Cpld BC#	Flow Frac.	FF	Heat (Btu/s)	FF	Outlet Quality	FF
1F	1.		1		0.0039	7						DEFAULT	
2F	1.		1		NONE							DEFAULT	
3F	1.		1		5e-04							DEFAULT	
5F	0.		0		NONE							DEFAULT	

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Fluid Boundary Conditions - Table 3 Gas Pressure Ratios								
BC#	Air Gas 1	FF	Gas 2	FF	Gas 3	FF	Gas 4	FF
1F	1.							
2F	1.							

Fluid Boundary Conditions - Table 3
Gas Pressure Ratios

BC#	Air Gas 1	FF	Gas 2	FF	Gas 3	FF	Gas 4	FF
3F	1.							
5F	1.							

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Fluid Boundary Conditions - Table 4
Gas Pressure Ratios

BC#	Gas 5	FF	Gas 6	FF	Gas 7	FF	Gas 8	FF
1F								
2F								
3F								
4F								
5F								

Flow Paths - Table 1

F.P. #	Description	Vol A	Elev (ft)	Ht (ft)	Vol B	Elev (ft)	Ht (ft)
1	Two Phase Break	1	30.		1F	30.	
2	Liquid Break Fl	1	30.		2F	30.	
3	Spray Flow	1	90.		3F	90.	
8	Accumulator Nit	1	30.		5F	30.	

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Flow Paths - Table 2

Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	De-Entrmt Frac.	Mom Trn Opt
1	1.	1.	1.	1.		-
2	1.	1.	1.	1.		-
3	1.	1.	1.	1.		-
8	1.	1.	1.	1.		-

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Flow Paths - Table 3

Flow Path #	Fwd. Loss Coeff.	Rev. Loss Coeff.	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.
1			OFF	OFF	0.0
2			OFF	OFF	0.0
3			OFF	OFF	0.0
8			OFF	OFF	0.0

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Thermal Conductors - Table 1

Cond #	Description	Vol A	HT Co	Vol B	HT Co	Cond Type	S. A. (ft2)	Init. T. (F)	Or
1	Containment Cyl	1	1	1	2	1	41300.	120.	I
2	Containment Dom	1	1	1	2	2	17300.	120.	C
3	Reactor Vessel	1	1	1	2	3	1260.	120.	I
4	Refueling Canal	1	1	1	2	4	1100.	120.	I
5	Refueling Canal	1	1	1	2	5	5500.	120.	I
6	Structural Stee	1	1	1	2	6	4055.	120.	I

Thermal Conductors - Table 1

Cond #	Description	Vol A	HT Co	Vol B	HT Co	Cond Type	S. A. (ft2)	Init. T.(F)	Or
7	Structural Stee	1	1	1	2	7	16925.	120.	I
8	Structural Stee	1	1	1	2	8	28500.	120.	I
9	Structural Stee	1	1	1	2	9	2000.	120.	I
10	Structural Stee	1	1	1	2	10	500.	120.	I
11	Handrails	1	1	1	2	11	1695.	120.	I
12	Grating	1	1	1	2	12	12400.	120.	I
13	Conduit + Cable	1	1	1	2	13	2000.	120.	I
14	Ductwork	1	1	1	2	14	18000.	120.	I
15	Walls 1.0-1.9 f	1	1	1	2	15	2806.	120.	I
16	Floors > 1.0 ft	1	1	1	2	16	12896.	120.	I
17	Walls 4.0-7.3 f	1	1	1	2	17	18588.	120.	I
18	Sump Floor	1	1	1	2	16	1088.	120.	F
19	Walls 2.0-3.2 f	1	1	1	2	16	28898.	120.	I
20	Floors 4.0-10.0	1	1	1	2	18	6810.	120.	I

Thermal Conductors - Table 2

Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
1	No		No	
2	No		No	
3	No		No	
4	No		No	
5	No		No	
6	No		No	
7	No		No	
8	No		No	
9	No		No	
10	No		No	
11	No		No	
12	No		No	

Thermal Conductors - Table 2				
Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
13	No		No	
14	No		No	
15	No		No	
16	No		No	
17	No		No	
18	No		No	
19	No		No	
20	No		No	

Heat Transfer Coefficient Types - Table 1									
Type #	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt	Rad Opt
1	Tagami			ADD	UCHI		VERT SURF	PIPE FLOW	OFF
2	Sp Heat	0.							
3	Sp Cond	1.	8	ADD			VERT SURF	PIPE FLOW	OFF
4	Sp Cond	0.4	8	ADD			VERT SURF	PIPE FLOW	OFF
5	Tagami		9	ADD	UCHI		VERT SURF	PIPE FLOW	OFF

Heat Transfer Coefficient Types - Table 2							
Type #	Phase Opt	Min Liq Fract	Max Liq Fract	Convection Bulk Temp Model	FF	Condensation Bulk Temp Model	FF
1	VAP			Tg-Tf		Tb-Tw	
2							
3	VAP			Tg-Tf		Tb-Tw	
4	VAP			Tg-Tf		Tb-Tw	
5	VAP			Tg-Tf		Tb-Tw	

Heat Transfer Coefficient Types - Table 3								
Type #	Char. Length (ft)	Nat Conv Coef FF	Nat Conv Exp FF	For Conv Coef FF	For Conv Exp FF	Nom Vel (ft/s)	Vel FF	Minimum Conv HTC (B/h-f2-F)
1								-1.
2								
3								-1.
4								-1.
5								-1.

HTC Types - Table 4				
Type #	Total Heat (Btu)	Peak Time (sec)	Initial Value (B/h-f2-F)	Post-BD Direct FF
1	170817450.	14.	0.	
2				
3				
4				
5	170817450.	14.	0.	

Thermal Conductor Types							
Type #	Description	Geom	Thick. (in)	O.D. (in)	Regions	Heat (Btu/ft3-s)	Heat FF
1	Painted CS	WALL	1.511	0.	3	0.	
2	Painted CS	WALL	0.761	0.	3	0.	
3	CS Lined Concre	WALL		0.	5	0.	
4	SS Lined Concre	WALL		0.	3	0.	
5	SS Lined Concre	WALL		0.	3	0.	
6	Painted CS	WALL	0.179	0.	3	0.	
7	Painted CS	WALL	0.261	0.	3	0.	
8	Painted CS	WALL	0.386	0.	3	0.	
9	Painted CS	WALL	0.753	0.	2	0.	
10	Painted CS	WALL	1.003	0.	2	0.	
11	Painted CS	WALL	0.083	0.	3	0.	
12	Painted CS	WALL	0.056	0.	3	0.	
13	Painted CS	WALL	0.061	0.	3	0.	
14	Painted CS	WALL	0.046	0.	3	0.	
15	Concrete	WALL	6.014	0.	2	0.	
16	Concrete	WALL	12.014	0.	2	0.	
17	Concrete	WALL	24.014	0.	2	0.	
18	Concrete	WALL	4.014	0.	2	0.	

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Thermal Conductor Type 1 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	1.5	15	0.

Thermal Conductor Type 2 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.75	8	0.

Thermal Conductor Type 3 CS Lined Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.25	3	0.
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Thermal Conductor Type 4 SS Lined Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	3	0.	0.1875	2	0.
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Thermal Conductor Type 5 SS Lined Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	3	0.	0.25	3	0.

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Thermal Conductor Type 6 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.168	3	0.

Thermal Conductor Type 7 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.25	5	0.

Thermal Conductor Type 8 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.375	10	0.

Thermal Conductor Type 9 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	7	0.	0.003	1	0.
2	2	0.003	0.75	15	0.

Thermal Conductor Type 10 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	7	0.	0.003	1	0.
2	2	0.003	1.	20	0.

Thermal Conductor Type 11 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.

Thermal Conductor Type 11 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
2	7	0.008	0.003	1	0.
3	2	0.011	0.072	1	0.

Thermal Conductor Type 12 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.045	1	0.

Thermal Conductor Type 13 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.05	1	0.

Thermal Conductor Type
14
Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.035	1	0.

Thermal Conductor Type
15
Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.
2	4	0.014	6.	12	0.

Thermal Conductor Type
16
Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.
2	4	0.014	12.	24	0.

Thermal Conductor Type
17
Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.

Thermal Conductor Type 17 Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
2	4	0.014	24.	48	0.

Thermal Conductor Type 18 Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.
2	4	0.014	4.	8	0.

Materials	
Type #	Description
1	Paint
2	Carbon Steel
3	Stainless Steel
4	Concrete
5	Gap
[	
7	Primer

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Material Type 1 Paint			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	1.	0.083	28.8

Material Type 1 Paint			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
500.	1.	0.083	28.8

Material Type 2 Carbon Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	490.	26.	0.115
500.	490.	26.	0.115

Material Type 3 Stainless Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	488.	8.	0.116
500.	488.	8.	0.116

Material Type 4 Concrete			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	144.	0.8	0.2
500.	144.	0.8	0.2

Material Type 5 Gap			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32. 500.	0.08 0.08	0.014 0.014	0.24 0.24

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Material Type 7 Primer			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32. 500.	1. 1.	0.9 0.9	28.8 28.8

Cooler/Heater										
Heater Cooler #	Description	Vol. #	On Trip #	Off Trip #	Flow Rate (CFM)	Flow Rate FF	Heat Rate (Btu/s)	Heat Rate FF	Phs Opt	Ctrlr Loc
1C	Fan Cooler 1	1	1				2.	3	VTS	1

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Component Trips									
Trip #	Sense Var.	Sensor 1 Loc.	Sensor 2 Loc.	Var. Limit	Set Point	Delay Time	Rset Trip	Cond Trip	Cond Type
1	PRESS	1		UPPER	19.7	85.			AND
2	TIME			UPPER	1e+08	0.			AND
3	PRESS	1		UPPER	37.7	135.			AND
4	TIME			UPPER	3802.	0.		3	AND

Functions				
FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1	Blowdown Mass R	Time (sec)	Flow Rate	422
2	Blowdown Enthal	Time (sec)	Enthalpy (	422
3	Fan Cooler Heat	Vapor Sat.	Heat Remov	6
4	Post-Blowdown M	Time (sec)	Flow Rate	422
5	Post-Blowdown E	Time (sec)	Enthalpy (	422
6	Spray Flow Rate	Time (sec)	Flow Rate	3
7	Break Drop Diam	Time (sec)	Multiplier	4
8	Wall Condensati	Ind. Var.	Dep. Var.	311
9	Blowdown Heat T	Time (sec)	Multiplier	4
13	Accumulator Nit	Time (sec)	Flow Rate	6

