Enclosure 3

UAP-HF-08083, Rev.0

Response Package to NRC's Requests for Additional Information

on

Topical Report MUAP-07012-P(R0) LOCA Mass and Energy Release Analysis Code Applicability Report for US-APWR

April 2008
(Non-Proprietary)

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on

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Non-Proprietary Version

April 2008

Table of Contents

INTRODUCTION

The following NRC's RAIs concerning the topical report, MUAP-07012-P(R0), "LOCA Mass and Energy Release Analysis Code Applicability Report for US-APWR" are responded to in the referenced reports below.

- "REQUEST FOR ADDITIONAL INFORMATION ON MASS AND ENERGY RELEASE ANALYSIS CODE APPLICABILITY FOR US-APWR TOPICAL REPORT MUAP-07012-P" dated December 31, 2007
- "A FOLLOW-UP REQUEST FOR ADDITIONAL INFORMATION ON MASS AND ENERGY RELEASE ANALYSIS CODE APPLICABILITY FOR US-APWR TOPICAL REPORT MUAP-07012-P" dated January 30, 2008

The referenced reports are integrated into this report. This report also provides partial responses to the requests received at the beginning of March 2008.

Table 0-1 shows the status for the responses to the requests on the topical report. The responses will be attached to the topical report as well as incorporated into the body of the report as shown in Table 0-1.

References

1. "MHI's Responses to NRC's Requests for Additional Information on Topical Report MUAP-07012-P(R0) LOCA Mass and Energy Release Analysis Code Applicability Report for US-APWR," UAP-HF-08033-P(Proprietary), UAP-HF-08033-NP(Non-Proprietary), January 2008.
2. "MHI's Second Responses to NRC's Requests for Additional Information on Topical Report MUAP-07012-P(R0) LOCA Mass and Energy Release Analysis Code Applicability Report for US-APWR," UAP-HF-08049-P(Proprietary), UAP-HF-08049-NP(Non-Proprietary), February 2008.
3. "MHI's Response to NRC's Follow-Up Request for Additional Information on Mass and Energy Release Analysis Code Applicability for US-APWR Topical Report MUAP-07012-P," UAP-HF-08048-P(Proprietary), UAP-HF-08048-NP(Non-Proprietary), February 2008.

Table 0-1 Status for Responses to RAIs

Item No.	Status for Responses	Revision of Topical Report to be Submitted	
RAIs dated December 31, 2007			
1a	Same as UAP-HF-08033	Being included in	Subsection 3.2.3.1
1b	Same as UAP-HF-08033		Subsection 3.2.3.1
2	Same as UAP-HF-08033		Subsection 3.3.2.2
3	Same as UAP-HF-08033		Section 3.4
4	Same as UAP-HF-08033		Section 3.4
5	Same as UAP-HF-08033		Section 3.4
6	Same as UAP-HF-08033		Subsection 3.2.3
7	Same as UAP-HF-08033		Section 3.4
8	Same as UAP-HF-08049		Section 3.4
9	Same as UAP-HF-08033		Subsection 3.2.1
10	Same as UAP-HF-08033	Not Applicable	
11a	Same as UAP-HF-08049	Being included in	Section 3.4
11b	Same as UAP-HF-08033		Subsection 3.3.2.2
11c	Same as UAP-HF-08033		Subsection 3.3.2.2
11d	Same as UAP-HF-08033		Subsection 3.3.2.2
11e	Same as UAP-HF-08033		Subsection 3.3.2.2
11f	Same as UAP-HF-08033		Subsection 3.3.2.2
11g	Same as UAP-HF-08033		Subsection 3.3.2.2
11h	Same as UAP-HF-08033		Subsection 3.3.2.2
11i	Same as UAP-HF-08033		Subsection 3.3.2.2
11j	Same as UAP-HF-08033		Subsection 3.3.2.2
11k	Same as UAP-HF-08049		Section 3.4
12	Same as UAP-HF-08033		Section 3.4
13	Same as UAP-HF-08033		Section 3.4
14	Response in UAP-HF-08033 is supplemented		Section 3.4
15	Same as UAP-HF-08033		Subsection 3.2.3
16	Same as UAP-HF-08049		Appendix D (added)
17	Same as UAP-HF-08049		Appendix D (added)
18	Same as UAP-HF-08033		Subsection 3.2.3
Follow-up Request dated January 30, 2008			
19	Same as UAP-HF-08048	Not Applicable	
Requests in March, 2008			
20	Response partially provided in this report	Being included in	Appendix E (added)
21	Response provided in this report		Section 3.2.3

1.0 Responses to RAIs dated December 31, 2007

Item 1

Beginning on page 3-3, modeling of the advanced accumulator within the SATAN-IV and WREFLOOD computer codes is described.

Item 1a

Please describe any differences between this modeling and the advanced accumulator model in WCOBRA/TRAC that will be used to show compliance with 10CFR50.46. If differences exist, justify that the effect will lead to conservative containment analyses. If there are no significant differences, the staff plans to perform only one review for the advanced accumulator model in all 3 computer codes.

RESPONSE

The equations used to calculate the accumulator performance are identical for all three codes and there are no significant differences that affect the calculated accumulator flow rate. The main difference in modeling of the accumulator among these codes is that the accumulator injection line is treated as a path in the model for SATAN-VI and WREFLOOD while it is explicitly modeled as a control volume with multiple cells for WCOBRA/TRAC. Therefore, the flow damper outlet pressure, P_D, used in the following equation for the cavitation factor has to be calculated with an iterative scheme in the SATAN-VI and WREFLOOD as described in Appendix A and Appendix B of the topical report, while P_D is obtained from the pressure of the cell next to the accumulator tank in the WCOBRA/TRAC calculation.

In calculating P_D with the iterative scheme, accumulator flow is assumed to be quasi-steady, as explained in the response to Item 1b.

$$\sigma_v = \frac{P_D + P_{at} - P_v}{\left(P_{gas} + \rho g H_t\right) - \left(P_D + \frac{\rho V_D^2}{2} + \rho g H_D\right)}$$

σ_v : Cavitation factor
P_{at} : Atmospheric pressure
P_D : Flow damper outlet pressure (gage)
P_{gas} : Gas pressure in accumulator (gage)
P_v : Saturated vapor pressure
V_D : Fluid velocity of the injection piping
ρ : Density of water
g : Acceleration of gravity
H_t : Difference in height between accumulator water level and vortex chamber
H_D : Difference in height between flow damper outlet piping and vortex chamber

Item 1b

The description of the advanced accumulator flow model appears to be quasi-steady so as not to account for fluid inertia in the injection path. Please provide a discussion on the effect of not including injection path fluid inertia on the containment analysis.

RESPONSE

Fluid inertia effects are potentially significant only when the rate of change of the flow rate is large. So the discussion here is focused on the blowdown phase. Fluid inertia in the injection path is accounted for in the momentum equation of the SATAN code. However, it is not accounted for to calculate the resistance of the flow damper.

Fluid inertia affects the cavitation factor, σ_v, through the damper exit pressure, P_D, as described in the response to Item 1a.

Figure 1-1 shows the relation between σ_v and flow rate coefficient, Cv. The resistance of the flow damper, K, is related to Cv by $K=1.0/Cv^2$. The upper curve gives the relation between σ_v and Cv for the large-flow phase, which covers the blowdown phase. This curve indicates that Cv is essentially unaffected by changes in σ_v when σ_v is larger than around 5.

Figure 1-2 shows the transient of σ_v of the intact-loop accumulator during the blowdown phase, which indicates that σ_v is large enough not to affect Cv especially in the early blowdown phase when the effect of fluid inertia is large. This demonstrates that even if P_D is changed by fluid inertia, in turn leading to a change of σ_v, Cv is not affected.

Figure 1-1 Characteristics of Flow Damper

Figure 1-2 Cavitation Factor during Blowdown Phase

Item 2

On page 3-3 the advanced accumulator model that is built into SATAN-VI and WREFLOOD is described. On page 3-15 injection of accumulator water into a cold leg using the US-APWR GOTHIC model is discussed. Has GOTHIC also been modified to include a model of the advanced accumulator? If so please describe this model and justify that it is conservative for containment analysis.

RESPONSE

GOTHIC has not been modified to include a model of the advanced accumulator because during the post-reflood phase the accumulator operates in the low flow mode, in which the flow resistance is nearly constant. The accumulator is modeled using basic GOTHIC modeling elements. The model includes the accumulator tank with the end of reflood water inventory and gas pressure specified. The flow from the accumulator is calculated by GOTHIC for the flow path connecting the accumulator to the cold leg with an constant resistance factor, whose value is calculated at the end of reflood in WREFLOOD (M1.0). Uncertainty of the flow resistance is included in the sensitivity studies for accumulator parameters.

Table 2-1 shows the result of the hand calculation using characteristics of the accumulator flow damper in order to confirm that the resistance factor at the end of reflood is appropriate on the accumulator conditions during long-term cooling period. The hand calculation was performed with the method described in Appendix B of the topical report. This result indicates that the flow resistance inputted in GOTHIC is consistent with the calculated value using accumulator conditions during long-term period.

Table 2-1 Hand Calculation of Accumulator Resistance Coefficient

Item 3

On page 3-5 it is stated that the treatment of uncertainties in the accumulator initial conditions (pressure, water mass and the injection pipe resistance) will be established by sensitivity studies. When will these sensitivity studies, as they relate to containment analysis, be completed and submitted for NRC staff review?

RESPONSE

These sensitivity studies are described in Subsection 6.2.1.1.3.4 of the US-APWR DCD.

The analyzed conditions and the results of the sensitivity studies are shown in Table 3-1. For the limiting case, minimum accumulator water volume and pressure and maximum injection resistance are assumed, to minimize steam condensation by the injected water. Sensitivity analyses demonstrate that the accumulator water volume, pressure, and injection resistance assumed for the limiting case give the most severe results. These parameters, however, do not have a large effect on the peak containment pressure and temperature because the peak pressure appears in the long term cooling phase, when steam condensation resulting from the accumulator water injection is relatively small compared to that in the reflood phase.

Table 3-1 Summary of Sensitivity of ECCS Conditions on the Containment Pressure and Temperature

Case	Limiting Case	Accumulator Max Water	Accumulator Max Flow
Break Location	Pump Suction	Pump Suction	Pump Suction
Break Size and Type	C_D=1.0 Double Ended Guillotine	C_D=1.0 Double Ended Guillotine	C_D=1.0 Double Ended Guillotine
Offsite Power	Lost	Lost	Lost
Assumption for Out of service*	1 Emergency Generator	1 Emergency Generator	1 Emergency Generator
Single Failure	1 Emergency Generator	1 Emergency Generator	1 Emergency Generator
Safety Injection	2 SIP Operation Minimum Safeguard	2 SIP Operation Minimum Safeguard	2 SIP Operation Minimum Safeguard
Accumulator Water Volume	Minimum	Maximum	Minimum
Accumulator Pressure	Minimum	Minimum	Maximum
Accumulator Line Resistance	Maximum	Maximum	Minimum
Peak Pressure, psia (psig)	72.2 (57.5)	71.9 (57.2)	72.1 (57.4)
Peak Atmospheric Temperature, °F	282	282	281
Peak RWSP Water Temperature, °F	251	251	251
24 hours Pressure, psia (psig)	23.6 (8.9)	Expected to be sufficiently low	Expected to be sufficiently low

* Out of service basis for the limiting conditions (maintenance or operation surveillance)

Item 4

The topical report states that the SATAN-VI(M1.0) computer code will be used to describe the blowdown portion of a LOCA and the WREFLOOD(M1.0) computer code will be used to describe the reflood portion. Please describe the transition between the SATAN-VI(M1.0) and WREFLOOD(M1.0) analyses in greater detail. For the sample calculation in MUAP-07012, provide the reactor system water mass and temperature, temperature of the fuel in the core, the neutron reflector, reactor vessel heavy metal, steam generator heavy metal and steam generator water mass and temperature at the time of transition.

RESPONSE

The blowdown period is defined as the time from the accident inception, at steady state 102 % power operation, to the time that the Reactor Coolant System has depressurized to the containment pressure. The refill period is defined as the period from the end of blowdown to the time that the vessel lower plenum has been refilled by the ECCS. The reflood period is defined to the period from the time when water enters the active core to the time that the reactor core is quenched.

The SATAN-VI computer code has a model for calculating counterflow conditions in vertical flow paths by utilizing a drift flux approach. The most significant use of this model is in the calculation of sustained downflow of the accumulator water in the downcomer (called end of bypass). It is used to more accurately calculate the water inventory in the vessel at end of blowdown. This model is incorporated to comply with the requirements of 10 CFR 50.46 and does not affect the mass and energy release results significantly since the reactor vessel lower plenum is conservatively assumed to be full at the end of blowdown. That is, the refill period is conservatively assumed to be 0 seconds. This assumption is in conformance with Acceptance Criterion 1.C.iii. of SRP 6.2.1.3.

WREFLOOD reads temperatures and mass inventory at the end of blowdown period from SATAN-VI (1.0). Then the code calculates the transient for the refill period during which the water level in the reactor vessel increases due to the ECCS injection, until it reaches the bottom of the fuel rods. With this calculation, the vessel inventory and the parameters related to the ECCS are updated. The problem time, however, is retained at the end of blowdown. Then calculation for reflood period starts.

The reactor system water mass and temperature, temperature of the fuel in the core, the neutron reflector, reactor vessel heavy metal, steam generator heavy metal and steam generator water mass and temperature at the time of transition for the limiting case in the US-APWR DCD are provided in Table 4-1.

Table 4-1 Water Mass and RCS Temperature Transient

Item 5

The staff could not find a description of treatment for the refill period following a LOCA in the topical report. Please describe treatment of this period of analysis and justify that this treatment is conservative.

RESPONSE

As described in the response to Item 4, the refill period is conservatively assumed to be zero seconds to initiate mass and energy release with the core reflood earlier.

Item 6

The topical reports described modeling of the advanced accumulator in SATAN-VI and WREFLOOD to produce the (M1.0) versions of the code. Please describe all other changes in SATAN-VI and WREFLOOD and justify that they are conservative for containment analysis.

RESPONSE

SATAN Changes (1 item):

(1) Modification of initial Neutron Reflector (NR) metal temperature.
NR is modeled using metal model in SATAN-VI. In the normal power operation, the neutron reflector metal temperature is higher than the coolant temperature due to the heat generated by gamma ray absorption. SATAN-VI is modified to allow different initial temperatures for the metal and fluid.

WREFLOOD Changes (5 items):

(1) Steam-Water Mixing model in WREFLOOD
High pressure SI of the US-APWR injects directly into the reactor vessel downcomer (DVI). The nozzle elevation in the downcomer is almost same as the bottom of the inlet nozzle as shown in Figure 2-4 of the topical report. Hence, SI water readily mixes with accumulated water in the downcomer when the downcomer is full. Contact between the injected water and steam from the intact loop is very limited in this situation.

Consequently, it is assumed that no mixing of the DVI water with the steam in the downcomer. This assumption is actually implemented in WREFLOOD (M1.0) by a revision of the mass and energy balance for the downcomer. Complete mixing of DVI flow and water flow from the intact loop is assumed for calculating the enthalpy of the water entering the downcomer. All flow from DVI and the intact loop is added to the downcomer water when the downcomer is not full. When the downcomer is full, the combined DVI and intact loop flow that is in excess of the core inlet flow is spilled to the containment. The enthalpy of this spillage is the mixture enthalpy of the combined DVI and intact loop water flow. Steam flow from the intact loop passes the downcomer with no interaction with DVI flow. Condensation due to direct contact of DVI water flow with steam flow from the intact loop in the downcomer is disregarded.

The treatment of the DVI injection is conservative since any condensation potential of the DVI is reduced in WREFLOOD (M1.0).

(2) Modification of neutron reflector (NR) metal heat

[

] Validity of the modeling approach for a conservative analysis is confirmed in Appendix C of the topical report.

(3) Coupling of WREFLOOD with GOTHIC

US-APWR has RWSP in the containment and the RWSP is water source of the high head injection system. RWSP water temperature changes during LOCA transient. Hence, coupled calculation of WREFLOOD with GOTHIC is enabled to make the injected water temperature consistent with RWSP temperature calculated in GOTHIC.

Communication between WREFLOOD and GOTHIC is conducted by the existing IPC (Inter-Process Communication) function of GOTHIC and no modification of GOTHIC is required. WREFLOOD is modified by the addition of two subroutines to communicate with GOTHIC and code logic to set the current containment pressure and RWSP water temperature in WREFLOOD to match the current GOTHIC calculated values.

Data transferred from WREFLOOD to GOTHIC are as follows:

WREFLOOD time
Break flow (SG side)
Break flow enthalpy (SG side)
Break flow (RCP side)
Break flow enthalpy (RCP side)
DVI flow
Spilt flow
Spilt flow enthalpy

Data transferred from GOTHIC to WREFLOOD are as follows:

GOTHIC time
Containment pressure
RWSP water enthalpy

Validation of this function is confirmed by comparing transferred data in both sender and receiver sides.

(4) Modification of core fuel rod numbers

(5) Modification of FOUT correlation.
The FOUT correlation calculates the fraction of core total outlet mass flow to the inlet mass flow, F_{out}. In WREFLOOD (M1.0) the input parameters to FOUT are modified for conservatism as follows:

[ ]

The above description is included in Subsection 3.2.3.5 of the topical report.

Item 7

The topical report references NRC staff approved Westinghouse methodology described in WCAP-10325-P-A. The WCAP provides lists of modeling options that were utilized in tables 1 through 4. Please provide comparisons of the options in these tables to those selected for analysis of USA-PWR. If differences exist, justify that the selected options are conservative.

RESPONSE

Comparisons of the options in the tables (7-1 through 7-4) to those selected for analysis of US-APWR are provided below. They show that, except for table 7-4, standard model options are used for the US-APWR. In table 7-4, PREF and HINJ are supplied from GOTHIC calculated values, since they are available through the simultaneous calculation with GOTHIC. The GOTHIC model is constructed to give conservatively high values for the containment pressure and RWSP enthalpy.

Table 7-1 Model Differences between SATAN V , SATAN VI and SATAN VI (M1.0)

	SATAN V	SATAN VI	SATAN VI (M1.0)
Drift Flux Model	No	Yes	Yes
Momentum Flux	No	Yes	Yes
Two Phase Pump Model	Simplified Model	Dynamic 2 ϕ Pump Model	Dynamic 2 ϕ Pump Model
Core Heat Release Model	Externally Calculated	Internally Calculated	Internally Calculated
Wall Heat Transfer Correlation (Nucleate Boiling)	Jens-Lottes	Thom	Thom
Thin Metal Heat Release Model	Externally Calculated	Internally Calculated	Internally Calculated
Film Boiling Heat Transfer Correlation	Dougall-Rohsenow	Westinghouse Transition Boiling	Westinghouse Transition Boiling

Table 7-2 SATAN VI and SATAN VI (M1.0) Comparisons of Significant Standard Inputs for ECCS & MASS/ENERGY RELEASE ANALYSES

Input	Appendix K ECCS Analysis	Mass & Energy Release Analysis SATAN VI	Mass & Energy Release Analysis SATAN VI (M1.0)
IMAX	49	71	71
IUCP	0	1	1
IDNB	3	2	2
NCORE	8	2	2
NCHAN	2	1	1
NHOT(1)	6	1	1
PCONT	Minimum Value	Maximum Value	Maximum Value
VWABG1	Intact Loop	Broken Loop	Broken Loop
VWABG2	Broken Loop	Intact Loop	Intact Loop
DNBR	1	0.7	0.7
CON(1)	1	0	0
CON(2)	1	0	0
CON(7)	1	0	0
CON(8)	0	1	1
CON(13)	Minimum Value	Maximum Value	Maximum Value

Table 7-3 MODEL DIFFERENCES BETWEEN VERSIONS OF WREFLOOD

	WREFLOOD(IAC)	WREFLOOD(FAC)	WREFLOOD(M1.0)
Injection Section Pressure Drop	No	Yes – Not Used for M & E Analyses	Yes – Not Used for M & E Analyses
Injection section Steam/Water Mixing	No	Yes	Yes – for Accumulator Injection No – for HHIS (DVI Injection)
Two Phase Pressure Drop Multiplier	No	Yes	Yes

Table 7-4 Comparisons of Significant Standard REFLOOD Inputs for ECCS and Mass & Energy Release Analysis

Input	ECCS value	M & E Value (WREFLOOD)	M & E Value (WREFLOOD (M1.0))	Comment
ITSAT	3	4	4	This input when set to a value of 4 defines the case as a mass & energy release analysis.
IPMP	0	1	1	Reactor Coolant Pumps homologous curves are used for M & E analyses.
PREF	Calculated Containment Pressure	Containment Design Pressure	Calculated Containment Pressure	Calculated containment pressure is conservatively high.
HINJ	Minimum RWSP Water Enthalpy	Maximum RWSP Water Enthalpy	Calculated RWSP Water Enthalpy	Maximum initial RWSP water enthalpy is used.

Item 8

Steam flow to the containment using the WREFLOOD code will be dependant on the piping resistances assumed for the reactor system. Please quantify the degree of conservatism which will be used in selecting piping resistances for the containment analysis.

RESPONSE

WREFLOOD analysis uses best estimate design value of primary loop piping resistance. A sensitivity analysis was performed to confirm quantitative effect of piping resistance error on the containment pressure. The sensitivity study used 20% lower piping resistance. In the sensitivity study GOTHIC loop resistance is also reduced 20% and analysis results show the effect of the reduced loop resistance both in reflood and post-reflood phases.

The following parameters from the sensitivity study are shown in Figure 8-1 to Figure 8-5 in comparison to the base case.

Integral of broken loop SG side break flow from WREFLOOD (Figure 8-1)
Integral of broken loop RCP side break flow from WREFLOOD (Figure 8-2)
Integral of broken loop SG side steam flow from GOTHIC (Figure 8-3)
Integral of broken loop RCP side steam flow from GOTHIC (Figure 8-4)
Containment pressure (Figure 8-5)

Results of the sensitivity study show slightly larger steam flow to the containment than the base case as shown in Figure 8-1 to Figure 8-4. The peak containment pressure is about 72.5 psia and is 0.3 psi higher than the base case as shown in Figure 8-5. The peak pressure is substantially lower than the design pressure. The effect of 20% lower loop resistance on the peak containment pressure is small, because most of the loop resistance is due to the RCP and piping resistance is relatively small.

This increase in the peak containment pressure due to lower primary loop resistance is small relative to the identified conservative margin in peak pressure[ ] as described in the response to Items 16 and 17.