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Function 1 Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	90838.6
0.1	40249.8	0.2	40863.9
0.3	43450.1	0.4	43869.5
0.5	43190.8	0.6	43369.9

Function
1
Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.7	43543.9	0.8	43325.7
0.9	42663.3	1.	41790.5
1.1	40832.3	1.2	39802.9
1.3	38643.3	1.4	37218.7
1.5	35493.1	1.6	33941.8
1.7	32779.7	1.8	31637.1
1.9	30411.9	2.	29059.8
2.1	27127.5	2.2	22721.4
2.3	19656.5	2.4	17469.7
2.5	15763.2	2.6	14522.8
2.7	13712.8	2.8	13142.4
2.9	12650.9	3.	12161.5
3.1	11714.7	3.2	11323.1
3.3	10962.	3.4	10619.1
3.5	10298.1	3.6	10009.5
3.7	9745.8	3.8	9505.3
3.9	9294.	4.	9110.1
4.2	8788.5	4.4	8488.1
4.6	8192.5	4.8	7930.2
5.	7728.1	5.2	7604.
5.4	7529.8	5.6	7477.7
5.8	7420.3	6.	7312.2
6.2	7383.	6.4	7471.5
6.6	7218.6	6.8	6487.4
7.	6029.8	7.2	5839.6
7.4	5702.4	7.6	5574.6
7.8	5422.5	8.	5267.1
8.2	5123.6	8.4	4954.4
8.6	4754.	8.8	4568.5
9.	4391.9	9.2	4214.3
9.4	4038.5	9.6	3851.7
9.8	3667.2	10.	3472.6
10.2	3267.	10.4	3036.6
10.6	2814.6	10.8	2580.2
11.	2333.	11.2	2013.2
11.4	1645.9	11.6	1401.4
11.8	1202.7	12.	1044.2

Function
1
Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
12.2	877.1	12.4	729.3
12.6	593.8	12.8	468.2
13.	365.5	13.2	260.5
13.4	158.9	13.6	71.1
13.8	29.	14.	0.
14.	0.	14.38	0.
14.58	0.	14.68	0.
14.73	0.	14.75	0.5
15.	29.1	15.1	33.2
15.2	37.3	15.3	42.4
15.4	48.1	15.5	53.6
15.6	58.9	15.7	64.
15.8	69.	15.88	72.6
15.9	73.7	16.	77.4
16.1	81.	16.2	84.5
16.3	87.8	16.4	91.1
16.5	94.2	16.6	97.3
16.7	100.3	16.8	103.2
16.9	106.	17.	108.8
18.	133.4	19.	221.3
19.56	404.4	20.01	419.3
21.01	413.8	22.01	405.3
22.91	397.7	23.01	396.8
24.01	388.8	25.01	381.1
26.01	373.8	27.01	367.
27.31	365.	28.01	360.5
29.01	354.4	30.01	348.6
31.01	343.1	32.01	337.8
32.31	336.3	33.01	332.9
34.01	344.7	35.01	340.5
36.01	336.2	37.01	332.1
37.61	329.7	38.01	216.1
39.01	205.4	40.01	203.5
41.01	201.3	42.01	199.1
43.01	196.9	44.01	194.7
45.01	192.5	46.01	190.2
47.01	188.1	48.01	185.9

Function 1 Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
49.01	183.8	50.01	181.7
51.01	179.5	52.01	177.4
53.01	175.2	54.01	173.1
55.01	170.9	56.01	168.8
57.01	166.6	58.01	164.5
59.01	162.3	60.01	160.2
61.01	158.	62.01	155.8
63.01	153.7	64.01	151.5
65.01	149.3	66.01	147.2
67.01	145.	68.01	142.8
69.01	140.7	70.01	138.5
71.01	136.4	71.21	136.
72.01	134.3	73.01	132.2
74.01	130.	75.01	127.9
77.01	123.8	79.01	119.6
81.01	115.6	83.01	111.6
85.01	107.7	87.01	103.8
89.01	100.1	91.01	96.5
93.01	92.9	94.11	91.
95.01	89.5	97.01	86.2
99.01	83.2	101.01	81.9
103.01	80.7	105.01	79.5
107.01	78.3	109.01	77.2
111.01	76.2	113.01	75.1
115.01	74.1	117.01	73.2
119.01	72.3	121.01	71.4
123.01	70.5	123.61	70.3
125.01	69.7	127.01	68.9
129.01	68.2	131.01	67.5
133.01	66.8	135.01	66.2
137.01	65.6	139.01	65.
141.01	64.4	143.01	63.9
145.01	63.4	147.01	62.9
149.01	62.5	151.01	62.1
153.01	61.7	155.01	61.3
157.01	60.9	158.31	60.7
159.01	60.6	161.01	60.3

Function 1 Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
163.01	60.	165.01	59.7
167.01	59.5	169.01	59.2
171.01	59.	173.01	58.8
175.01	58.6	177.01	58.5
179.01	58.3	181.01	58.2
183.01	58.	185.01	57.9
187.01	57.8	189.01	57.7
191.01	57.7	193.01	57.6
195.01	57.5	197.01	57.5
197.21	57.5	197.3	99.7
202.3	100.7	207.3	100.4
212.3	100.2	217.3	99.9
222.3	99.6	227.3	100.6
232.3	100.4	237.3	100.1
242.3	99.8	247.3	100.8
252.3	100.5	257.3	100.3
262.3	100.	267.3	101.
272.3	100.7	277.3	100.4
282.3	100.1	287.3	97.4
292.3	97.1	297.3	96.9
302.3	97.8	307.3	97.5
312.3	97.2	317.3	98.2
322.3	97.9	327.3	97.6
332.3	97.3	337.3	98.2
342.3	97.9	347.3	97.6
352.3	97.4	357.3	98.2
362.3	97.9	367.3	97.6
372.3	98.5	377.3	98.2
382.3	97.9	387.3	98.8
392.3	98.4	397.3	98.1
402.3	97.8	407.3	98.7
412.3	98.5	417.3	98.2
422.3	99.1	427.3	98.9
432.3	98.6	437.3	99.5
442.3	99.2	447.3	98.9
452.3	99.8	457.3	99.5
462.3	99.2	467.3	100.

Function
1
Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
472.3	99.7	477.3	99.4
482.3	99.2	487.3	98.9
492.3	99.6	497.3	99.3
502.3	99.	507.3	98.7
512.3	98.4	517.3	99.2
522.3	98.9	527.3	98.6
532.3	98.2	537.3	99.
542.3	98.6	547.3	98.3
552.3	98.	557.3	98.7
562.3	98.3	567.3	98.
572.3	97.6	577.3	98.3
582.3	97.9	587.3	97.6
592.3	97.2	597.3	97.8
602.3	97.5	607.3	97.1
612.3	97.7	617.3	97.4
622.3	97.	627.3	97.6
632.3	97.2	637.3	96.8
642.3	97.4	647.3	97.
652.3	96.6	657.3	97.1
662.3	96.7	667.3	96.2
672.3	96.7	677.3	96.3
682.3	96.8	687.3	96.3
692.3	96.7	697.3	96.2
702.3	95.8	707.3	96.1
712.3	95.6	717.3	96.
722.3	96.3	727.3	95.8
732.3	96.1	737.3	95.5
742.3	95.8	747.3	96.
752.3	95.4	757.3	95.5
762.3	95.7	767.3	95.
772.3	95.1	777.3	95.2
782.3	95.2	787.3	95.2
792.3	95.2	797.3	95.1
802.3	95.	807.3	94.9
812.3	94.7	817.3	94.5
822.3	94.8	827.3	94.5
832.3	94.7	837.3	94.3

Function
1
Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
842.3	94.3	847.3	94.3
852.3	94.2	857.3	94.5
862.3	94.1	867.3	94.
872.3	93.8	877.3	93.9
882.3	94.1	887.3	94.
892.3	93.7	897.3	93.7
902.3	93.4	907.3	93.5
912.3	93.5	917.3	93.4
922.3	37.5	1135.9	37.5
1136.	44.1	1137.3	44.1
1528.25	44.1	1528.35	40.9
3600.	33.8	3600.1	23.3
3802.	22.7	3802.1	22.7
3992.	22.2	3992.1	22.2
6171.	19.4	6171.1	20.4
6201.	20.4	6201.1	20.4
10000.	17.7	10000.1	17.6
20000.	14.6	20000.1	14.3
30000.	13.1	30000.1	13.
100000.	9.2	100000.	9.
500000.	5.2	500000.	5.2
1000000.	3.9	10000000.	1.2

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	540.561
0.1	540.841	0.2	543.901
0.3	547.905	0.4	552.598
0.5	557.833	0.6	563.176
0.7	568.306	0.8	573.177
0.9	577.716	1.	582.185
1.1	586.69	1.2	591.204
1.3	595.683	1.4	600.177
1.5	604.676	1.6	609.588
1.7	615.377	1.8	622.05
1.9	629.585	2.	637.963
2.1	646.908	2.2	655.172
2.3	665.513	2.4	674.887
2.5	682.095	2.6	687.757
2.7	692.219	2.8	695.712
2.9	698.848	3.	702.374
3.1	707.101	3.2	713.181
3.3	720.267	3.4	727.725
3.5	735.362	3.6	742.94
3.7	750.36	3.8	757.671
3.9	764.67	4.	771.108
4.2	782.313	4.4	792.131
4.6	799.083	4.8	800.382
5.	794.953	5.2	783.488
5.4	768.078	5.6	752.113
5.8	737.589	6.	726.529
6.2	716.285	6.4	711.274
6.6	735.91	6.8	771.914
7.	780.626	7.2	772.829
7.4	764.387	7.6	759.126
7.8	756.922	8.	756.449
8.2	757.821	8.4	763.233
8.6	770.23	8.8	776.816
9.	783.831	9.2	793.692
9.4	806.22	9.6	821.78
9.8	841.367	10.	866.095
10.2	896.804	10.4	937.568