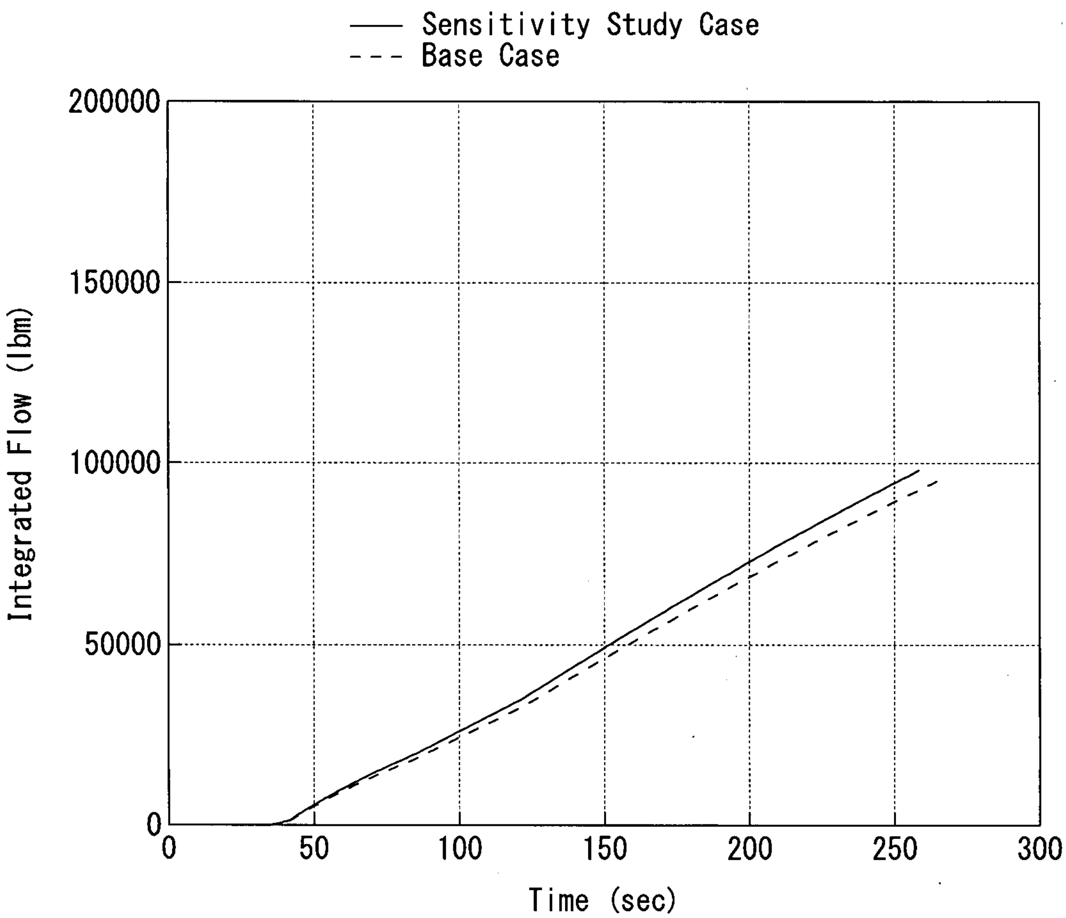


Figure 8-1 Integral of Broken Loop SG Side Break Flow from WREFLOOD

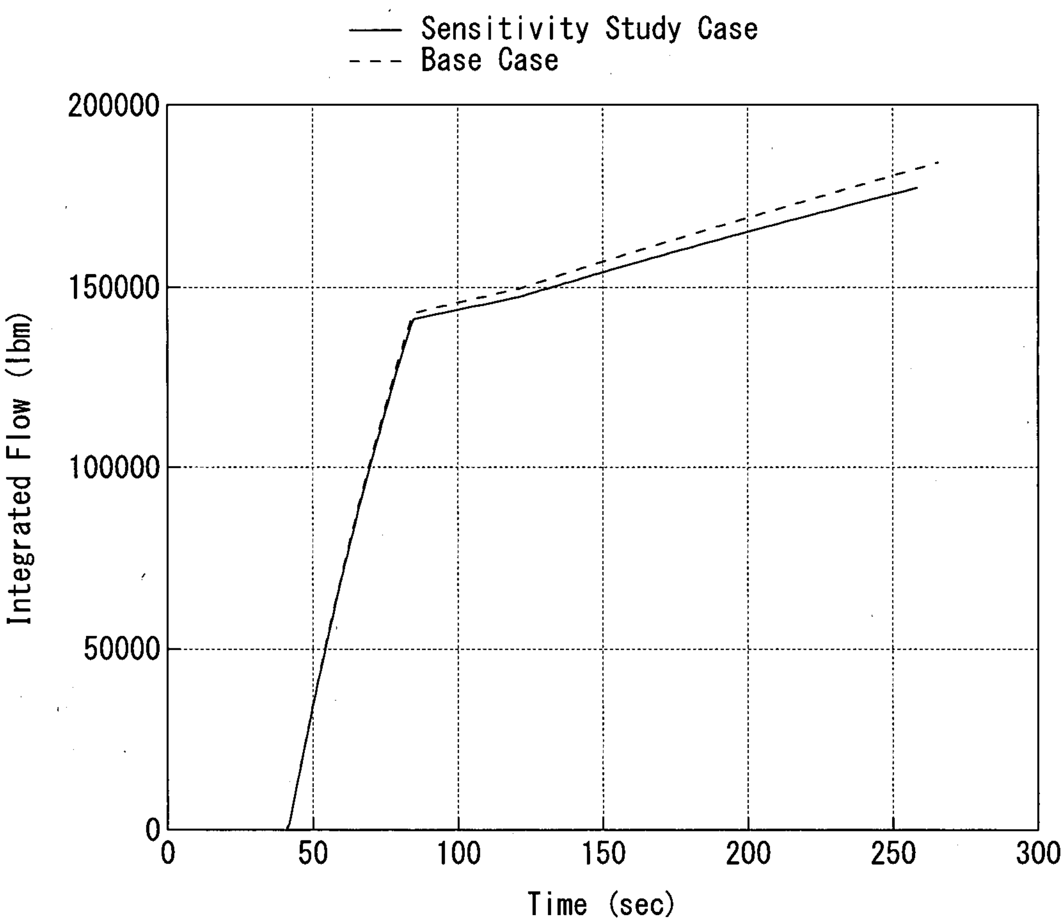


Figure 8-2 Integral of Broken Loop RCP Side Break Flow from WREFLOOD

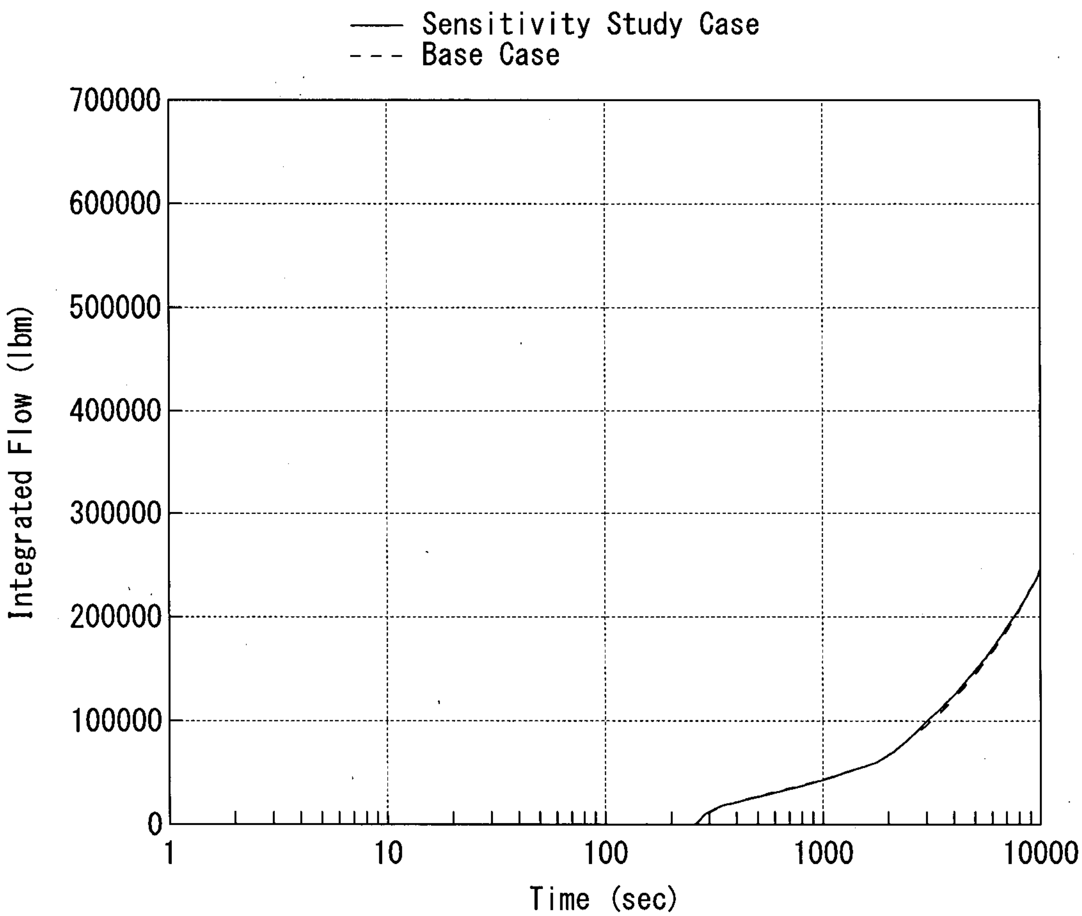


Figure 8-3 Integral of Broken Loop SG Side Steam Flow from GOTHIC

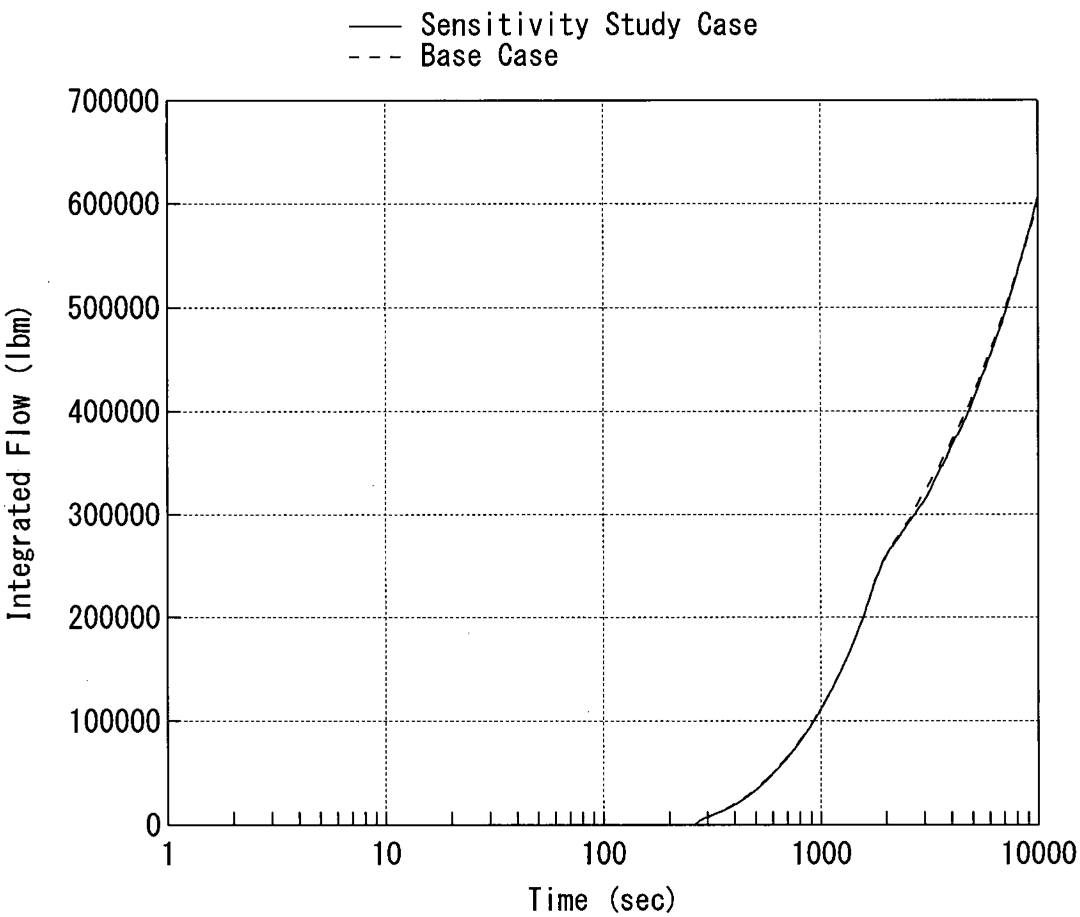


Figure 8-4 Integral of Broken Loop RCP Side Steam Flow from GOTHIC

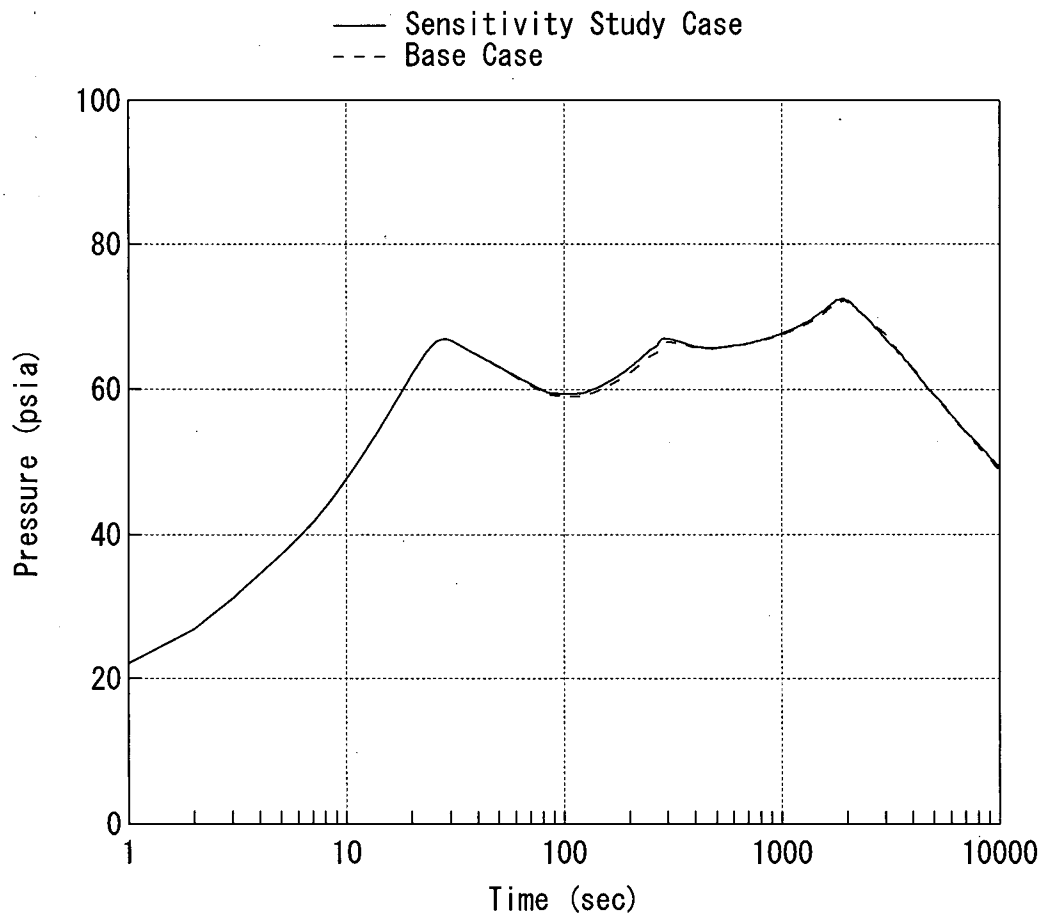


Figure 8-5 Containment Pressure

Item 9

Figure 3-2 provides the SATAN-VI noding diagram for US-APWR. Please identify the nodes by which flow from the accumulators and the HHIS enters the reactor system.

RESPONSE

Figure 9-1 shows the SATAN-VI noding diagram for US-APWR with the accumulator injection paths. [ ] The high head injection is conservatively assumed unavailable during the blowdown phase along with the assumption of loss of offsite power.

[ ]

Figure 9-1 Noding Diagram of SATAN-VI (Blowdown Phase Mass and Energy Release Analysis)

Item 10

Starting on page 3-12 a brief description of the GOTHIC containment model is presented. When will the detailed containment model be provided for staff review?

RESPONSE

The brief description of the GOTHIC containment model is presented for information. A detailed containment model is provided in the DCD.

Item 11

Starting on page 3-13 the GOTHIC model for predicting mass and energy release is described. Please describe the GOTHIC model in greater detail including the following considerations:

Item 11-a

Steam flow to the containment using the GOTHIC reactor system model will be dependant on the piping resistances assumed for the reactor system. Please quantify the degree of conservatism which will be used in selecting piping resistances for the containment analysis.

RESPONSE

GOTHIC loop resistances are best estimate values and as described in response to Item 8, the effect of lower loop resistance is small relative to conservatism in the peak pressure due to other modeling assumptions as described in the response to Items 16 and 17.

Sensitivity studies to confirm effect of the conservativeness are performed and peak containment pressure reduction in the post-reflood phase is[ ]. This peak containment pressure reduction well surpasses pressure rise due to conservative loop resistance and US-APWR analysis model still has sufficient conservatism.

Item 11-b

The GOTHIC computer code provides very versatile methodology which gives many options to the users. Please identify all options selected that are relevant to mass and energy release calculations and justify that they are conservative.

RESPONSE

The GOTHIC model for the long term mass and energy release is based on the approach used for the Surry Nuclear Plant (Ref. 1). In the Surry analysis, it was shown that the methodology gave a mass and energy release rate that was very close to that calculated using the Westinghouse methodology (Ref. 1) which is conservative.

The peak containment pressure is determined mainly by the rate of energy release from the secondary side of the steam generators. From the FLECHT SEASET Steam Generator Separate Effects Tests (Ref. 2), it is apparent that the heat release rate from the steam generators is dominated by the rate of water delivery to the SG primary side. As long as the SGs are hotter than the primary system, the heat from the secondary side is enough to boil all of the water that enters the SG tubes. Heat transfer to the generated steam is relatively small. Therefore, the mass and energy release is primarily a function of the buoyancy driven water flow through the intact and broken loops and the amount of water that is carried from the core and into the SG tubes. Based on these observations, the predicted mass and energy release may be influenced by

- Noding of the SG primary side
- Noding of the SG secondary side
- Noding of the hot legs
- Noding of the SG inlet riser and inlet plenum
- Core and Upper Plenum noding
- Hydraulic diameter for the core and upper plenum nodes
- Loop resistance factors
- Flow Path stratified flow option
- Flow Path momentum transport option
- Flow Path compressibility option
- Liquid/Vapor Interface Area

Based on the above models, the long term mass and energy will be conservatively predicted by GOTHIC. The following options relevant to mass and energy release calculations are identified for each node and junction in Table 11-b-1 and Table 11-b-2.

For Volumes, see Table 11-b-1 (1/2):

For Flow Paths, see Table 11-b-1 (2/2):

References

1. Letter from Gerald T. Bischof (Virginia Electric and Power Company) to United States Nuclear Regulatory Commission dated November 6, 2006, Transmittal of Approved Topical Report DOM-NAF-3 NP-A, "GOTHIC Methodology for Analyzing the Response to Postulated Pipe Ruptures inside Containment." ADAMS Accession No. ML063190467.
2. R. C. Howard and L. E. Hochreiter, "PWR FLECHT SEASET Steam Generator Separate Effects Task Data Analysis and Evaluation Report", NRC/EPRI/Westinghouse-9, June 1981

Table 11-b-1 GOTHIC Options Used for US-APWR Mass and Energy Release Evaluation, Long Term of Loss-of-Coolant Accident (1 Sheet of 2)

Table 11-b-1 GOTHIC Options Used for US-APWR Mass and Energy Release Evaluation, Long Term of Loss-of-Coolant Accident (2 Sheet of 2)

Figure 11-b-1 Noding Diagram of US-APWR Containment Integrity Analysis for Loss-of-Coolant Accident

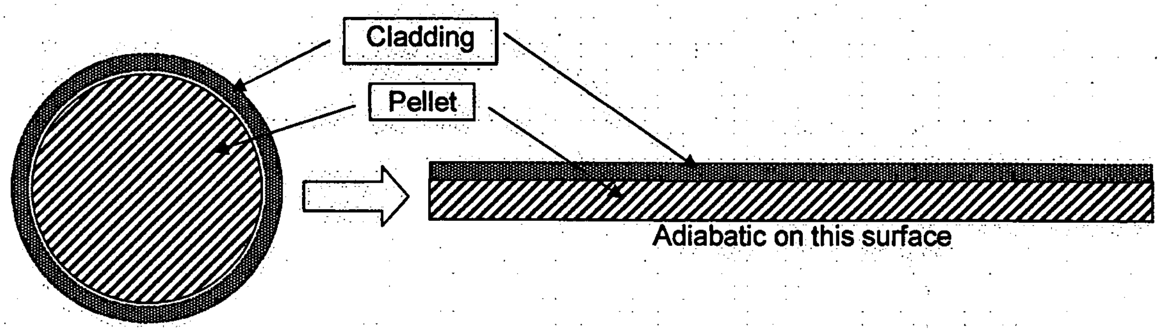
Item 11-c

On page 3-14 it is stated that the fuel rods are modeled as a single WALL type conductor with a thickness specified to include the total mass of the fuel. Please describe how the fuel rods, including the cladding, are represented in the GOTHIC model in greater detail. Justify that it is conservative to model the cylindrical fuel rods with slab geometry and that the sensible heat in the fuel rods is released to the containment in a conservative manner.

RESPONSE

The following figure of the cross section of the fuel illustrates how a fuel rod, including the cladding, is represented in the GOTHIC model. The slab conductor is defined such that the surface area exposed to the fluid and the mass of each material are preserved. Compared to the cylindrical rod geometry, the slab geometry has a shorter effective conduction length which results in a faster (conservative) release of the stored energy in the fuel.

Since the core has quenched and is covered, the energy to be released is from the decay power generation and a small amount of stored energy as the pressure slowly changes. Therefore, the exact core geometry is less important.



Cylindrical Fuel rod GOTHIC Slab Conductor

Item 11-d

The FILM heat transfer option is stated to be used on all sides of the primary and secondary system conductors in contact with the fluid. Please describe this option in greater detail. What heat transfer correlations are used to calculate heat flow to liquid, steam and two-phase mixtures? Justify that these values are conservatively high for calculating the energy release.

RESPONSE

The FILM option is used for heat transfer for all conductors in the primary and secondary systems. This option includes convective and boiling heat transfer modes to the vapor and liquid. The heat transfer will be to the liquid phase unless there is insufficient water to support a liquid film on the surfaces. Convective heat transfer is the maximum of standard correlations for natural and forced convection. For boiling heat transfer, both nucleate and bulk boiling correlations are included. Film boiling is conservatively not considered.

The correlations are all based on best estimates. However, the following modeling conservatisms assure that the overall heat transfer rate is conservatively high:

1. All the vessel metal conductors are assigned to the core region to assure that they are in contact with the liquid to maximize the heat release.
2. The lumped modeling approach for the uphill SG tubes and the SG secondary side assures that both sides of the tubes are fully in contact with the water to maximize the heat transfer rate and the heat release from the steam generators.
3. For the downhill SG tubes, the outside of the tubes are in full contact with the SG water to maximize the heat transfer to the steam. The heat transfer to the steam on the inside of the tubes is the maximum of forced and natural convection.
4. All of the metal on the secondary side of the SG is in full contact with the liquid to maximize the heat release rate.

Using the FILM option, the logic for selecting the heat transfer coefficients for heat transfer between the conductor surface and the fluid is shown in Figure 11-d-1. Heat transfer coefficients are calculated for both the liquid and vapor phases, even though all heat transfer is generally to only one phase as determined by the logic shown in Figure 11-d-1. The phase heat transfer coefficients are multiplied by ramp functions that force the heat transfer to zero as the phase is depleted. The ramp functions are

and

The ramp functions are applied as modifiers on the heat transfer coefficients, described below.

Single Phase Vapor

The single-phase vapor heat transfer coefficient (Hspv) is given by

$$H_{spv} = Max\begin{bmatrix} \frac{8k_v}{D_h} \\ \frac{k_v}{D_h}0.023Re_v^{0.8}Pr_v^{0.4} \\ \frac{k_v}{D_h}Max\left(0.13\left[Gr_vPr_v\right]^{1/3}, 0.59\left[Gr_vPr_v\right]^{0.25}\right) \end{bmatrix}$$

The first formula is a minimum value based on conduction through the vapor. The second formula is the Dittus-Boelter correlation for turbulent forced convection (Ref. 1). The third formula is for turbulent natural convection. The temperature difference in the Grashof number is given by

$$\Delta T = T_v - Max[T_w, T_{sat}(P_{vs})]$$

The wall source term for single-phase vapor heat transfer is

$$Q_{w_v} = \lambda_{w_v}H_{spv}A_{cn}(T_w - T_v)$$

Single-Phase Liquid

The single-phase liquid heat transfer coefficient is given by

$$H_{spl} = Max\begin{bmatrix} \frac{2k_l}{\delta} \\ \frac{k_l}{D_h}0.023Re_l^{0.8}Pr_l^{0.4} \\ \frac{k_l}{D_h}Max\left(0.13\left[Gr_lPr_l\right]^{1/3}, 0.59\left[Gr_lPr_l\right]^{0.25}\right) \end{bmatrix}$$

These formulas are essentially identical to those used for single phase vapor. The primary difference is that the formulas are based on liquid properties. The first formula gives the heat transfer coefficient for conduction through a liquid film of thickness

[ ]

where the parameter f_{wa} is an adjustment factor for wetted areas. If there is sufficient liquid in the volume to cover all the wettable walls with a film that is at least 0.0001 ft thick, then all the wettable walls will be wet. If there is insufficient liquid to cover all the wettable walls, then a fraction of each wettable wall will be dry. A wall is wettable if the surface temperature is below the saturation temperature at the total fluid pressure.

The third formula is for turbulent natural convection. The temperature difference in the Grashof number is given by

$$\Delta T = T_l - Min[T_w, T_{sat}]$$

The wall source term for single-phase liquid heat transfer is

$$Q_{w_l} = \lambda_{w_l}H_{spl}A_{cn}(T_w - T_l)$$

Boiling

If the wall temperature is greater than the saturation temperature at the total pressure, then the liquid is in a boiling heat transfer regime. In the nucleate boiling regime, the Chen (Ref. 2) correlation is used. If the liquid is subcooled, subcooled boiling occurs that allows the generation of steam without bringing the bulk liquid temperature up to the saturation temperature. The Chen correlation is extended to cover subcooled nucleate boiling.

Condensation

Although condensation heat transfer correlations are incorporated into GOTHIC, they do not come into play for the reactor coolant system model.

References

1. Dittus, F.W., and L.M.K. Boelter, University of California, Publ. Eng., 2, 443, 1930.

2. Chen, J.C., A Correlation for Boiling Heat Transfer to Saturated Fluids in ConvectiveFlow, ASME 63-HT-34, American Society of Mechanical Engineers, 1963.

Figure 11-d-1 Heat Transfer Selection Logic

Item 11-e

Core decay heat is stated to be calculated using the 1979 ANS model with two standard deviations of uncertainty added. NRC Information Notice 96-39 describes how users obtained differing results from the ANS standard depending on the input options selected. Please provide the assumptions selected for actinide contribution, actinide production, neutron capture effect, fissions per initial fissile atom and power history that will be input into the standard for US-APWR containment analysis and justify that conservative values have been selected.

RESPONSE

A decay heat curve based on ANSI/ANS-5.1-1979 (ANS-1979) model, which had been incorporated into the original SATAN and WREFLOOD codes, is used for the containment analyses for the US-APWR. The decay heat curve is shown in Figure 11-e-1 and the assumptions for input selection for this decay heat curve are described in the WCAP-10325-P-A "Westinghouse LOCA Mass and Energy Release Model for Containment Design March 1979 Version" as follows:

1.	Actinide contribution	: ^{239}U and ^{239}Np
2.	Actinide production (R-factor)	: 0.70
3.	Neutron capture effect	: Gmax
4.	Power history	: 10^8 seconds
5.	Fissile element	: 92% ^{235}U, 8% ^{238}U

These assumptions are considered applicable for the US-APWR since:

1. Actinide decay heat: the contribution of both ^{239}U and ^{239}Np decay heat was included considering an infinite operating time. Explicit analysis of the US-APWR core show that the most limiting R-factor is about [ ].
2. Fission products (FPs) decay heat: the decay heat multiplier to account for the effect for neutron capture (G-factor) is assumed to be the maximum table value (G-max). The length of full power operation of 10^8 seconds before shutdown covers up to US-APWR 24-month operation conditions. Finally, the assumption that fission products are attributed to an 8% of ^{238}U and 92% ^{235}U with the conservative assumption that the fission energy release is 200MeV/fission covers US-APWR core conditions.

Therefore, the decay heat originally incorporated into SATAN and WREFLOOD code, which input selection assumptions are described in the WCAP-10325-P-A for generic use, can be apply for the US-APWR mass and energy analysis.

Figure 11-e-1 Core Decay Heat Curve

Item 11-f

The GOTHIC model is stated to use two conductors to model the reactor system metal. Describe the components which are included within each to the conductors and justify that this treatment is conservative.

RESPONSE

Item 11-g

Describe and justify the treatment of the sensible heat within the primary system piping.

RESPONSE

Item 11-h

Treatment of the "primary loop metal located on the secondary side of the steam generators" is discussed. Please identify the components referred to. The initial temperature of this metal is said to be set equal to the secondary side fluid temperature. Justify that this assumption is conservative.

RESPONSE

Item 11-i

Please identify all code modifications made to GOTHIC for mass and energy release calculations.

RESPONSE

GOTHIC version 7.2a-patch5, revised from version 7.2a, is used for the US-APWR analyses.

This patch to GOTHIC version 7.2a was created to correct errors in the implementation of the Yeh correlation. The Yeh correlation is used to predict the two-phase mixture level and the vapor volume fraction within subdivided volume cells that are connected to a Flow Path or Network Link. These values are then used to determine the outflow conditions for the connected Flow Path or Network Link.

Two errors were identified in the original implementation: 1) the phase velocities were used to calculate the mixture level rather than the superficial velocities, 2) the Yeh correlation was only applied if the liquid volume fraction in the cell was above 0.5. Item 1 tended to cause the mixture level to be overestimated, while item 2 tended to cause the mixture level to be underestimated. Because of these counteracting effects, it is difficult to predetermine the impact of the problem on a particular model and to determine conservative input adjustments to counteract the errors. The patch was implemented for use in modeling situations that require the Yeh correlation on an interim basis until the next full release of GOTHIC becomes available. The patch is released under NAI's QA program for GOTHIC, which satisfies the requirements of 10CFR50 Appendix B with error reporting in accordance with 10CFR21.

The modifications to the Yeh correlation described above are the only differences between GOTHIC 7.2a and GOTHIC 7.2a-patch 5. No modifications were made to the GOTHIC version 7.2a-patch5.

<u>Item 11-j</u>

On page 3-15 the discussion of the treatment of two-phase level by GOTHIC is not clear. Please describe this modeling in greater detail and justify that the treatment of the two-phase mixture leaving the core and calculated to enter the steam generators is conservative. Describe the assumptions made for relative velocity between steam and the liquid and justify that these assumptions are conservative. For the sample calculation in MUAP-07012-P, provide plots of the void fractions and mass flow rates of the fluid leaving the core and entering the steam generators as a function of time. It would be helpful if a comparison could be made of the steaming rate for the post-reflood period between the methodology of WCAP-10325-P-A and that of the US-APWR topical.

<u>RESPONSE</u>

[ ]

Plots of the void fractions and integrated mass flow rates of the fluid leaving the core and entering the steam generators as a function of time are provided with Figures 11-j-2 through 11-j-6.

A comparison is shown in Table 11-j-1 of the models affecting steaming rate for the post- reflood period between the methodology of WCAP-10325-P-A and that of the US-APWR topical report.

Table 11-j-1 Comparison of GOTHIC US-APWR model with FROTH (1/3)

Item	FROTH	GOTHIC	Comment
1. Steam generation rate in core	FROTH calculates steam generation rate in core accounting for decay heat and heat from metal. Water is assumed always saturated.	GOTHIC calculates steam generation rate by energy balance in core accounting for inlet flow, outlet flow, decay heat and heat from metal. Inlet flow and outlet flow are calculated by momentum equation. Subcooled inlet water is allowable.	FROTH calculation model is too conservative. GOTHIC is realistic.
2. Core void fraction	Calculated by Yeh correlation with steam velocity of half of total core generated steam flow. The calculated void fraction is corresponding to core average.	[ ] All steam generated in the core is used for void fraction calculation. Ishii's drag coefficient is applied for interfacial force calculation. Calculated void fraction is corresponding to core exit void fraction.	Generally GOTHIC gives higher void fraction in the core because of higher steam velocity. Higher void fraction gives smaller water head in core and results in larger available water head for SG froth and larger available pressure drop for steam flow in loop. These result in conservative result.
3. Downcomer level	Assumed always full	GOTHIC calculates water level with mass and energy balance considering water flow from intact loop, injected water flow, water flow to core and spilt water flow.	No artificial modeling is applied in GOTHIC.GOTHIC model is realistic.
4. Flow split of steam flow from core	[ ]	Loop momentum balance decides flow split internally.	GOTHIC calculates more flow to intact loop than FROTH. This results in more rapid heat release from intact loop SG secondary side than FROTH.

Table 11-j-1 Comparison of GOTHIC US-APWR model with FROTH (2/3)

Item	FROTH	GOTHIC	Comment
5. Steam generator inlet water flow calculation	[ ]	GOTHIC calculates droplet and water flow into SG U-tube from dynamic momentum equation for each phase. Water head and pressure drop due to flow are considered in momentum equation. [ ] If water enters hot side, entire heat transfer area in U-tube hot side is available for steam generation.	Global primary system momentum balance in GOTHIC is almost the same as in FROTH.

Table 11-j-1 Comparison of GOTHIC US-APWR model with FROTH (3/3)

Item	FROTH	GOTHIC	Comment
6. Steam-water mixing	Assumed complete mixing in both intact loop and broken loop cold legs	Assumed almost complete mixing in only intact cold leg	GOTHIC model is conservative.
7. SG heat transfer model	McAdams correlation for secondary side is applied. Heat transfer resistance of tube and primary side is neglected.	GOTHIC FILM option heat transfer model is applied to both secondary side and primary side of U-tubes. Tubes are modeled by conductors. Heat transfer correlation of SG U-tube secondary side is by McAdams.	No substantial difference between FROTH and GOTHIC.
8. The steam condition at the outlet of steam generator	Saturated steam is assumed.	Steam condition is calculated by heat transfer model in SG tubes.	No artificial assumption is applied to GOTHIC. Actually no substantial effects on containment pressure.
9. The containment back pressure	The containment design pressure is used and constant during transient. This pressure is equal to primary system pressure in FROTH.	GOTHIC calculates both the primary system and the containment transients simultaneously. Transient containment pressure is used. GOTHIC treatment is realistic.	In US-APWR the advanced accumulator still works during post-reflood phase. Realistic primary system pressure transient is desirable for the advanced accumulator flow calculation.