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
10.6	989.683	10.8	1054.55
11.	1133.66	11.2	1210.35
11.4	1234.47	11.6	1240.36
11.8	1243.83	12.	1246.51
12.2	1249.69	12.4	1251.54
12.6	1253.11	12.8	1254.39
13.	1255.89	13.2	1257.07
13.4	1259.54	13.6	1263.65
13.8	1269.3	14.	1269.3
14.	1269.3	14.38	1269.3
14.58	1269.3	14.68	1269.3
14.73	1269.3	14.75	1223.
15.	1175.91	15.1	1179.27
15.2	1176.53	15.3	1178.13
15.4	1177.1	15.5	1177.
15.6	1177.65	15.7	1178.8
15.8	1178.23	15.88	1178.21
15.9	1177.33	16.	1177.92
16.1	1177.97	16.2	1177.65
16.3	1178.49	16.4	1177.9
16.5	1178.64	16.6	1178.24
16.7	1178.06	16.8	1178.14
16.9	1178.53	17.	1178.17
18.	1178.91	19.	1180.01
19.56	1183.69	20.01	1184.1
21.01	1184.09	22.01	1183.81
22.91	1183.69	23.01	1183.89
24.01	1183.49	25.01	1183.4
26.01	1183.37	27.01	1183.03
27.31	1183.04	28.01	1182.94
29.01	1182.69	30.01	1182.54
31.01	1182.39	32.01	1182.52
32.31	1182.43	33.01	1182.16
34.01	1182.48	35.01	1182.34
36.01	1182.34	37.01	1182.28
37.61	1182.33	38.01	1180.2
39.01	1179.95	40.01	1179.64

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
41.01	1179.6	42.01	1179.59
43.01	1179.59	44.01	1179.59
45.01	1179.54	46.01	1179.77
47.01	1179.44	48.01	1179.77
49.01	1179.46	50.01	1179.15
51.01	1179.48	52.01	1179.16
53.01	1179.48	54.01	1179.12
55.01	1179.43	56.01	1179.04
57.01	1179.33	58.01	1178.91
59.01	1179.19	60.01	1178.73
61.01	1178.96	62.01	1179.18
63.01	1178.64	64.01	1178.87
65.01	1179.12	66.01	1178.59
67.01	1178.88	68.01	1179.21
69.01	1178.75	70.01	1179.18
71.01	1178.82	71.21	1178.58
72.01	1178.51	73.01	1178.27
74.01	1179.01	75.01	1178.95
77.01	1178.23	79.01	1178.98
81.01	1178.33	83.01	1178.31
85.01	1178.05	87.01	1178.75
89.01	1178.24	91.01	1177.71
93.01	1178.49	94.11	1178.53
95.01	1178.19	97.01	1178.14
99.01	1177.55	101.01	1178.16
103.01	1177.8	105.01	1178.
107.01	1178.79	109.01	1178.67
111.01	1177.58	113.01	1178.63
115.01	1178.72	117.01	1177.8
119.01	1177.46	121.01	1177.72
123.01	1178.58	123.61	1177.79
125.01	1178.38	127.01	1178.76
129.01	1178.02	131.01	1177.84
133.01	1178.24	135.01	1177.43
137.01	1177.17	139.01	1177.45
141.01	1178.29	143.01	1177.82
145.01	1177.86	147.01	1178.42

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
149.01	1177.58	151.01	1177.18
153.01	1177.16	155.01	1177.61
157.01	1178.5	158.31	1178.15
159.01	1177.88	161.01	1177.67
163.01	1177.85	165.01	1178.43
167.01	1177.39	169.01	1178.7
171.01	1178.36	173.01	1178.35
175.01	1178.66	177.01	1177.26
179.01	1178.16	181.01	1177.32
183.01	1178.77	185.01	1178.46
187.01	1178.38	189.01	1178.55
191.01	1176.9	193.01	1177.51
195.01	1178.34	197.01	1177.33
197.21	1177.24	197.3	1272.31
202.3	1271.54	207.3	1272.05
212.3	1271.29	217.3	1271.8
222.3	1272.3	227.3	1272.22
232.3	1271.38	237.3	1271.81
242.3	1272.23	247.3	1271.94
252.3	1272.28	257.3	1271.36
262.3	1271.69	267.3	1271.19
272.3	1271.44	277.3	1271.7
282.3	1271.95	287.3	1271.63
292.3	1272.02	297.3	1271.09
302.3	1271.65	307.3	1271.96
312.3	1272.26	317.3	1271.32
322.3	1271.53	327.3	1271.74
332.3	1271.95	337.3	1272.06
342.3	1272.18	347.3	1272.29
352.3	1271.09	357.3	1272.25
362.3	1272.27	367.3	1272.28
372.3	1271.91	377.3	1271.83
382.3	1271.74	387.3	1271.15
392.3	1272.25	397.3	1272.06
402.3	1272.28	407.3	1272.32
412.3	1271.64	417.3	1272.24
422.3	1272.03	427.3	1271.24

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
432.3	1271.73	437.3	1271.27
442.3	1271.65	447.3	1272.01
452.3	1271.29	457.3	1271.54
462.3	1271.78	467.3	1272.06
472.3	1272.18	477.3	1272.29
482.3	1271.1	487.3	1271.18
492.3	1272.33	497.3	1272.29
502.3	1272.24	507.3	1272.17
512.3	1272.09	517.3	1271.52
522.3	1271.3	527.3	1271.07
532.3	1272.11	537.3	1271.15
542.3	1272.05	547.3	1271.64
552.3	1271.21	557.3	1271.14
562.3	1271.86	567.3	1271.26
572.3	1271.95	577.3	1271.44
582.3	1271.98	587.3	1271.2
592.3	1271.7	597.3	1272.03
602.3	1271.19	607.3	1271.82
612.3	1272.08	617.3	1271.21
622.3	1271.63	627.3	1271.49
632.3	1271.71	637.3	1271.91
642.3	1271.34	647.3	1271.33
652.3	1271.29	657.3	1271.57
662.3	1271.33	667.3	1272.36
672.3	1272.15	677.3	1271.65
682.3	1271.06	687.3	1271.63
692.3	1271.94	697.3	1272.28
702.3	1271.23	707.3	1272.31
712.3	1272.33	717.3	1271.64
722.3	1271.95	727.3	1271.44
732.3	1271.26	737.3	1271.76
742.3	1271.08	747.3	1271.35
752.3	1271.24	757.3	1272.27
762.3	1271.59	767.3	1272.16
772.3	1272.17	777.3	1271.75
782.3	1272.21	787.3	1272.21
792.3	1271.74	797.3	1272.07

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
802.3	1271.94	807.3	1271.36
812.3	1271.55	817.3	1271.13
822.3	1272.37	827.3	1271.66
832.3	1272.21	837.3	1271.05
842.3	1272.08	847.3	1271.71
852.3	1271.21	857.3	1271.47
862.3	1271.2	867.3	1272.36
872.3	1272.1	877.3	1271.64
882.3	1272.25	887.3	1271.22
892.3	1272.21	897.3	1271.61
902.3	1272.27	907.3	1271.27
912.3	1271.37	917.3	1271.67
922.3	1273.09	1135.9	1273.09
1136.	1247.99	1137.3	1247.72
1528.25	1247.72	1528.35	1151.89
3600.	1150.76	3600.1	1148.42
3802.	1151.63	3802.1	1151.61
3992.	1151.43	3992.1	1151.42
6171.	1153.39	6171.1	1151.01
6201.	1149.63	6201.1	1148.48
10000.	1152.44	10000.1	1152.28
20000.	1153.23	20000.1	1146.93
30000.	1146.75	30000.1	1154.57
100000.	1147.01	100000.	1152.27
500000.	1154.48	500000.	1153.61
1000000.	1138.56	10000000.	1158.83

Function
3
Fan Cooler Heat Removal vs. Vapor Temp.
Ind. Var.: Vapor Sat. Temp. (F)
Dep. Var.: Heat Removal (BTU/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
100.	833.3	136.	2944.44
205.	8750.	244.	13111.1
270.	15833.3	350.	15833.3

Function
4
Post-Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	40408.9
0.1	20560.5	0.2	21794.3
0.3	22153.6	0.4	21877.7
0.5	21321.6	0.6	20652.8
0.7	19960.7	0.8	19245.8
0.9	18631.9	1.	18154.6
1.1	17772.	1.2	17410.3
1.3	17048.6	1.4	16772.
1.5	16703.2	1.6	16612.8
1.7	16402.	1.8	16171.6
1.9	15951.7	2.	15737.3
2.1	15506.3	2.2	15254.4
2.3	14992.2	2.4	14811.4
2.5	14736.7	2.6	14653.1
2.7	14562.7	2.8	14477.
2.9	14381.3	3.	14184.7
3.1	13438.9	3.2	13217.4
3.3	13070.7	3.4	13498.5
3.5	14334.5	3.6	14328.9
3.7	14219.8	3.8	14170.7
3.9	14108.7	4.	13994.
4.2	13744.8	4.4	13417.1
4.6	13073.4	4.8	12740.8

Function 4 Post-Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
5.	12377.1	5.2	12042.7
5.4	11713.7	5.6	11327.3
5.8	10993.6	6.	10627.4
6.2	10323.4	6.4	10097.1
6.6	9720.8	6.8	9466.8
7.	9115.5	7.2	8845.5
7.4	8715.8	7.6	8648.7
7.8	8748.8	8.	8386.7
8.2	8302.6	8.4	7866.8
8.6	7781.6	8.8	7385.3
9.	7428.2	9.2	6701.7
9.4	6678.8	9.6	6381.
9.8	6082.3	10.	5881.9
10.2	6607.2	10.4	6150.1
10.6	5644.4	10.8	5384.8
11.	5176.	11.2	4950.5
11.4	4702.	11.6	4411.1
11.8	4050.8	12.	3660.
12.2	3253.9	12.4	2819.4
12.6	2436.3	12.8	2032.2
13.	1614.8	13.2	1186.7
13.4	740.6	13.6	307.2
13.8	0.	14.	0.
14.	0.	14.38	0.
14.58	0.	14.68	0.
14.73	0.	14.75	0.
15.	0.	15.1	0.
15.2	0.	15.3	0.
15.4	0.	15.5	0.
15.6	0.	15.7	0.
15.8	0.	15.88	0.
15.9	0.	16.	0.
16.1	0.	16.2	0.
16.3	0.	16.4	0.
16.5	0.	16.6	0.
16.7	0.	16.8	0.
16.9	0.	17.	0.

Function
4
Post-Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
18.	0.	19.	1854.4
19.56	4074.3	20.01	4203.3
21.01	4144.	22.01	4060.9
22.91	3985.9	23.01	3977.6
24.01	3896.3	25.01	3817.7
26.01	3742.1	27.01	3669.4
27.31	3648.2	28.01	3599.7
29.01	3532.7	30.01	3468.4
31.01	3406.5	32.01	3346.9
32.31	3329.5	33.01	3289.6
34.01	3432.4	35.01	3381.
36.01	3330.4	37.01	3281.5
37.61	3252.8	38.01	1738.
39.01	193.4	40.01	192.8
41.01	192.1	42.01	191.5
43.01	190.8	44.01	190.1
45.01	189.5	46.01	188.8
47.01	188.1	48.01	187.5
49.01	186.9	50.01	186.2
51.01	185.6	52.01	185.
53.01	184.3	54.01	183.7
55.01	183.1	56.01	182.5
57.01	181.8	58.01	181.2
59.01	180.6	60.01	180.
61.01	179.4	62.01	178.8
63.01	178.2	64.01	177.6
65.01	177.	66.01	176.4
67.01	175.8	68.01	175.2
69.01	174.7	70.01	174.1
71.01	173.5	71.21	173.4
72.01	173.	73.01	172.4
74.01	171.9	75.01	171.3
77.01	170.2	79.01	169.2
81.01	168.2	83.01	167.2
85.01	166.3	87.01	165.4
89.01	164.5	91.01	163.7
93.01	162.9	94.11	162.4

Function
4
Post-Blowdown Mass Release
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
95.01	162.1	97.01	161.4
99.01	160.7	101.01	160.
103.01	159.3	105.01	158.6
107.01	158.	109.01	157.4
111.01	156.8	113.01	156.2
115.01	155.6	117.01	155.
119.01	154.5	121.01	154.
123.01	153.5	123.61	153.3
125.01	153.	127.01	152.5
129.01	152.1	131.01	151.6
133.01	151.2	135.01	150.8
137.01	150.4	139.01	150.1
141.01	149.7	143.01	149.4
145.01	149.	147.01	148.7
149.01	148.4	151.01	148.1
153.01	147.8	155.01	147.6
157.01	147.3	158.31	147.2
159.01	147.1	161.01	146.8
163.01	146.6	165.01	146.4
167.01	146.2	169.01	146.
171.01	145.8	173.01	145.7
175.01	145.5	177.01	145.3
179.01	145.2	181.01	145.1
183.01	144.9	185.01	144.8
187.01	144.7	189.01	144.6
191.01	144.5	193.01	144.4
195.01	144.3	197.01	144.2
197.21	144.2	197.3	170.2
202.3	169.3	207.3	169.5
212.3	169.8	217.3	170.1
222.3	170.3	227.3	169.3
232.3	169.6	237.3	169.9
242.3	170.1	247.3	169.1
252.3	169.4	257.3	169.7
262.3	170.	267.3	169.
272.3	169.3	277.3	169.6
282.3	169.8	287.3	172.6

Function 4 Post-Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
292.3	172.8	297.3	173.1
302.3	172.2	307.3	172.4
312.3	172.7	317.3	171.8
322.3	172.1	327.3	172.4
332.3	172.6	337.3	171.7
342.3	172.	347.3	172.3
352.3	172.6	357.3	171.7
362.3	172.	367.3	172.3
372.3	171.5	377.3	171.8
382.3	172.1	387.3	171.2
392.3	171.5	397.3	171.8
402.3	172.1	407.3	171.2
412.3	171.5	417.3	171.7
422.3	170.8	427.3	171.1
432.3	171.4	437.3	170.5
442.3	170.8	447.3	171.
452.3	170.2	457.3	170.5
462.3	170.8	467.3	169.9
472.3	170.2	477.3	170.5
482.3	170.8	487.3	171.1
492.3	170.3	497.3	170.6
502.3	170.9	507.3	171.2
512.3	171.5	517.3	170.8
522.3	171.1	527.3	171.4
532.3	171.7	537.3	171.
542.3	171.3	547.3	171.7
552.3	172.	557.3	171.3
562.3	171.7	567.3	172.
572.3	172.3	577.3	171.7
582.3	172.	587.3	172.4
592.3	172.8	597.3	172.1
602.3	172.5	607.3	172.9
612.3	172.2	617.3	172.6
622.3	173.	627.3	172.4
632.3	172.8	637.3	173.2
642.3	172.6	647.3	173.
652.3	173.4	657.3	172.9

Function 4 Post-Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
662.3	173.3	667.3	173.7
672.3	173.2	677.3	173.7
682.3	173.2	687.3	173.7
692.3	173.2	697.3	173.7
702.3	174.2	707.3	173.8
712.3	174.3	717.3	174.
722.3	173.6	727.3	174.2
732.3	173.9	737.3	174.5
742.3	174.2	747.3	174.
752.3	174.6	757.3	174.4
762.3	174.3	767.3	174.9
772.3	174.8	777.3	174.8
782.3	174.7	787.3	174.7
792.3	174.8	797.3	174.8
802.3	174.9	807.3	175.1
812.3	175.3	817.3	175.5
822.3	175.1	827.3	175.5
832.3	175.2	837.3	175.7
842.3	175.6	847.3	175.7
852.3	175.8	857.3	175.5
862.3	175.9	867.3	175.9
872.3	176.1	877.3	176.1
882.3	175.8	887.3	176.
892.3	176.2	897.3	176.3
902.3	176.5	907.3	176.5
912.3	176.5	917.3	176.6
922.3	232.4	1135.9	232.4
1136.	225.9	1137.3	225.9
1528.25	225.9	1528.35	229.
3600.	236.2	3600.1	246.7
3802.	247.2	3802.1	63.2
3992.	63.7	3992.1	63.7
6171.	66.5	6171.1	0.3
6201.	0.3	6201.1	165.8
10000.	168.5	10000.1	168.6
20000.	171.6	20000.1	171.9
30000.	173.1	30000.1	173.2

Function 4 Post-Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
100000.	177.	100000.	177.2
500000.	181.	500000.	181.
1000000.	182.3	10000000.	185.

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	539.261
0.1	538.857	0.2	539.106
0.3	539.369	0.4	539.761
0.5	540.168	0.6	540.539
0.7	540.737	0.8	540.825
0.9	540.878	1.	540.934
1.1	540.971	1.2	540.954
1.3	540.885	1.4	540.88
1.5	540.956	1.6	540.997
1.7	540.955	1.8	540.898
1.9	540.84	2.	540.786
2.1	540.74	2.2	540.698
2.3	540.669	2.4	540.739
2.5	540.876	2.6	541.001
2.7	541.125	2.8	541.248
2.9	541.364	3.	541.378
3.1	541.331	3.2	541.637
3.3	541.869	3.4	542.551
3.5	542.639	3.6	542.568
3.7	542.718	3.8	542.965
3.9	543.187	4.	543.374
4.2	543.757	4.4	544.118
4.6	544.504	4.8	544.891
5.	545.319	5.2	545.825
5.4	546.372	5.6	547.015
5.8	547.725	6.	548.534
6.2	549.406	6.4	550.49
6.6	551.523	6.8	552.711
7.	553.586	7.2	550.38
7.4	541.389	7.6	529.942
7.8	519.024	8.	508.814
8.2	499.094	8.4	489.807
8.6	481.3	8.8	473.584
9.	465.309	9.2	458.896
9.4	451.027	9.6	444.165
9.8	437.878	10.	429.65
10.2	415.625	10.4	404.099

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
10.6	397.011	10.8	388.199
11.	377.178	11.2	366.063
11.4	356.195	11.6	347.326
11.8	338.9	12.	330.585
12.2	322.283	12.4	314.234
12.6	306.638	12.8	299.594
13.	293.412	13.2	288.42
13.4	284.945	13.6	283.511
13.8	283.511	14.	283.511
14.	283.511	14.38	283.511
14.58	283.511	14.68	283.511
14.73	283.511	14.75	283.511
15.	283.511	15.1	283.511
15.2	283.511	15.3	283.511
15.4	283.511	15.5	283.511
15.6	283.511	15.7	283.511
15.8	283.511	15.88	283.511
15.9	283.511	16.	283.511
16.1	283.511	16.2	283.511
16.3	283.511	16.4	283.511
16.5	283.511	16.6	283.511
16.7	283.511	16.8	283.511
16.9	283.511	17.	283.511
18.	283.511	19.	107.61
19.56	108.926	20.01	109.94
21.01	110.553	22.01	110.864
22.91	111.147	23.01	111.18
24.01	111.502	25.01	111.83
26.01	112.163	27.01	112.503
27.31	112.604	28.01	112.843
29.01	113.189	30.01	113.535
31.01	113.886	32.01	114.24
32.31	114.344	33.01	114.59
34.01	113.823	35.01	114.166
36.01	114.485	37.01	114.802
37.61	114.995	38.01	134.399
39.01	428.887	40.01	426.267

Function 5 Post-Blowdown Enthalpy Release Ind. Var.: Time (sec) Dep. Var.: Enthalpy (BTU/lbm)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
41.01	423.422	42.01	420.357
43.01	417.512	44.01	414.661
45.01	411.57	46.01	408.591
47.01	405.817	48.01	402.833
49.01	399.849	50.01	397.078
51.01	394.091	52.01	391.102
53.01	388.322	54.01	385.329
55.01	382.334	56.01	379.337
57.01	376.547	58.01	373.549
59.01	370.55	60.01	367.554
61.01	364.551	62.01	361.549
63.01	358.551	64.01	355.559
65.01	352.573	66.01	349.599
67.01	346.634	68.01	343.683
69.01	340.552	70.01	337.634
71.01	334.735	71.21	334.119
72.01	331.665	73.01	328.811
74.01	325.793	75.01	322.993
77.01	317.297	79.01	311.556
81.01	305.969	83.01	300.544
85.01	295.13	87.01	289.923
89.01	284.935	91.01	280.005
93.01	275.32	94.11	272.95
95.01	270.885	97.01	266.542
99.01	262.218	101.01	258.26
103.01	254.382	105.01	250.601
107.01	246.763	109.01	243.029
111.01	239.399	113.01	235.876
115.01	232.46	117.01	229.152
119.01	225.805	121.01	222.569
123.01	219.444	123.61	218.6
125.01	216.43	127.01	213.526
129.01	210.592	131.01	207.908
133.01	205.194	135.01	202.589
137.01	200.092	139.01	197.568
141.01	195.28	143.01	192.965
145.01	190.88	147.01	188.766