Figure 11-j-1 Concept of two-phase level of the vessel by GOTHIC

Figure 11-j-2 Transient of Total Vapor Volume Fraction in Hot Leg Inlet

Note: Both Void in the Pool and Separated Vapor Region are Considered, see Figure 11-j-1

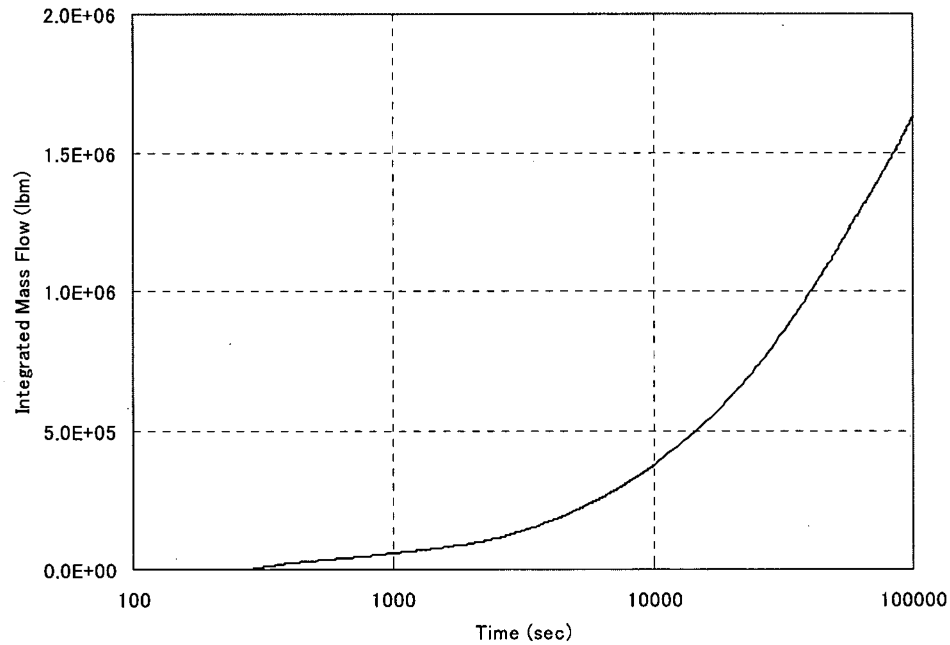


Figure 11-j-3 Integrated Vapor Mass Flow Rate into SG (Intact Loop)

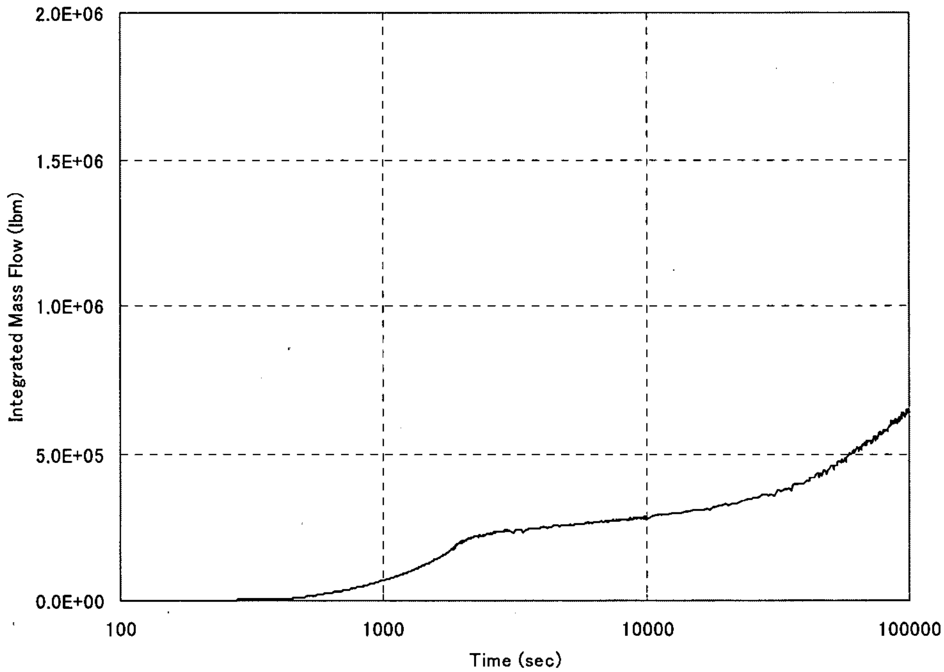


Figure 11-j-4 Integrated Liquid Mass Flow Rate into SG (Intact Loop)

Notes: Drop Including

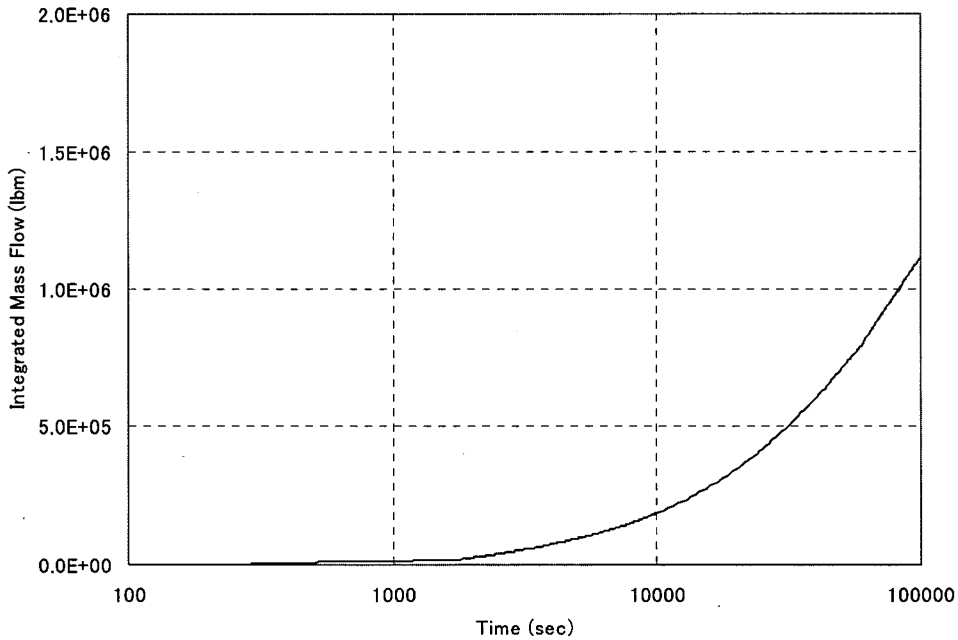


Figure 11-j-5 Integrated Vapor Mass Flow Rate into SG (Broken Loop)

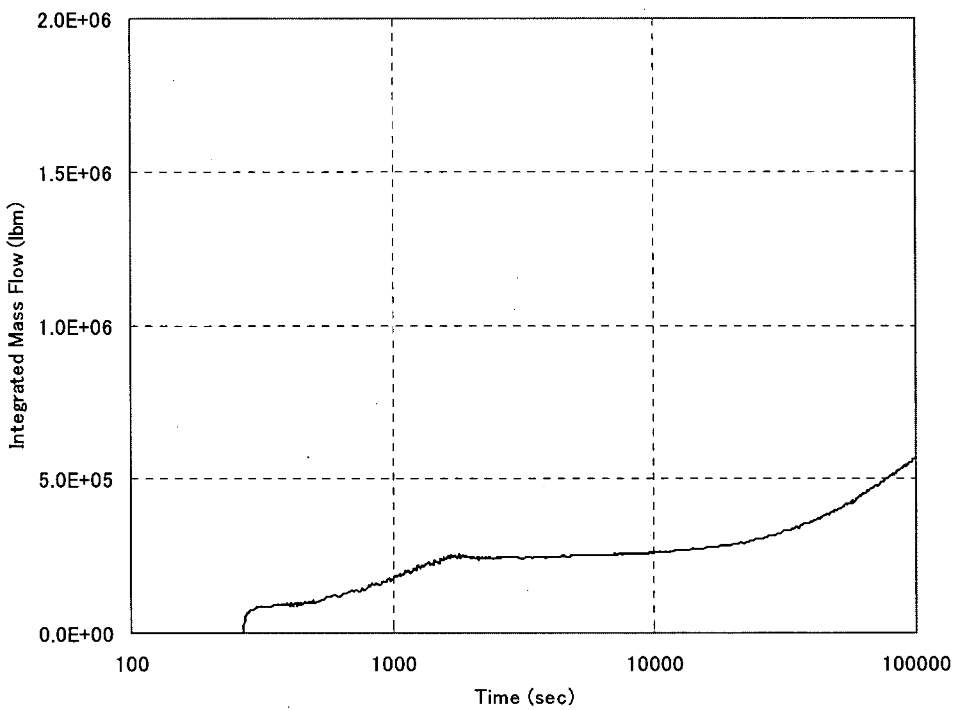


Figure 11-j-6 Integrated Liquid Mass Flow Rate into SG (Broken Loop)

Notes: Drop Including

Item 11-k

In long term cooling analyses using RELAP5, the staff has found that the loop seals at the reactor coolant pump suctions close by being refilled with water. This water comes either from liquid carryover out of the core or from backflow of ECCS in the cold legs. During the blowdown period all the loop seals are calculated to open but during the post-reflood period the loop seals begin to close until only one loop seal is left open. Flow through a single loop is adequate to remove the steam produced by the core and provide for core cooling. The staff's concern is that if following a double ended pump suction break, if all the steam flow is through the broken loop, the steam will not pass through any ECCS injection points and will enter the containment through the break without any steam quenching occurring. As a sensitivity study, please provide an analysis of the containment pressure if three coolant loops were blocked during the post-reflood period and only the broken loop were open to pass steam.

RESPONSE

A sensitivity study was performed to address the concern raised by the NRC that the loop seal formation in the intact loop pump suction leg during post-reflood phase may occur and will block steam flow to the injection point of the intact loop cold leg with no steam condensation. This causes steam flow to increase in the broken loop and may raise containment pressure.

In the sensitivity study, steam flow to the intact loop cold leg is completely blocked by removing flow path from the pump suction leg to the cold leg as shown in Figure 11-k-1 to simulate the loop seal formation in the intact loop pump suction leg.

The following parameters from calculated results are shown in Figure 11-k-2 to Figure 11-k-7 in comparison to the base case.

Break steam flow from broken loop SG side (Figure 11-k-2)
Break steam flow from broken loop RCP side (Figure 11-k-3)
Integral of total steam flow to the containment (Figure 11-k-4)
Broken loop SG secondary side temperature (Figure 11-k-5)
Intact loop SG secondary side temperature (Figure 11-k-6)
Containment pressure (Figure 11-k-7)

For the sensitivity case, almost all steam generated in the core flows into the broken loop and the net steam release from the RCP side break is almost zero, as shown in Figures 11-k-2 and 11-k-3. On the other hand, the steam release from the RCP side for the base case is quite large because of the generated steam in the intact-loop SG tubes, as described below. As a result, total steam flow to the containment for the sensitivity case is much smaller than the base case as shown in Figure 11-k-4.

The secondary side temperature of the broken loop SG and intact loop SG are shown in Figure 11-k-5 and Figure 11-k-6, respectively. Cooldown of the broken loop SG secondary side is faster than the base case, but the intact loop SG secondary side, which has much more energy than broken loop SG, is only slightly cooled due to the oscillatory flow through the intact hot leg. The net result is much slower energy release to the containment and the containment pressure during post-reflood phase is much lower than the base case as shown in Figure 11-k-7.

Figure 11-k-1 Noding Diagram of GOTHIC for Simulation of Loop Seal Formation in Intact Loop