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
149.01	186.749	151.01	184.82
153.01	182.973	155.01	181.093
157.01	179.424	158.31	178.27
159.01	177.72	161.01	176.22
163.01	174.681	165.01	173.222
167.01	171.839	169.01	170.531
171.01	169.294	173.01	168.01
175.01	166.909	177.01	165.871
179.01	164.782	181.01	163.753
183.01	162.894	185.01	161.978
187.01	161.115	189.01	160.305
191.01	159.545	193.01	158.832
195.01	158.168	197.01	157.549
197.21	157.479	197.3	280.763
202.3	280.319	207.3	279.937
212.3	279.391	217.3	278.846
222.3	278.466	227.3	278.108
232.3	277.57	237.3	277.034
242.3	276.661	247.3	276.315
252.3	275.786	257.3	275.259
262.3	274.732	267.3	274.398
272.3	273.878	277.3	273.361
282.3	273.005	287.3	281.196
292.3	280.792	297.3	280.227
302.3	279.758	307.3	279.362
312.3	278.805	317.3	278.348
322.3	277.798	327.3	277.249
332.3	276.862	337.3	276.419
342.3	275.879	347.3	275.34
352.3	274.803	357.3	274.375
362.3	273.845	367.3	273.318
372.3	272.745	377.3	272.226
382.3	271.709	387.3	271.31
392.3	270.802	397.3	270.295
402.3	269.75	407.3	269.283
412.3	268.702	417.3	268.277
422.3	267.827	427.3	267.257

Function
5
Post-Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
432.3	266.688	437.3	266.255
442.3	265.697	447.3	265.295
452.3	264.727	457.3	264.182
462.3	263.639	467.3	263.246
472.3	262.715	477.3	262.184
482.3	261.657	487.3	261.131
492.3	260.616	497.3	260.103
502.3	259.593	507.3	259.084
512.3	258.577	517.3	257.947
522.3	257.454	527.3	256.964
532.3	256.476	537.3	255.878
542.3	255.406	547.3	254.786
552.3	262.471	557.3	261.909
562.3	261.257	567.3	260.761
572.3	260.266	577.3	259.589
582.3	259.11	587.3	258.483
592.3	257.859	597.3	257.374
602.3	256.757	607.3	256.127
612.3	255.646	617.3	255.036
622.3	254.43	627.3	253.837
632.3	253.252	637.3	252.671
642.3	252.119	647.3	251.56
652.3	251.005	657.3	250.351
662.3	249.82	667.3	249.294
672.3	256.368	677.3	255.666
682.3	255.081	687.3	254.406
692.3	253.861	697.3	253.214
702.3	252.574	707.3	251.938
712.3	251.329	717.3	250.594
722.3	250.035	727.3	249.342
732.3	248.689	737.3	248.032
742.3	247.433	747.3	246.73
752.3	246.143	757.3	245.5
762.3	252.052	767.3	251.476
772.3	250.766	777.3	249.959
782.3	249.343	787.3	248.634
792.3	247.834	797.3	247.233

Function 5 Post-Blowdown Enthalpy Release Ind. Var.: Time (sec) Dep. Var.: Enthalpy (BTU/lbm)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
802.3	246.544	807.3	245.764
812.3	245.048	817.3	244.398
822.3	243.648	827.3	242.899
832.3	249.199	837.3	248.449
842.3	247.705	847.3	246.831
852.3	246.12	857.3	245.281
862.3	244.571	867.3	243.807
872.3	243.075	877.3	242.191
882.3	241.448	887.3	247.343
892.3	246.56	897.3	245.639
902.3	244.886	907.3	243.995
912.3	243.129	917.3	242.247
922.3	246.635	1135.9	246.635
1136.	243.287	1137.3	242.987
1528.25	242.987	1528.35	97.5507
3600.	100.032	3600.1	88.0041
3802.	88.0166	3802.1	87.9731
3992.	87.978	3992.1	87.978
6171.	87.9383	6171.1	134.667
6201.	146.	6201.1	137.031
10000.	136.977	10000.1	131.08
20000.	131.075	20000.1	104.028
30000.	104.027	30000.1	103.073
100000.	103.117	100000.	84.6936
500000.	84.6917	500000.	83.8939
1000000.	83.9188	10000000.	83.8962

Function
6
Spray Flow Rate
Ind. Var.: Time (sec)
Dep. Var.: Flow Rate (lbm/s)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.1	178.75
1000000.	178.75		

Function
7
Break Drop Diameter Multiplier
Ind. Var.: Time (sec)
Dep. Var.: Multiplier

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	1.	14.	1.
14.1	0.	1000000.	0.

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.500001	31.0535
1.	43.9163	2.	62.107
3.	76.0652	4.	87.8325
5.00001	98.1997	6.00001	107.572
7.00001	116.191	8.00001	124.214
9.00001	131.749	10.	138.875
11.	145.654	12.	152.13
13.	158.342	14.	164.32
15.	170.087	16.	175.665
17.	181.071	18.	186.321
19.	191.426	20.	196.399

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
21.	201.249	22.	205.985
23.	198.704	24.	191.757
25.	185.136	26.	178.833
27.	172.839	28.	167.144
29.	161.738	30.	156.607
31.	151.744	32.	147.135
33.	142.766	34.	138.624
35.	134.695	36.	130.971
37.	127.439	38.	124.093
39.	120.921	40.	117.916
41.	115.068	42.	112.373
43.	109.821	44.	107.406
45.	105.122	46.	102.961
47.	100.918	48.	98.9866
49.	97.1614	50.	95.4373
51.0001	93.8087	52.0001	92.2711
53.0001	90.8193	54.0001	89.4495
55.0001	88.1571	56.0001	86.9384
57.0001	85.7895	58.0001	84.7071
59.0001	83.6873	60.0001	82.7271
61.0001	81.8233	62.0001	80.9732
63.0001	80.1737	64.0001	79.4224
65.0001	78.7166	66.0001	78.0377
67.0001	77.3995	68.0001	76.8003
69.0001	76.2375	70.0001	75.7096
71.0001	75.2145	72.0001	74.7506
73.0001	74.316	74.0001	73.9095
75.0001	73.5292	76.0001	73.1741
77.0001	72.8425	78.0001	72.5333
79.0001	72.2452	80.0001	71.9771
81.0001	71.7279	82.0001	71.4966
83.0001	71.2821	84.0001	71.0846
85.0001	70.9068	86.0001	70.7442
87.0001	70.5924	88.0001	70.4507
89.0001	70.3042	90.0001	70.1593
91.0001	70.0221	92.0001	69.8923
93.0001	69.7696	94.0001	69.6527

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
95.0001	69.5418	96.0001	69.4362
97.0001	69.3349	98.0001	69.2377
99.0001	69.1447	100.	69.0577
101.	68.9764	102.	68.9007
103.	68.8303	104.	68.7649
105.	68.7042	106.	68.6478
107.	68.5956	108.	68.5471
109.	68.5023	110.	68.4607
111.	68.4222	112.	68.3866
113.	68.3537	114.	68.3232
115.	68.2949	116.	68.2688
117.	68.2446	118.	68.2221
119.	68.2016	120.	68.1827
121.	68.1655	122.	68.1498
123.	68.1354	124.	68.1223
125.	68.1103	126.	68.0992
127.	68.0891	128.	68.0798
129.	68.0712	130.	68.0632
131.	68.0557	132.	68.0487
133.	68.0421	134.	68.0358
135.	68.0297	136.	68.0238
137.	68.018	138.	68.0121
139.	68.0062	140.	67.9985
141.	67.9582	142.	67.919
143.	67.8811	144.	67.8442
145.	67.8085	146.	67.7736
147.	67.7393	148.	67.7057
149.	67.6725	150.	67.64
151.	67.608	152.	67.5768
153.	67.5463	154.	67.5166
155.	67.4875	156.	67.4591
157.	67.4312	158.	67.404
159.	67.3774	160.	67.3513
161.	67.3258	162.	67.3007
163.	67.2761	164.	67.252
165.	67.2283	166.	67.2051
167.	67.1822	168.	67.1598

Function 8 Wall Condensation HTX Ind. Var.: Dep. Var.:			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
169.	67.1377	170.	67.1159
171.	67.0945	172.	67.0734
173.	67.0526	174.	67.0321
175.	67.0119	176.	66.9919
177.	66.9721	178.	66.9524
179.	66.9328	180.	66.9134
181.	66.8942	182.	66.8752
183.	66.8565	184.	66.8381
185.	66.8199	186.	66.802
187.	66.7842	188.	66.7665
189.	66.749	190.	66.7316
191.	66.7143	192.	66.6971
193.	66.68	194.	66.663
195.	66.646	196.	66.6291
197.	66.6123	198.	66.5955
199.	66.5788	209.	66.415
219.	66.2703	229.	66.1452
239.	66.0407	249.	65.9498
259.	65.8729	269.	65.8067
279.	65.7518	289.	65.7054
299.	65.6684	309.	65.6384
319.	65.4822	329.	65.332
339.	65.1873	349.	65.0457
359.	64.9072	369.	64.7693
379.	64.633	389.	64.4965
399.	64.3609	409.	64.2244
419.	64.0883	429.	63.9524
439.	63.8188	449.	63.6858
459.	63.5546	469.	63.4237
479.	63.2941	489.	63.1646
499.	63.0361	599.	61.7815
699.	60.5199	799.	59.2629
899.	57.973	999.	56.6961
1099.	55.3918	1199.	54.0459
1299.	52.6972	1399.	51.3745
1499.	50.1468	1599.	49.0052
1699.	48.0775	1799.	47.1675

Function
8
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
1899.	46.2838	1999.	45.4242
2099.	44.5904	2199.	43.7787
2299.	42.9884	2399.	42.2188
2499.	41.4682	2599.	40.7352
2699.	40.0231	2799.	39.3252
2899.	38.6518	2999.	39.7282
3099.	40.593	3199.	41.3578
3299.	42.0341	3399.	42.6585
3499.	43.2326	3599.	43.759
3699.	44.2499	3799.	44.7052
3899.	45.1303	3999.	45.1248
4999.	42.5485	5999.	40.1068
6999.	37.6599	7999.	35.2619
8999.	32.9576	9999.	30.7671
19999.	21.3619	29999.	18.6501
39999.	17.1548	49999.	16.0192
59999.	14.9607	69999.	13.9801
79999.	13.0149	89999.	12.1094
99999.	11.2449	199999.	9.97442
299999.	9.44674	399999.	8.95265
499999.	8.49698	599999.	8.06067
699999.	7.66104	799999.	7.26935
899999.	6.9091	999999.	6.57074
1100000.	6.45591	1200000.	6.39476
1300000.	6.3115	1400000.	6.23837
1500000.	6.14982	1600000.	6.11368
1700000.	6.07941	1800000.	6.03757
1900000.	6.0035	2000000.	5.96926
2100000.	5.91277	2200000.	5.9026
2300000.	5.87032	2400000.	5.83614
2500000.	5.80421	2600000.	5.77205
2700000.	5.7403	2800000.	5.71281
2900000.	5.67726	3000000.	5.66197
3000000.	5.66191		

Function
9
Blowdown Heat Transfer Multiplier
Ind. Var.: Time (sec)
Dep. Var.: Multiplier

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.4	22.	0.4
23.	1.	1000000.	1.

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Function 13 Accumulator Nitrogen Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	38.2	0.
38.3	233.21	58.3	233.21
58.4	0.	1000000.	0.

Volume Initial Conditions

Vol #	Pressure (psia)	Vapor Temp. (F)	Liquid Temp. F	Relative Humidity (%)	Liquid Volume Fraction	Ice Volume Fract.	Ice Surf.A. (ft2)
def	16.85	120.	120.	17.7	1e-05	0.	0.
[ ] a,c							

Initial Gas Pressure Ratios

Vol #	Air Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7	Gas 8
def	1.	0.	0.	0.	0.	0.	0.	0.

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Run Control Parameters (Seconds)								
Time Int	DT Min	DT Max	DT Ratio	End Time	Print Int	Graph Int	Max CPU	Dump Int
1	0.001	0.05	1.	1.	1.	0.1	600.	0.
2	0.001	0.05	1.	600.	50.	2.	600.	0.
3	0.001	0.05	1.	5000.	200.	20.	600.	0.
4	0.001	1.	1.	10000.	400.	200.	600.	0.
5	0.001	10.	1.	1e+05	10000.	5000.	2400.	0.

Run Parameters Menu	
Parameter	Value
Restart Time (sec)	0
Restart Time Step #	0
Restart Time Control	NEW
Revap. Fraction	0
Hetero. Nucleation?	YES
Min. NC HT Coeff. (Btu/ft2-hr-F)	0
Reference Pressure (psia)	0
Forced Ent. Drop Dia. (ft)	0.00833
Vaper Phase Head Cor.?	NO
Solution Method	DIRECT
Include Kinetic Energy?	NO

Ice Condenser Parameters			
Initial Temp. (F)	Bulk Density (lbm/ft3)	Surface Area Multiplier Function	Heat Transfer Option
15.	33.43		UCHIDA

Graphs							
Graph #	Title	Mon	Curve Number 1	2	3	4	5
1	Containment Pre		PR1				
2	Containment Tem		TV1				
3	Sump Water Temp		TL1	TL2			
4	Sump Level		LL1				
5	Fan Cooler Heat		CQ1C				
6	Spray Flow Rate		FD3	FD7	FL7		
7	Metal and Concr		HA1	HA5			
8			TL3				
9			LL3	LL2			
10			FL4				

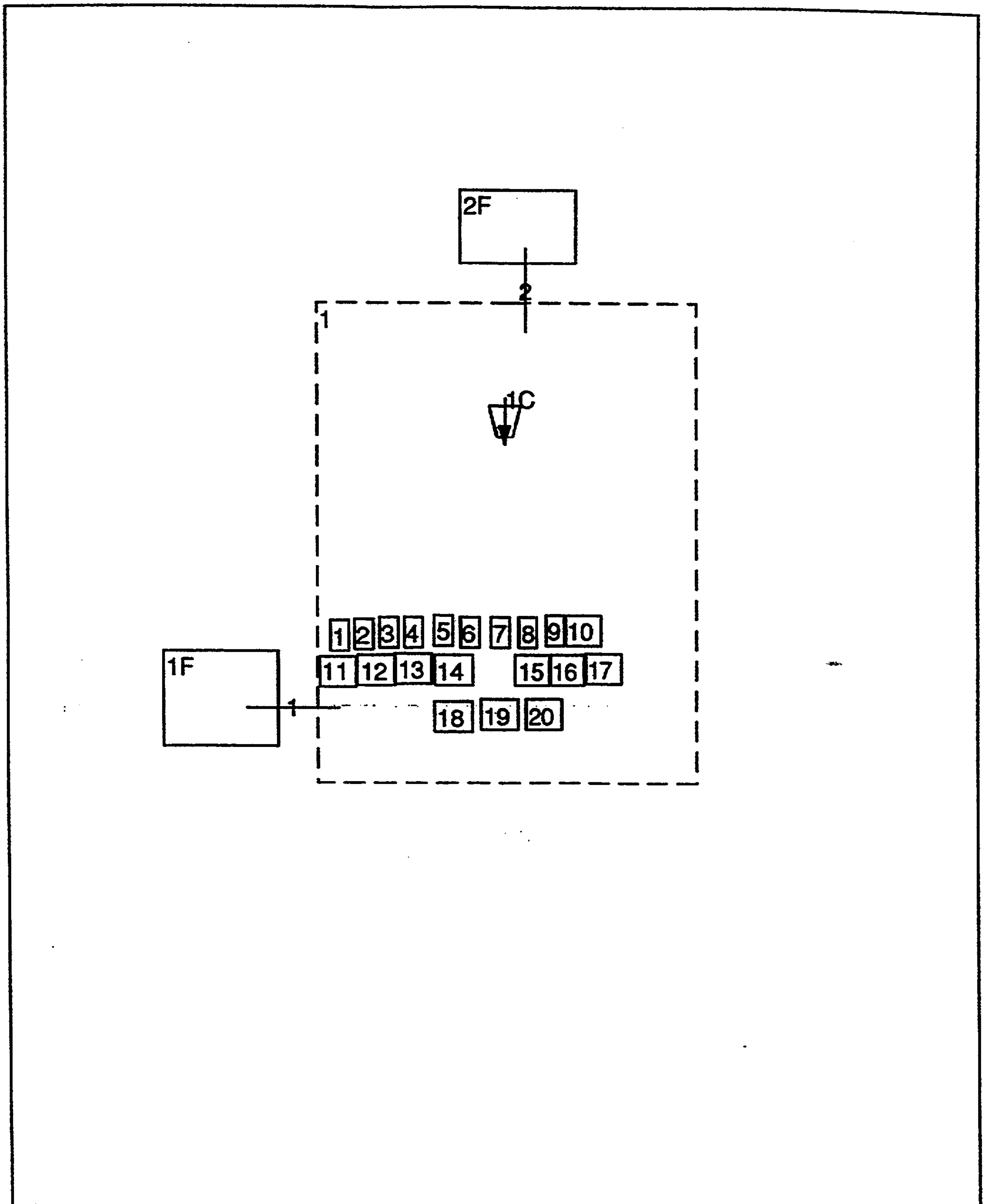
Noncondensing Gases						
Gas No.	Description	Symbol	Type	Mol. Weight	Lennard-Jones Diameter (Ang)	Parameters e/K (K)
1	Air	Air	POLY	28.97	3.617	97.

Noncondensing Gases - Cp/Visc. Equations						
Gas No.	Cp Equation (Required) Tmin (R)	Tmax (R)	Cp (Btu/lbm-R)	Visc. Equation (Optional) Tmin (R)	Tmax (R)	Viscosity (lbm/ft-hr)
1	360.	2280.	0.238534-6.2006			

Appendix C

Phase 2 GOTHIC MSLB Input Deck and Noding Diagram

waunee Containment DBA Model - MSLB Peak Pressure
/11/00 13:33:52
)THIC Version 5.0(QA)-e - October 1996



Control Volumes							
Vol #	Description	Vol (ft3)	Elev (ft)	Ht (ft)	Hyd. D. (ft)	L/V IA (ft2)	Burn Opt
1	Containment Vol	1320000.	0.	100.	10.	0.	NONE

Fluid Boundary Conditions - Table 1										
BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	ON Trip	OFF Trip
1F	Two Phase Break	60.		E1	2	1	1	0	0
2F	Spray from RWST	14.7		100		1	4	2	0

Fluid Boundary Conditions - Table 2													
BC#	Liq. V. Frac.	FF	Stm. P.R.	FF	Drop D. (in)	FF	Cpld BC#	Flow Frac.	FF	Heat (Btu/s)	FF	Outlet Quality	FF
1F	1.		1		0.0039	5						DEFAULT	
2F	1.		1		5e-04							DEFAULT	

Fluid Boundary Conditions - Table 3 Gas Pressure Ratios								
BC#	Air Gas 1	FF	Gas 2	FF	Gas 3	FF	Gas 4	FF
1F	1.							
2F	1.							

Fluid Boundary Conditions - Table 4 Gas Pressure Ratios								
BC#	Gas 5	FF	Gas 6	FF	Gas 7	FF	Gas 8	FF
1F								
2F								

Flow Paths - Table 1							
F.P. #	Description	Vol A	Elev (ft)	Ht (ft)	Vol B	Elev (ft)	Ht (ft)
1	Two Phase Break	1	30.		1F	30.	
2	Spray Flow	1	90.		2F	90.	