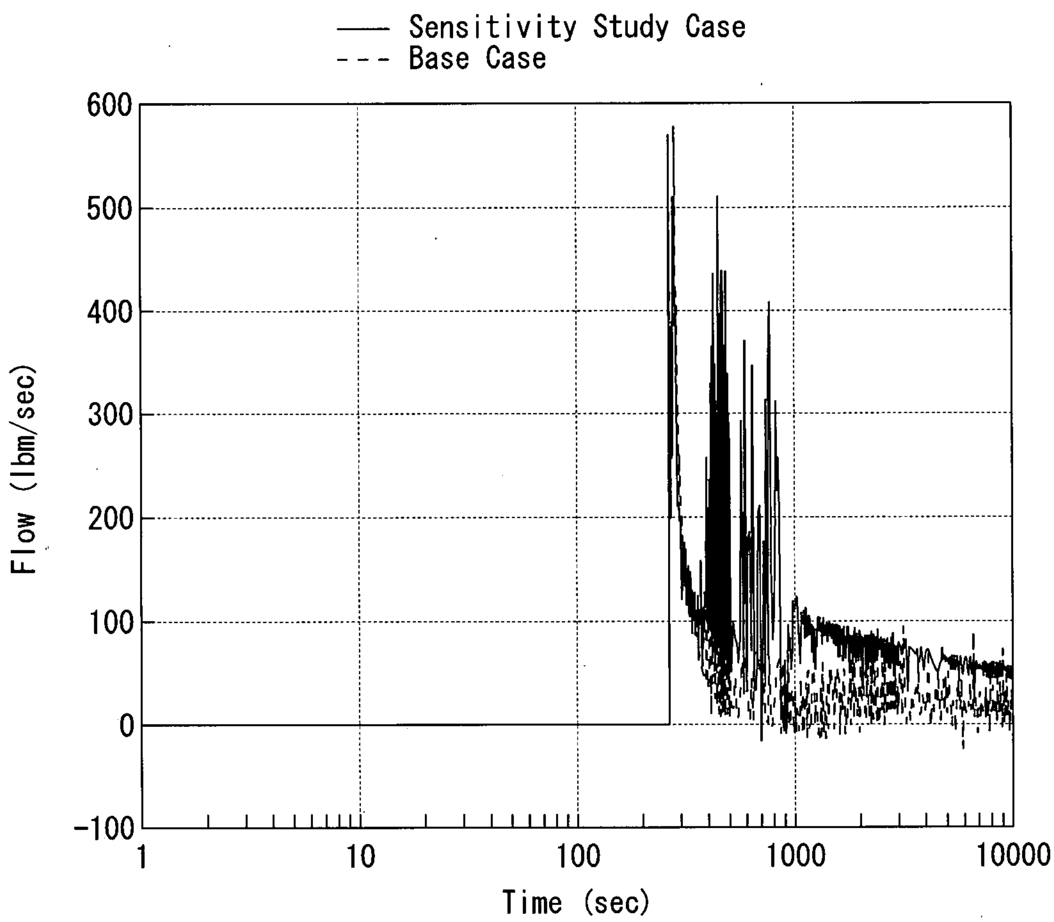


Figure 11-k-2 Break Steam Flow from Broken Loop SG Side

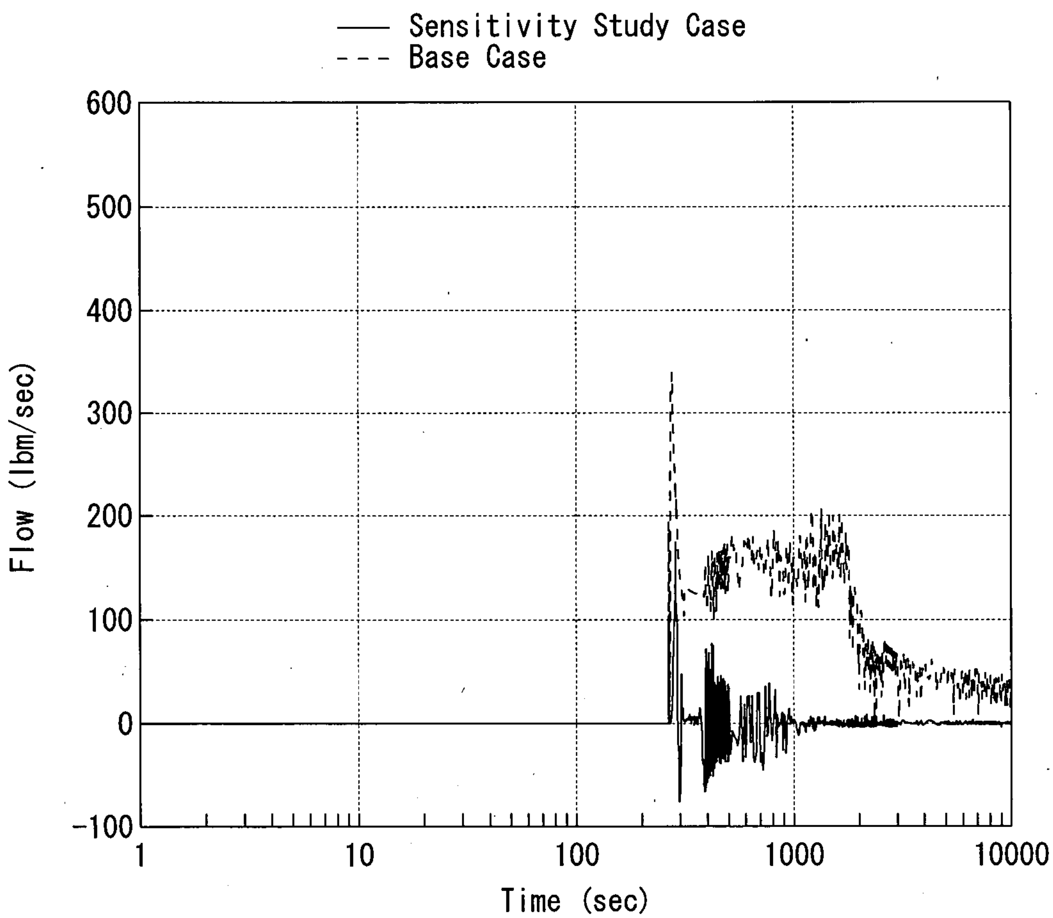


Figure 11-k-3 Break Steam Flow from Broken Loop RCP Side

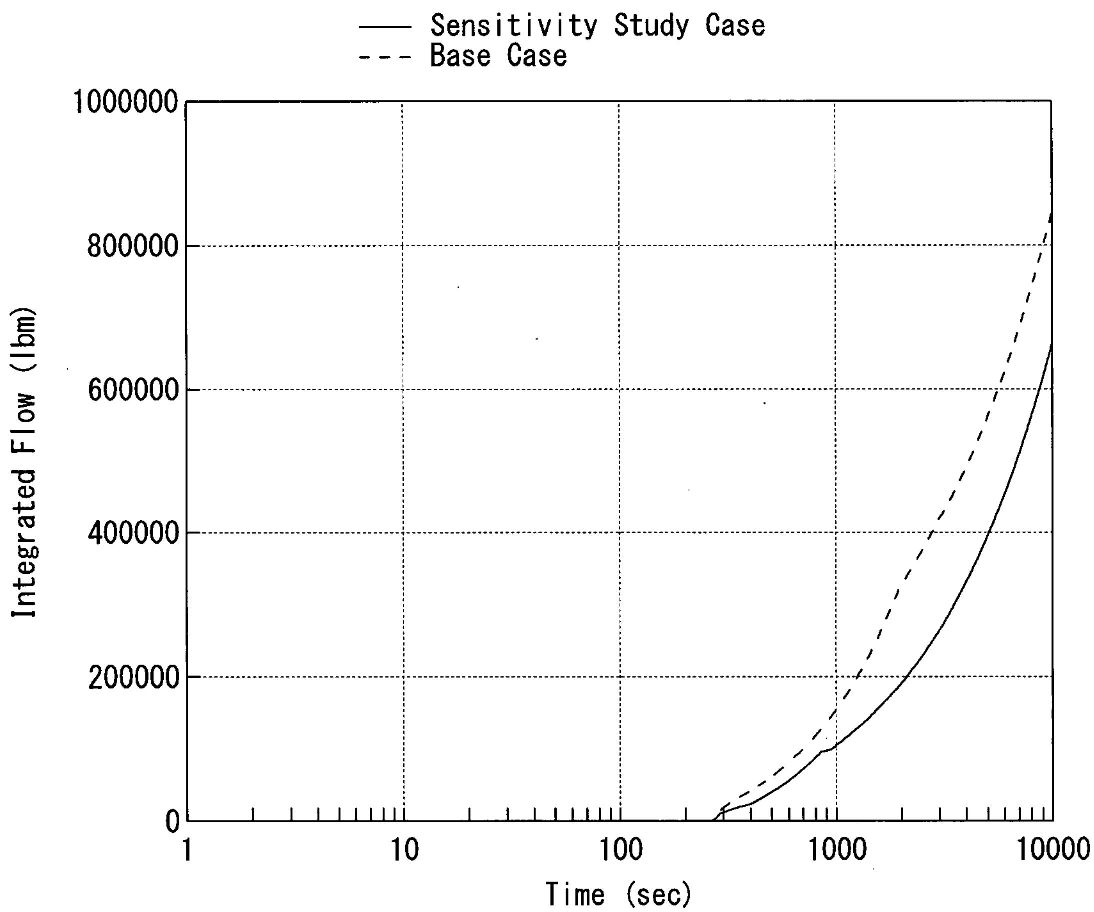


Figure 11-k-4 Integral of Total Steam Flow to the Containment

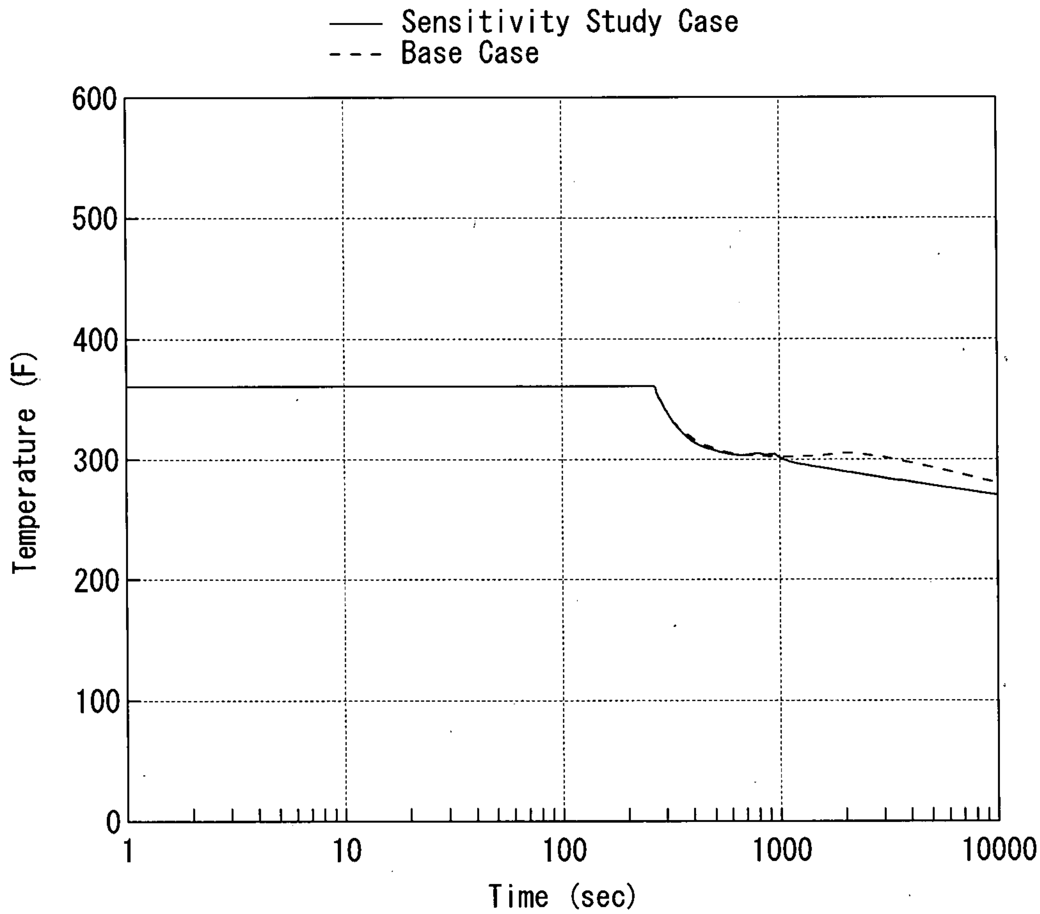


Figure 11-k-5 Broken Loop SG Secondary Side Temperature

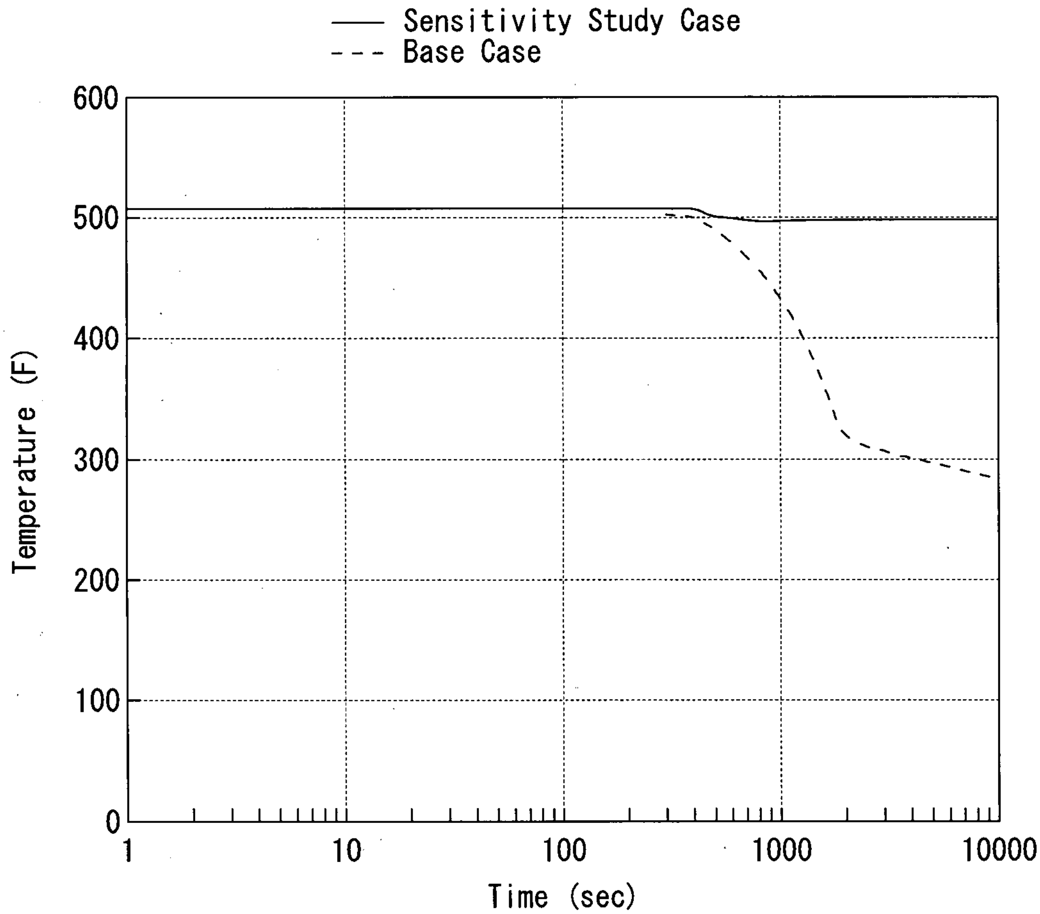


Figure 11-k-6 Intact Loop SG Secondary Side Temperature

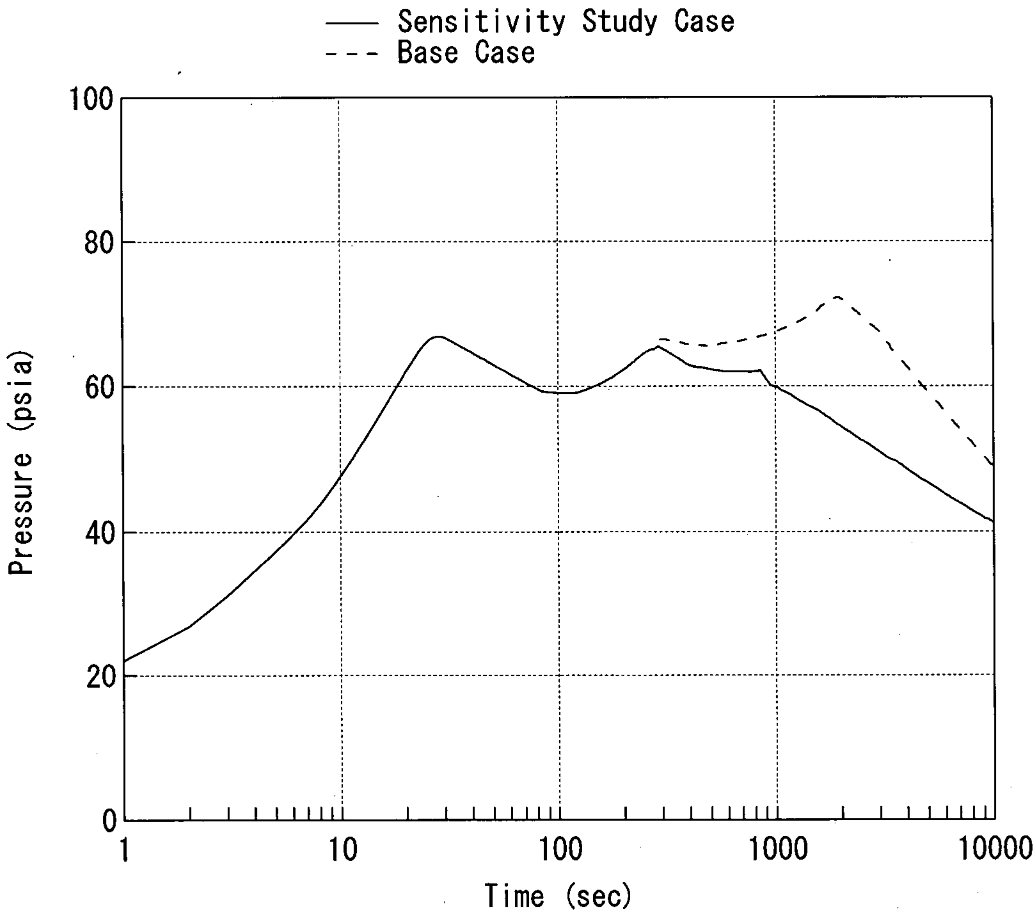


Figure 11-k-7 Containment Pressure

Item 12

Section 5.1 of WCAP-10325-P-A describes model conservatisms which primarily involve code inputs. Please provide a comparison of the assumptions to be made for analysis of US-APWR with those of Section 5.1 of WCAP-10325-P-A and justify any differences.