Flow Paths - Table 2						
Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	De-Entrmt Frac.	Mom Trn Opt
1	1.	1.	1.	1.		-
2	1.	1.	1.	1.		-

Flow Paths - Table 3					
Flow Path #	Fwd. Loss Coeff.	Rev. Loss Coeff.	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.
1			OFF	OFF	0.0
2			OFF	OFF	0.0

Cond #	Description	Vol A	HT Co	Vol B	HT Co	Cond Type	S. A. (ft2)	Init. T. (F)	Or
1	Containment Cyl	1	1	1	2	1	41300.	120.	I
2	Containment Dom	1	1	1	2	2	19500.	120.	C
3	Reactor Vessel	1	1	1	2	3	1260.	120.	I
4	Refueling Canal	1	1	1	2	4	1100.	120.	I
5	Refueling Canal	1	1	1	2	5	5500.	120.	I
6	Structural Stee	1	1	1	2	6	4055.	120.	I
7	Structural Stee	1	1	1	2	7	16925.	120.	I
8	Structural Stee	1	1	1	2	8	28500.	120.	I
9	Structural Stee	1	1	1	2	9	2000.	120.	I
10	Structural Stee	1	1	1	2	10	500.	120.	I
11	Handrails	1	1	1	2	11	1695.	120.	I
12	Grating	1	1	1	2	12	12400.	120.	I
13	Conduit + Cable	1	1	1	2	13	2000.	120.	I
14	Ductwork	1	1	1	2	14	18000.	120.	I
15	Walls 1.0-1.9 f	1	1	1	2	15	2806.	120.	I
16	Floors >1.0 ft	1	1	1	2	16	12896.	120.	I
17	Walls 4.0-7.3 f	1	1	1	2	17	18588.	120.	I
18	Sump Floor	1	1	1	2	16	1088.	120.	F
19	Walls 2.0-3.2 f	1	1	1	2	16	28898.	120.	I
20	Floors 4.0-10.0	1	1	1	2	18	6810.	120.	I

Thermal Conductors - Table 1

Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
1	No		No	
2	No		No	
3	No		No	
4	No		No	
5	No		No	
6	No		No	
7	No		No	
8	No		No	
9	No		No	
10	No		No	
11	No		No	
12	No		No	

Thermal Conductors - Table 2

Thermal Conductors - Table 2				
Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
13	No		No	
14	No		No	
15	No		No	
16	No		No	
17	No		No	
18	No		No	
19	No		No	
20	No		No	

Heat Transfer Coefficient Types - Table 1										
Type #	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt	Rad Opt
1	Tagami			ADD	UCHI		VERT SURF	PIPE FLOW	OFF
2	Sp Heat	0.							
3	Sp Cond	1.	6	ADD			VERT SURF	PIPE FLOW	OFF
4	Sp Cond	0.4	6	ADD			VERT SURF	PIPE FLOW	OFF
5	Tagami		7	ADD	UCHI		VERT SURF	PIPE FLOW	OFF

Heat Transfer Coefficient Types - Table 2							
Type #	Phase Opt	Min Liq Fract	Max Liq Fract	Convection Bulk Temp Model	FF	Condensation Bulk Temp Model	FF
1	VAP			Tg-Tf		Tb-Tw	
2							
3	VAP			Tg-Tf		Tb-Tw	
4	VAP			Tg-Tf		Tb-Tw	
5	VAP			Tg-Tf		Tb-Tw	

Heat Transfer Coefficient Types - Table 3								
Type #	Char. Length (ft)	Nat Conv Coef FF	Nat Conv Exp FF	For Conv Coef FF	For Conv Exp FF	Nom Vel (ft/s)	Vel FF	Minimum Conv HTC (B/h-f2-F)
1								-1.
2								
3								-1.
4								-1.
5								-1.

HTC Types - Table 4				
Type #	Total Heat (Btu)	Peak Time (sec)	Initial Value (B/h-f2-F)	Post-BD Direct FF
1	0.	0.01	0.	
2				
3				
4				
5	0.	0.01	0.	

Thermal Conductor Types

Type #	Description	Geom	Thick. (in)	O.D. (in)	Regions	Heat (Btu/ft3-s)	Heat FF
1	Painted CS	WALL	1.511	0.	3	0.	
2	Painted CS	WALL	0.761	0.	3	0.	
3	CS Lined Concre	WALL		0.	5	0.	
4	SS Lined Concre	WALL		0.	3	0.	
5	SS Lined Concre	WALL		0.	3	0.	
6	Painted CS	WALL	0.179	0.	3	0.	
7	Painted CS	WALL	0.261	0.	3	0.	
8	Painted CS	WALL	0.386	0.	3	0.	
9	Painted CS	WALL	0.753	0.	2	0.	
10	Painted CS	WALL	1.003	0.	2	0.	
11	Painted CS	WALL	0.083	0.	3	0.	
12	Painted CS	WALL	0.056	0.	3	0.	
13	Painted CS	WALL	0.061	0.	3	0.	
14	Painted CS	WALL	0.046	0.	3	0.	
15	Concrete	WALL	6.014	0.	2	0.	
16	Concrete	WALL	12.014	0.	2	0.	
17	Concrete	WALL	24.014	0.	2	0.	
18	Concrete	WALL	4.014	0.	2	0.	

Thermal Conductor Type
1
Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	1.5	15	0.

Thermal Conductor Type 2 — Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.75	8	0.

Thermal Conductor Type 3 — CS Lined Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.25	5	0.

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Thermal Conductor Type 4 — SS Lined Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	3	0.	0.1875	2	0.

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Thermal Conductor Type 5 SS Lined Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	3	0.	0.25	3	0.

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Thermal Conductor Type 6 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.168	3	0.

Thermal Conductor Type 7 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.25	5	0.

Thermal Conductor Type 8 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.375	10	0.

Thermal Conductor Type 9 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	7	0.	0.003	1	0.
2	2	0.003	0.75	15	0.

Thermal Conductor Type 10 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	7	0.	0.003	1	0.
2	2	0.003	1.	20	0.

Thermal Conductor Type 11 Painted CS					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.

Thermal Conductor Type 11 Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
2	7	0.008	0.003	1	0.
3	2	0.011	0.072	1	0.

Thermal Conductor Type 12 Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.045	1	0.

Thermal Conductor Type 13 Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.05	1	0.

Thermal Conductor Type 14 Painted CS

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.008	1	0.
2	7	0.008	0.003	1	0.
3	2	0.011	0.035	1	0.

Thermal Conductor Type 15 Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.
2	4	0.014	6.	12	0.

Thermal Conductor Type 16 Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.
2	4	0.014	12.	24	0.

Thermal Conductor Type 17 Concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.014	1	0.

Thermal Conductor Type 17 Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
2	4	0.014	24.	48	0.

Thermal Conductor Type 18 Concrete					
Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1 2	1 4	0. 0.014	0.014 4.	1 8	0. 0.

Materials	
Type #	Description
1	Paint
2	Carbon Steel
3	Stainless Steel
4	Concrete
5	Gap
7	Primer

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Material Type 1 Paint			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	1.	0.25	32.4

Material Type 1 Paint			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
500.	1.	0.25	32.4

Material Type 2 Carbon Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	490.	26.	0.115
500.	490.	26.	0.115

Material Type 3 Stainless Steel			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	488.	8.	0.116
500.	488.	8.	0.116

Material Type 4 Concrete			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	144.	0.8	0.2
500.	144.	0.8	0.2

Material Type 5 Gap			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	0.08	0.015	0.213
500.	0.08	0.015	0.213

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Material Type 7 Primer			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
32.	1.	0.9	28.8
500.	1.	0.9	28.8

Cooler/Heater										
Heater Cooler #	Description	Vol. #	On Trip #	Off Trip #	Flow Rate (CFM)	Flow Rate FF	Heat Rate (Btu/s)	Heat Rate FF	Phs Opt	Ctrlr Loc
1C	Fan Cooler 1	1	1		1e+05		4.	3	VTS	1

Component Trips									
Trip #	Sense Var.	Sensor 1 Loc.	Sensor 2 Loc.	Var. Limit	Set Point	Delay Time	Rset Trip	Cond Trip	Cond Type
1	PRESS	1		UPPER	19.7	75.			AND
2	PRESS	1		UPPER	37.7	106.			AND

Functions				
FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1	Blowdown Mass R	Time (sec)	Flow Rate	9724
2	Blowdown Enthal	Time (sec)	Enthalpy (	9724
3	Fan Cooler Heat	Vapor Sat.	Heat Remov	6
4	Spray Flow Rate	Time (sec)	Flow Rate	5
5	Break Drop Diam	Time (sec)	Multiplier	4
6	Wall Condensati	Ind. Var.	Dep. Var.	311
7	Blowdown Heat T	Time (sec)	Multiplier	4

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Function 1 Blowdown Mass Release Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	4740.
0.003	4740.	0.007	4740.
0.015	4750.	0.031	4750.
0.063	4770.	0.127	4810.
0.227	4860.	0.327	4910.
0.427	4960.	0.527	5000.
0.627	5060.	0.727	5120.
0.827	5190.	0.927	5270.

Function
2
Blowdown Enthalpy Release
Ind. Var.: Time (sec)
Dep. Var.: Enthalpy (BTU/lbm)

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.001	1200.
0.003	1200.	0.007	1200.
0.015	1200.	0.031	1190.
0.063	1190.	0.127	1180.
0.227	1170.	0.327	1160.
0.427	1140.	0.527	1130.
0.627	1110.	0.727	1100.
0.827	1080.	0.927	1060.
1.03	1050.	1.13	1040.
1.23	1030.	1.33	1020.
1.34	1020.	1.35	1020.
1.38	1020.	1.43	1010.
1.49	1010.	1.55	1000.
1.61	1000.	1.67	995.
1.73	989.	1.79	984.
1.85	979.	1.92	974.
1.98	968.	2.04	966.
2.1	967.	2.16	967.
2.22	967.	2.28	967.
2.34	968.	2.4	968.
2.47	968.	2.53	968.
2.59	969.	2.65	969.
2.71	969.	2.77	969.
2.83	970.	2.89	970.
2.95	970.	3.02	971.
3.08	972.	3.14	973.
3.2	974.	3.26	975.
3.32	976.	3.38	977.
3.44	979.	3.5	980.
3.57	981.	3.63	982.
3.69	983.	3.75	985.
3.81	986.	3.87	987.
3.93	988.	3.99	990.
4.06	990.	4.12	991.
4.18	992.	4.24	992.
4.3	993.	4.36	994.
4.42	994.	4.48	995.

Function 3 Fan Cooler Heat Removal vs. Vapor Temp. Ind. Var.: Vapor Sat. Temp. (F) Dep. Var.: Heat Removal (BTU/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
100.	866.67	136.	2944.44
205.	8750.	244.	13111.1
270.	15833.3	350.	15833.3

Function 4 Spray Flow Rate Ind. Var.: Time (sec) Dep. Var.: Flow Rate (lbm/s)			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.1	343.3
3600.	343.3	3601.	0.
1000000.	0.		

Function 5 Break Drop Diameter Multiplier Ind. Var.: Time (sec) Dep. Var.: Multiplier			
Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	1.	100.	1.
101.	0.	1000000.	0.