RESPONSE

The assumptions for the US-APWR analysis are compared with those of Section 5.1 of WCAP-10325-P-A in Table 12-1. The comparison shows that the assumptions are essentially the same except for the SG secondary side mass and the post-reflood model, which is based on the GOTHIC code in the US-APWR compared to the FROTH code in WCAP-10325-P-A. In the FROTH analysis for post-reflood period, the steam exiting from the SG is artificially assumed to be saturated. In the GOTHIC analysis, the steam exit condition depends on the calculated heat transfer across the SG tubes and the steam may exit in a superheated condition. This is consistent with the observations from the FLECHT-SEASET Steam Generator Separate Effects tests. The influence of the steam condition on the containment peak pressure is slight.

Table 12-1 A comparison of the assumptions to be made for analysis of US-APWR with those of Section 5.1 of WCAP-10325-P-A

	WCAP-10325-P-A Section 5.1	US-APWR
Initial system conditions		
Power level	102 %	same
Fluid temperature	+4 F	same
System volume	+3 %	same
Steam generator parameter, Secondary mass	Based on 100% power, +10%	Based on 100 % power, B.E. + 3 % (consistent with primary system mass.)
Metal stored energy	maximized	same
Decay heat	maximized	same
Core stored energy	maximized	same
Blowdown modeling		
Break size	A full double ended area	same
Core heat transfer coefficient	Best judgment for maximizing to heat release from the core	same
Reflood modeling		
Carryover fraction correlation	ECCS type application	same
Steam water mixing pressure drop	excluded	same
Exit steam generator fluid conditions	saturated	same
Post-reflood modeling		
Exit steam generator fluid conditions	saturated	GOTHIC calculated value

Item 13

Tables 6A and 7A of WCAP10325-P-A provide mass and energy balances for the sample case of a postulated double ended pump suction break. Please provide similar tables for the sample case in MUAP-07012-P and indicate the reference temperature upon which the energy balance is based.

RESPONSE

Mass and energy balance tables for the limiting case in the US-APWR DCD are provided as Tables 13-1 and 13-2.

Table 13-1 Mass Distribution Transient

Phase		Prior to LOCA	End of Blowdown	End of Core Reflood	At Peak Pressure	1 Day into Recirc.
Time (seconds)		0.00	31.60	265.54	1963.7	86400
Initial Mass	RCS and ACC	1278.06	1278.06	1278.06	1278.06	1278.06
Added Mass	Pumped Injection	0.00	0.00	49.70	613.90	28362.65
	Total Added	0.00	0.00	49.70	613.90	28362.65
Total Available (Initial Mass +Total added)		**1278.06**	**1278.06**	**1327.76**	**1891.96**	**29640.71**
RCS Mass Distribution	Reactor Coolant	752.18	68.17	207.23	189.83	206.26
	Accumulator	525.89	460.87	92.06	9.21	0.00
	RCS Total Contents	1278.06	529.05	299.28	199.04	206.26
Effluent	Break Flow	0.00	748.99	1028.49	1698.94	29439.66
	ECCS Spill	0.00	0.00	0.00	0.00	0.00
	Total Effluent	0.00	748.99	1028.49	1698.94	29439.66
Total Accountable		**1278.06**	**1278.04**	**1327.77**	**1897.98**	**29645.92**

Unit: Thousand lbm

Table 13-2 Energy Distribution Transient

Phase		Prior to LOCA	End of Blowdown	End of Core Reflood	At Peak Pressure	1 Day into Recirc.
	Time (seconds)	0.00	31.60	265.54	1963.7	86400
Initial Energy		1287.49	1287.49	1287.49	1287.49	1287.49
Added Energy	Pumped Injection	0.00	0.00	5.67	90.83	5021.69
	Energy Generated during Shutdown from Decay Heat	0.00	15.58	49.83	224.04	3254.97
	Heat from Secondary	0.00	26.04	26.04	26.04	26.04
	Total Added	0.00	41.62	81.54	340.91	8302.70
Total Available	**(Initial Energy + Added)**	**1287.49**	**1329.11**	**1369.03**	**1628.40**	**9590.19**
RCS Energy Distribution	Reactor Coolant Internal Energy	441.38	17.09	58.37	80.46	70.92
	Accumulator Internal Energy	47.09	41.27	8.24	0.81	0.00
	Energy Stored in Core	43.40	23.08	7.58	5.56	3.77
	Energy Stored in RCS Structure	267.87	255.87	183.82	104.11	63.84
	Steam Generator Coolant Internal Energy	349.58	379.25	318.99	197.89	141.91
	Energy Stored in Steam Generator Metal	138.16	136.48	117.14	77.51	65.60
	RCS Total Contents	1287.49	853.03	694.16	466.34	346.04
Effluent	Break Flow	0.00	476.08	652.54	1132.84	9231.34
	ECCS Spill	0.00	0.00	0.00	0.00	0.00
	Total Effluent	0.00	476.08	652.54	1132.84	9231.34
Total Accountable		**1287.49**	**1329.11**	**1346.70**	**1599.18**	**9577.38**

Unit: Million Btu
Reference Temperature: 32 degF

Item 14

Tables 13A, 14A, 14B, 15A and 15B of WCAP10325-P-A provide tabulations of the mass and energy release of steam and water from the reactor including ECCS spillage as a function of time for containment analysis. Please provide similar tables for the sample case of MUAP-07012-P.

RESPONSE

Tables 13A, 14A, 14B, 15A and 15B of WCAP-10325-P-A are based on the old mass and energy release model that does not consider steam condensation on the injected water. MHI does not use this methodology. MHI's methodology corresponds to the revised mass and energy release model discussed in the same WCAP, and the results are listed Tables 8A, 9A and 10A.

Those tables show mass and energy releases as a function of time not for steam and water, but for Break Path No.1 (SG side) and Break Path No.2 (Reactor Vessel side), instead. Tables 14-1 through 14-3 provide tabulations of the mass and energy release for the postulated double ended pump suction break described in the US-APWR DCD, which correspond to the Tables 8A through 10A of WCAP 10325-P-A, respectively.

Table 14-3, the post-reflood mass and energy table for the limiting pump-suction break case, lists the mass and energy release rates for the reactor vessel side and the steam generator side of the break. Since steam and water are treated separately using non-equilibrium features in the GOTHIC, each enthalpy value in Table 14-3 is obtained by averaging the conditions either for saturated or superheated steam and that of subcooled water using GOTHIC output. Each set of time dependent mass and energy data in Table 14-3 is picked up from plotting data at regular intervals. The data in Table 14-3 are presented as Table 6.2.1-21 in the US-APWR DCD.

Table 14-4 gives the post-reflood mass and energy for the same case with the separated steam and liquid. Since mass and energy data in Table 14-4 are calculated ones so as to conserve integral values, they are not necessarily identical to values at the same time in Table 14-3. The data in Table 14-4 are included in the GOTHIC input data provided as the response to Item 19.

Table 14-1 Break Mass and Energy Flow for the Blowdown Phase of the DEPSG Break (Sheet 1 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00037	39367.7	551.1	21695.5	47451.3	553.0	26240.6
0.00102	39475.9	548.5	21652.5	101757.9	550.6	56027.9
0.0112	39130.1	548.1	21447.2	42091.4	548.5	23087.1
0.0211	36128.7	547.7	19787.7	41741.5	548.6	22899.4
0.0515	23343.8	545.7	12738.7	41730.0	548.8	22901.4
0.0611	21272.1	546.1	11616.7	41772.5	549.0	22933.1
0.0711	20482.9	546.9	11202.1	49613.7	549.3	27252.8
0.0912	20875.8	547.9	11437.9	49573.9	549.5	27240.9
0.111	21872.9	548.2	11990.7	52298.0	549.9	28758.7
0.161	23599.5	548.5	12944.3	53529.7	550.8	29484.2
0.222	24642.8	548.5	13516.6	53292.9	552.1	29423.0
0.301	25143.0	548.8	13798.5	52771.2	554.1	29240.5
0.351	25174.2	549.0	13820.6	52247.1	555.6	29028.5
0.451	24831.4	549.4	13642.4	51440.1	558.8	28744.7
0.611	23851.7	549.8	13113.7	49667.7	564.7	28047.4
0.701	23376.9	550.0	12857.3	48773.6	568.3	27718.0
0.801	22955.5	550.1	12627.8	47097.0	572.2	26948.9
0.892	22593.8	550.2	12431.1	45168.5	575.4	25990.0
1.00	22156.2	550.2	12190.3	45392.0	579.0	26282.0
1.09	21789.4	550.3	11990.7	45312.7	581.6	26353.9
1.27	21309.6	550.4	11728.8	44761.2	586.5	26252.4
1.75	20552.4	550.6	11316.2	42786.2	600.7	25701.7
2.20	20134.6	550.7	11088.1	40939.5	616.1	25222.8
2.32	20005.2	550.7	11016.9	40291.3	620.9	25016.9
2.61	19758.0	550.8	10882.7	38300.3	634.5	24301.5
2.82	19471.7	550.9	10727.0	36444.7	646.1	23546.9
3.30	18855.6	551.2	10393.2	31566.7	676.2	21345.4
3.37	18744.9	551.2	10332.2	30574.1	680.5	20805.7
3.51	18535.4	551.3	10218.6	27856.7	689.3	19201.6
3.59	18426.4	551.4	10160.3	26605.1	694.5	18477.2
3.78	18178.5	551.6	10027.3	24039.6	705.4	16957.5
3.98	17916.9	551.8	9886.5	21866.8	714.3	15619.5
4.16	17712.0	552.0	9777.0	20321.5	721.2	14655.9
4.32	17550.1	552.2	9691.2	19287.2	726.8	14017.9
4.56	17298.1	552.5	9557.2	18071.0	733.8	13260.5
4.86	17033.0	552.9	9417.5	16955.9	740.8	12560.9

Table 14-1 Break Mass and Energy Flow for the Blowdown Phase of the DEPSG Break (Sheet 2 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
5.12	16808.2	553.3	9300.0	16226.0	745.1	12090.0
5.60	16450.3	554.1	9115.1	15301.9	749.0	11461.1
5.92	16242.6	554.7	9009.8	14891.4	749.1	11155.1
6.14	16098.5	555.1	8936.3	14686.4	748.0	10985.4
6.68	15794.6	556.1	8783.4	14368.9	743.1	10677.5
7.22	15531.3	557.1	8652.5	14258.5	735.7	10490.0
7.62	15350.4	557.9	8564.0	14294.0	729.0	10420.3
7.98	15206.5	558.6	8494.4	14488.9	722.0	10461.0
8.02	15196.1	558.7	8490.1	14723.8	721.5	10623.2
8.26	15128.7	559.1	8458.5	15040.2	716.4	10774.8
8.34	15756.0	559.7	8818.6	15093.6	718.5	10844.8
8.40	16029.0	559.7	8971.4	15026.1	722.8	10860.9
8.52	16090.0	559.8	9007.2	14553.7	739.5	10762.5
8.78	16004.4	560.2	8965.7	12886.7	789.0	10167.6
8.90	15895.1	560.4	8907.6	12425.1	801.9	9963.7
9.08	15710.5	560.6	8807.3	12142.2	807.6	9806.0
9.86	14727.4	561.8	8273.9	11967.7	802.2	9600.5
10.1	14508.6	562.2	8156.7	11851.1	802.3	9508.1
10.5	14119.1	562.5	7942.0	11638.6	804.5	9363.3
11.2	13710.6	562.7	7715.0	11289.3	808.4	9126.3
11.6	13507.9	562.5	7598.2	11339.8	795.6	9021.9
11.9	13352.6	562.3	7508.2	11560.2	778.4	8998.5
12.5	13080.4	562.0	7351.2	12052.3	747.6	9010.3
13.1	12837.1	561.8	7211.9	12244.3	729.1	8927.3
13.6	12635.0	561.6	7095.8	12079.1	722.0	8721.1
14.5	12335.9	561.6	6927.8	11422.7	725.2	8283.7
15.1	12101.4	561.7	6797.4	10849.1	734.6	7969.7
16.1	11666.0	561.9	6555.1	10022.9	753.8	7555.3
16.8	11348.1	562.2	6379.9	9476.6	769.2	7289.4
17.7	10874.8	562.8	6120.3	8789.5	787.7	6923.5
18.4	10529.9	563.4	5932.5	8373.0	794.6	6653.2
19.0	10210.8	564.1	5759.9	8052.5	797.2	6419.5
20.0	9673.4	566.4	5479.0	7519.7	802.2	6032.3
20.6	9374.9	568.2	5326.8	7234.7	804.5	5820.3
21.8	8726.0	573.3	5002.6	6752.6	812.2	5484.5
22.0	8449.6	575.0	4858.5	6591.6	817.4	5388.0
22.1	8455.7	575.8	4868.8	6529.7	820.1	5355.0