Function
6
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	0.500001	31.0535
1.	43.9163	2.	62.107
3.	76.0652	4.	87.8325
5.00001	98.1997	6.00001	107.572
7.00001	116.191	8.00001	124.214
9.00001	131.749	10.	138.875
11.	145.654	12.	152.13
13.	158.342	14.	164.32
15.	170.087	16.	175.665
17.	181.071	18.	186.321
19.	191.426	20.	196.399
21.	201.249	22.	205.985
23.	198.704	24.	191.757
25.	185.136	26.	178.833
27.	172.839	28.	167.144
29.	161.738	30.	156.607
31.	151.744	32.	147.135
33.	142.766	34.	138.624
35.	134.695	36.	130.971
37.	127.439	38.	124.093
39.	120.921	40.	117.916
41.	115.068	42.	112.373
43.	109.821	44.	107.406
45.	105.122	46.	102.961
47.	100.918	48.	98.9866
49.	97.1614	50.	95.4373
51.0001	93.8087	52.0001	92.2711
53.0001	90.8193	54.0001	89.4495
55.0001	88.1571	56.0001	86.9384
57.0001	85.7895	58.0001	84.7071
59.0001	83.6873	60.0001	82.7271
61.0001	81.8233	62.0001	80.9732
63.0001	80.1737	64.0001	79.4224
65.0001	78.7166	66.0001	78.0377
67.0001	77.3995	68.0001	76.8003
69.0001	76.2375	70.0001	75.7096
71.0001	75.2145	72.0001	74.7506

Function
6
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
73.0001	74.316	74.0001	73.9095
75.0001	73.5292	76.0001	73.1741
77.0001	72.8425	78.0001	72.5333
79.0001	72.2452	80.0001	71.9771
81.0001	71.7279	82.0001	71.4966
83.0001	71.2821	84.0001	71.0846
85.0001	70.9068	86.0001	70.7442
87.0001	70.5924	88.0001	70.4507
89.0001	70.3042	90.0001	70.1593
91.0001	70.0221	92.0001	69.8923
93.0001	69.7696	94.0001	69.6527
95.0001	69.5418	96.0001	69.4362
97.0001	69.3349	98.0001	69.2377
99.0001	69.1447	100.	69.0577
101.	68.9764	102.	68.9007
103.	68.8303	104.	68.7649
105.	68.7042	106.	68.6478
107.	68.5956	108.	68.5471
109.	68.5023	110.	68.4607
111.	68.4222	112.	68.3866
113.	68.3537	114.	68.3232
115.	68.2949	116.	68.2688
117.	68.2446	118.	68.2221
119.	68.2016	120.	68.1827
121.	68.1655	122.	68.1498
123.	68.1354	124.	68.1223
125.	68.1103	126.	68.0992
127.	68.0891	128.	68.0798
129.	68.0712	130.	68.0632
131.	68.0557	132.	68.0487
133.	68.0421	134.	68.0358
135.	68.0297	136.	68.0238
137.	68.018	138.	68.0121
139.	68.0062	140.	67.9985
141.	67.9582	142.	67.919
143.	67.8811	144.	67.8442
145.	67.8085	146.	67.7736

Function
6
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
147.	67.7393	148.	67.7057
149.	67.6725	150.	67.64
151.	67.608	152.	67.5768
153.	67.5463	154.	67.5166
155.	67.4875	156.	67.4591
157.	67.4312	158.	67.404
159.	67.3774	160.	67.3513
161.	67.3258	162.	67.3007
163.	67.2761	164.	67.252
165.	67.2283	166.	67.2051
167.	67.1822	168.	67.1598
169.	67.1377	170.	67.1159
171.	67.0945	172.	67.0734
173.	67.0526	174.	67.0321
175.	67.0119	176.	66.9919
177.	66.9721	178.	66.9524
179.	66.9328	180.	66.9134
181.	66.8942	182.	66.8752
183.	66.8565	184.	66.8381
185.	66.8199	186.	66.802
187.	66.7842	188.	66.7665
189.	66.749	190.	66.7316
191.	66.7143	192.	66.6971
193.	66.68	194.	66.663
195.	66.646	196.	66.6291
197.	66.6123	198.	66.5955
199.	66.5788	209.	66.415
219.	66.2703	229.	66.1452
239.	66.0407	249.	65.9498
259.	65.8729	269.	65.8067
279.	65.7518	289.	65.7054
299.	65.6684	309.	65.6384
319.	65.4822	329.	65.332
339.	65.1873	349.	65.0457
359.	64.9072	369.	64.7693
379.	64.633	389.	64.4965
399.	64.3609	409.	64.2244

Function
6
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
419.	64.0883	429.	63.9524
439.	63.8188	449.	63.6858
459.	63.5546	469.	63.4237
479.	63.2941	489.	63.1646
499.	63.0361	599.	61.7815
699.	60.5199	799.	59.2629
899.	57.973	999.	56.6961
1099.	55.3918	1199.	54.0459
1299.	52.6972	1399.	51.3745
1499.	50.1468	1599.	49.0052
1699.	48.0775	1799.	47.1675
1899.	46.2838	1999.	45.4242
2099.	44.5904	2199.	43.7787
2299.	42.9884	2399.	42.2188
2499.	41.4682	2599.	40.7352
2699.	40.0231	2799.	39.3252
2899.	38.6518	2999.	39.7282
3099.	40.593	3199.	41.3578
3299.	42.0341	3399.	42.6585
3499.	43.2326	3599.	43.759
3699.	44.2499	3799.	44.7052
3899.	45.1303	3999.	45.1248
4999.	42.5485	5999.	40.1068
6999.	37.6599	7999.	35.2619
8999.	32.9576	9999.	30.7671
19999.	21.3619	29999.	18.6501
39999.	17.1548	49999.	16.0192
59999.	14.9607	69999.	13.9801
79999.	13.0149	89999.	12.1094
99999.	11.2449	199999.	9.97442
299999.	9.44674	399999.	8.95265
499999.	8.49698	599999.	8.06067
699999.	7.66104	799999.	7.26935
899999.	6.9091	999999.	6.57074
1100000.	6.45591	1200000.	6.39476
1300000.	6.3115	1400000.	6.23837
1500000.	6.14982	1600000.	6.11368

Function
6
Wall Condensation HTX
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
1700000.	6.07941	1800000.	6.03757
1900000.	6.0035	2000000.	5.96926
2100000.	5.91277	2200000.	5.9026
2300000.	5.87032	2400000.	5.83614
2500000.	5.80421	2600000.	5.77205
2700000.	5.7403	2800000.	5.71281
2900000.	5.67726	3000000.	5.66197
3000000.	5.66191		

Function
7
Blowdown Heat Transfer Multiplier
Ind. Var.: Time (sec)
Dep. Var.: Multiplier

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.4	7.5	0.4
7.6	1.	1000000.	1.

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Volume Initial Conditions							
Vol #	Pressure (psia)	Vapor Temp. (F)	Liquid Temp. F	Relative Humidity (%)	Liquid Volume Fraction	Ice Volume Fract.	Ice Surf.A. (ft2)
def	16.85	120.	120.	17.	0.	0.	0.

Initial Gas Pressure Ratios								
Vol #	Air Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7	Gas 8
def	1.	0.	0.	0.	0.	0.	0.	0.

Run Control Parameters (Seconds)								
Time Int	DT Min	DT Max	DT Ratio	End Time	Print Int	Graph Int	Max CPU	Dump Int
1	0.001	0.05	1.	390.	20.	1.	1200.	0.

Run Parameters Menu	
Parameter	Value
Restart Time (sec)	0
Restart Time Step #	0
Restart Time Control	NEW
Revap. Fraction	0.08
Hetero. Nucleation?	YES
Min. NC HT Coeff. (Btu/ft2-hr-F)	0
Reference Pressure (psia)	0
Forced Ent. Drop Dia. (ft)	0.00833
Vaper Phase Head Cor.?	NO
Solution Method	DIRECT
Include Kinetic Energy?	NO

Ice Condenser Parameters			
Initial Temp. (F)	Bulk Density (lbm/ft3)	Surface Area Multiplier Function	Heat Transfer Option
15.	33.43		UCHIDA

Graphs							
Graph #	Title	Mon	Curve Number 1	2	3	4	5
1	Containment Pre		PR1				
2	Containment Tem		TV1				
3	Sump Water Temp		TL1				

Graphs							
Graph #	Title	Mon	Curve Number 1	2	3	4	5
4	Sump Level		LL1				
5	Fan Cooler Heat		CQ1C				
6	Spray Flow Rate		FD2				
7	Metal and Concr		HA1	HA5			
8	Sump Mass		AL1	DL1			
9	Drop Mass		AD1	DD1			

Noncondensing Gases						
Gas No.	Description	Symbol	Type	Mol. Weight	Lennard-Jones Diameter (Ang)	Parameters e/K (K)
1	Air	Air	POLY	28.97	3.617	97.

Noncondensing Gases - Cp/Visc. Equations						
Gas No.	Cp Equation (Required) Tmin (R)	Tmax (R)	Cp (Btu/lbm-R)	Visc. Equation (Optional) Tmin (R)	Tmax (R)	Viscosity (lbm/ft-hr)
1	360.	2280.	0.238534-6.2006			

ATTACHMENT 3

Letter from Mark E. Reddemann (WPSC)

To

Document Control Desk (NRC)

Dated

April 27, 2001

WCAP-15427, Rev 1
"Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant."

Westinghouse authorization letter, CAW-01-1448, accompanying affidavit, Proprietary Information Notice, and Copyright Notice.

Westinghouse Electric Company, LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

April 19, 2001

CAW-01-1448

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant", WCAP-15427, Revision 1 (Proprietary), April 2001

Dear Mr. Collins:

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-01-1448 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Nuclear Management Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-01-1448 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosures

cc: S. Bloom/NRR/OWFN/DRPW/PDIV2 (Rockville, MD) 1L

P:DATA/DOCUMENTS/0557s

CAW-01-1448

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared H. A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 19th day
of April, 2001

Notary Public

Notarial Seal
Patricia L. Crown, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Feb. 7, 2005
Member, Pennsylvania Association of Notaries

PATRICIA L. CROWN
COMMONWEALTH OF PENNSYLVANIA
NOTARY PUBLIC

P:DATA/DOCUMENTS/0557s

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Business Unit of the Westinghouse Electric Company LLC ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse Application for Withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Electric Company LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Development and Qualification of a GOTHIC Containment Evaluation Model for the Kewaunee Nuclear Power Plant", WCAP-15427, Revision 1 (Proprietary), April 2001 for information in support of Nuclear Management Company's submittal to the Commission, transmitted via Nuclear Management Company's letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention: Mr. Samuel J. Collins. The proprietary information was provided by Westinghouse Electric Company LLC.

This information is part of that which will enable Westinghouse to:

(a) Provide documentation of the methods to be used to employ Westinghouse models for performing containment design basis analyses.

(b) Assist the customer in the licensing process.

Further this information has substantial commercial value as follows:

(a) Westinghouse's plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of this information to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar licensing support documentation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar design programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).