Table 14-1 Break Mass and Energy Flow for the Blowdown Phase of the DEPSG Break (Sheet 3 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
22.4	8174.3	575.8	4706.8	6346.2	827.6	5252.1
22.5	8121.9	576.2	4679.8	6197.9	834.7	5173.4
23.2	7506.8	565.4	4244.3	5537.6	857.3	4747.4
23.5	7418.9	546.8	4056.7	5363.3	856.3	4592.6
23.9	7051.1	525.4	3704.6	5304.6	868.6	4607.6
24.1	6856.5	513.9	3523.6	5096.0	903.6	4604.7
24.3	6495.3	498.7	3239.2	4570.4	988.9	4519.7
24.6	6032.6	482.1	2908.3	3837.4	1123.2	4310.2
24.9	5684.8	470.7	2675.8	3371.5	1203.1	4056.3
25.2	5326.6	456.8	2433.2	2966.9	1233.0	3658.2
25.6	4825.7	439.8	2122.3	2576.6	1242.3	3200.9
26.0	4511.2	428.2	1931.7	2360.9	1246.8	2943.6
26.3	4022.2	420.6	1691.7	2222.3	1249.5	2776.8
26.6	3691.6	407.9	1505.8	2051.7	1252.1	2568.9
26.7	3693.4	402.7	1487.3	1970.7	1253.3	2469.9
27.1	3875.1	388.7	1506.3	1753.1	1256.9	2203.5
27.3	3818.1	383.4	1463.9	1620.9	1258.7	2040.2
28.1	3258.2	364.5	1187.6	1223.5	1265.0	1547.7
28.3	3013.6	356.1	1073.1	1089.7	1266.4	1380.0
28.7	2733.2	342.7	936.7	863.0	1268.5	1094.7
29.0	2602.6	334.0	869.3	746.2	1269.7	947.5
29.2	2413.3	327.3	789.9	678.6	1270.3	862.0
29.6	1782.4	315.2	561.8	578.3	1271.8	735.5
29.9	1036.9	308.6	320.0	502.1	1272.6	639.0
30.2	0.0	0.0	0.0	408.8	1273.5	520.6
31.6	0.0	0.0	0.0	0.0	0.0	0.0

Table 14-2 Break Mass and Energy Flow for the Reflood Phase of the DEPSG Break (Sheet 1 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
31.6	0.0	0.0	0.0	0.0	0.0	0.0
32.9	0.0	0.0	0.0	0.0	0.0	0.0
33.0	0.0	0.0	0.0	49.1	1179.3	57.9
33.1	0.0	0.0	0.0	17.1	1179.3	20.2
33.2	0.0	0.0	0.0	2.8	1179.3	3.3
33.4	0.0	0.0	0.0	0.0	0.0	0.0
33.5	0.0	0.0	0.0	21.6	1179.3	25.5
33.6	0.0	0.0	0.0	31.5	1179.3	37.1
33.7	0.0	0.0	0.0	35.3	1179.3	41.6
33.8	0.0	0.0	0.0	46.0	1179.3	54.2
33.9	0.0	0.0	0.0	52.2	1179.3	61.6
35.7	0.0	0.0	0.0	115.4	1179.6	136.1
36.7	0.0	0.0	0.0	140.3	1179.7	165.5
37.7	0.0	0.0	0.0	161.5	1179.9	190.6
38.7	0.0	0.0	0.0	180.2	1180.0	212.6
39.7	0.0	0.0	0.0	197.1	1180.2	232.6
40.7	0.0	0.0	0.0	212.4	1180.3	250.7
41.8	3737.2	158.2	591.2	444.4	1183.5	525.9
42.8	4175.0	166.3	694.3	495.5	1184.7	587.0
43.8	4145.4	167.3	693.5	491.6	1184.7	582.4
44.8	4094.6	167.9	687.5	485.3	1184.5	574.8
45.8	4041.6	168.5	681.0	478.8	1184.4	567.1
46.0	4030.9	168.7	680.0	477.5	1184.3	565.5
46.8	3988.3	169.2	674.8	472.4	1184.2	559.4
47.8	3935.2	169.7	667.8	466.0	1184.1	551.8
48.8	3882.9	170.3	661.3	459.8	1184.0	544.4
49.8	3831.4	170.9	654.8	453.8	1183.8	537.2
50.8	3781.0	171.5	648.4	447.9	1183.7	530.2
51.8	3731.6	172.1	642.2	442.2	1183.6	523.4
52.8	3683.4	172.6	635.8	436.6	1183.4	516.7
53.1	3669.1	172.8	634.0	435.0	1183.4	514.8
53.8	3636.3	173.2	629.8	431.3	1183.3	510.4
54.8	3590.3	173.7	623.6	426.1	1183.2	504.2
55.8	3545.5	174.3	618.0	421.0	1183.1	498.1
56.8	3501.8	174.8	612.1	416.1	1183.0	492.2
57.8	3459.1	175.4	606.7	411.4	1182.9	486.6
58.8	3417.4	175.9	601.1	406.8	1182.7	481.1
59.8	3376.7	176.5	596.0	402.3	1182.6	475.8

Table 14-2 Break Mass and Energy Flow for the Reflood Phase of the DEPSG Break (Sheet 2 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
60.8	3337.0	177.0	590.6	398.0	1182.5	470.6
61.2	3321.4	177.2	588.6	396.2	1182.5	468.5
61.8	3298.2	177.5	585.4	393.7	1182.4	465.5
62.8	3260.4	178.1	580.7	389.6	1182.3	460.6
63.8	3223.3	178.6	575.7	385.7	1182.2	456.0
64.8	3187.2	179.1	570.8	381.8	1182.2	451.4
65.8	3151.8	179.6	566.1	378.0	1182.1	446.8
66.8	3117.2	180.2	561.7	374.4	1182.0	442.5
67.8	3083.3	180.7	557.2	370.8	1181.9	438.2
68.8	3050.2	181.2	552.7	367.3	1181.8	434.1
69.8	3017.7	181.7	548.3	363.9	1181.7	430.0
70.2	3004.9	181.9	546.6	362.6	1181.7	428.5
70.8	2985.9	182.2	544.0	360.6	1181.6	426.1
71.8	2954.8	182.8	540.1	357.4	1181.6	422.3
72.8	2924.3	183.3	536.0	354.3	1181.5	418.6
73.8	2894.3	183.8	532.0	351.2	1181.4	414.9
74.8	2865.0	184.3	528.0	348.2	1181.3	411.3
75.8	2836.2	184.8	524.1	345.3	1181.3	407.9
76.8	2808.0	185.3	520.3	342.4	1181.2	404.4
77.8	2780.2	185.8	516.6	339.6	1181.1	401.1
78.8	2753.0	186.3	512.9	336.9	1181.1	397.9
79.8	2726.3	186.8	509.3	334.2	1181.0	394.7
80.8	2700.0	187.4	506.0	331.6	1180.9	391.6
81.8	2674.2	187.9	502.5	329.0	1180.9	388.5
82.8	2648.8	188.4	499.0	326.5	1180.8	385.5
83.8	2623.9	188.9	495.7	324.1	1180.8	382.7
84.8	182.6	1140.4	208.2	410.6	1182.1	485.4
85.8	191.9	1039.8	199.5	404.4	1182.2	478.1
87.8	190.7	1042.8	198.9	403.0	1182.2	476.4
91.8	188.4	1049.3	197.7	400.2	1182.1	473.1
92.8	187.8	1051.0	197.4	399.5	1182.1	472.2
100.8	183.4	1064.4	195.2	394.2	1182.0	465.9
108.8	179.3	1076.7	193.1	389.2	1181.9	460.0
116.8	175.5	1087.6	190.9	384.2	1181.8	454.0
120.8	173.7	1092.5	189.8	381.6	1181.7	450.9
122.8	257.2	934.6	240.4	481.6	1183.7	570.1
124.8	256.2	936.2	239.9	480.5	1183.7	568.8
128.8	254.4	938.6	238.8	478.4	1183.7	566.3

Table 14-2 Break Mass and Energy Flow for the Reflood Phase of the DEPSG Break (Sheet 3 of 3)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
132.8	252.7	940.1	237.6	476.0	1183.7	563.4
136.8	251.3	940.6	236.4	473.6	1183.6	560.6
140.8	249.9	940.2	235.0	471.1	1183.6	557.6
148.8	247.7	937.4	232.2	465.9	1183.5	551.4
150.8	247.2	936.3	231.5	464.6	1183.5	549.9
154.8	246.4	933.7	230.1	461.8	1183.5	546.5
162.8	244.8	927.5	227.1	456.2	1183.4	539.9
170.8	243.3	920.5	224.0	450.5	1183.4	533.1
174.8	242.7	916.9	222.5	447.6	1183.4	529.7
190.8	239.9	902.8	216.6	436.2	1183.3	516.2
198.8	238.3	896.6	213.7	430.6	1183.2	509.5
206.8	236.7	890.9	210.9	425.0	1183.2	502.9
214.8	234.8	886.2	208.1	419.4	1183.2	496.2
222.8	232.8	882.5	205.4	413.9	1183.1	489.7
230.8	230.5	880.0	202.8	408.4	1183.1	483.2
238.8	227.9	878.8	200.3	402.9	1183.1	476.7
246.8	225.2	878.3	197.8	397.4	1183.0	470.1
254.8	223.8	872.3	195.2	392.4	1183.0	464.2
262.8	222.1	867.5	192.7	387.4	1183.0	458.3
265.5	221.5	866.2	191.9	385.7	1182.9	456.2
265.6	92.6	114.1	10.6	119.9	1179.4	141.4

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 1 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
266.0	453.7	663.8	301.2	542.7	1207.8	655.5
270.0	2012.4	333.0	670.1	4548.9	321.9	1464.3
274.0	721.1	733.2	528.7	3042.4	347.9	1058.5
278.0	460.8	935.5	431.1	2599.8	416.8	1083.6
282.0	658.4	649.4	427.6	1056.3	775.8	819.5
286.0	303.0	1019.0	308.8	1014.9	649.0	658.7
290.0	305.0	844.4	257.5	840.9	591.8	497.6
294.0	357.9	666.6	238.6	543.7	705.7	383.7
298.1	414.3	564.2	233.7	258.3	1173.8	303.2
302.1	428.5	520.7	223.1	210.6	1174.2	247.3
306.1	424.4	496.6	210.8	175.1	1179.2	206.5
310.1	417.2	476.5	198.8	223.9	857.1	191.9
314.1	418.1	495.2	207.0	179.4	967.0	173.5
318.1	418.5	512.4	214.4	225.3	853.9	192.4
322.1	418.6	514.0	215.2	248.3	779.9	193.6
326.1	419.3	511.5	214.5	228.0	799.6	182.3
330.1	418.8	509.4	213.3	215.1	803.5	172.8
334.1	415.5	510.0	211.9	202.9	808.4	164.0
338.1	411.7	510.7	210.3	179.7	843.8	151.6
342.1	408.5	511.5	208.9	156.1	892.2	139.3
346.1	405.4	512.2	207.6	136.6	937.2	128.0
350.1	402.6	513.3	206.7	118.1	987.4	116.6
354.1	399.7	514.7	205.7	101.9	1041.7	106.1
358.1	397.4	516.9	205.4	88.7	1075.9	95.4
362.1	394.9	519.9	205.3	78.8	1117.7	88.1
366.1	392.5	522.6	205.1	68.2	1155.3	78.8
370.1	390.2	525.5	205.1	59.9	1184.1	70.9
374.1	388.2	528.6	205.2	53.5	1190.3	63.7
378.1	385.5	531.4	204.9	49.2	1189.8	58.5
382.1	381.7	532.9	203.4	45.4	1189.8	54.0
386.1	371.1	531.3	197.2	41.9	1189.8	49.9
390.1	416.0	577.5	240.2	142.3	985.9	140.3
394.1	355.2	592.8	210.6	252.8	671.2	169.7
398.1	356.1	558.1	198.7	35.3	1187.9	41.9
402.1	399.2	532.9	212.7	60.1	1188.5	71.4
406.1	355.0	619.2	219.8	400.9	545.4	218.7
410.2	316.0	580.3	183.4	9.1	1157.6	10.5

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 2 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
414.2	320.0	537.6	172.0	33.7	1187.6	40.0
418.2	414.1	591.8	245.1	113.9	1186.0	135.1
422.2	366.8	635.0	232.9	177.5	743.4	132.0
426.2	300.8	591.7	178.0	32.7	1175.5	38.4
430.2	324.9	536.2	174.2	24.6	1186.6	29.2
434.2	388.0	627.8	243.6	154.3	919.2	141.8
438.2	313.5	639.7	200.5	19.9	1172.0	23.3
442.2	356.8	595.1	212.3	33.3	1186.3	39.5
446.2	282.7	687.6	194.4	17.3	809.3	14.0
450.3	317.7	649.0	206.2	21.2	1185.5	25.1
454.3	273.9	709.0	194.2	10.8	930.9	10.1
458.3	338.0	685.2	231.6	77.8	1173.5	91.3
462.3	255.9	728.0	186.3	20.6	1143.1	23.5
466.3	255.8	731.9	187.2	10.0	1166.5	11.7
470.3	310.8	715.3	222.3	83.6	1095.6	91.6
474.4	333.2	716.7	238.8	59.6	1185.3	70.6
478.4	292.7	730.3	213.8	18.2	1184.6	21.6
482.4	275.9	760.8	209.9	53.0	1181.5	62.6
486.4	229.9	782.4	179.9	23.2	1104.2	25.6
490.4	305.0	775.5	236.5	70.3	1155.6	81.2
494.4	284.7	833.8	237.4	86.4	1026.3	88.7
498.4	243.6	774.8	188.7	14.2	1155.6	16.4
520.4	267.9	889.0	238.2	29.2	754.8	22.0
560.5	162.4	1028.7	167.1	234.8	393.5	92.4
600.5	229.7	1020.2	234.3	105.4	935.5	98.6
640.5	189.5	1031.6	195.5	21.3	449.8	9.6
680.5	189.8	1138.1	216.0	69.4	1076.7	74.7
720.5	164.9	1250.0	206.1	1664.7	288.1	479.6
760.5	184.6	1229.0	226.9	137.2	710.8	97.5
800.6	190.7	999.5	190.6	64.5	527.4	34.0
840.6	190.1	1073.2	204.0	60.8	1162.3	70.7
880.6	192.0	1064.3	204.3	95.6	848.0	81.1
920.6	219.3	959.3	210.4	37.7	1168.4	44.0
960.7	194.5	1145.2	222.7	1853.8	284.4	527.2
1000.7	199.1	1051.5	209.4	31.2	1180.8	36.8
1040.7	157.9	1055.4	166.6	91.9	270.3	24.8
1080.7	208.2	962.2	200.3	0.0	0.0	0.0

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 3 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
1120.7	184.4	1159.8	213.9	39.5	1179.4	46.6
1160.8	176.6	982.8	173.6	29.0	270.7	7.9
1200.8	236.0	1026.2	242.2	60.0	1038.2	62.3
1240.8	167.9	1075.9	180.6	290.0	337.9	98.0
1280.8	163.2	1029.3	168.0	125.9	271.6	34.2
1320.8	211.6	885.2	187.3	194.1	271.7	52.7
1360.8	193.7	889.7	172.3	69.7	305.1	21.3
1400.8	287.3	903.6	259.6	32.6	1180.6	38.5
1440.9	256.3	849.6	217.8	51.2	1180.5	60.4
1480.9	220.7	913.5	201.6	42.6	1146.0	48.8
1520.9	330.1	829.3	273.8	668.8	307.8	205.9
1560.9	295.8	799.8	236.6	387.0	368.2	142.5
1600.9	217.7	968.5	210.8	66.0	294.1	19.4
1641.0	215.4	913.6	196.8	27.9	1180.5	32.9
1681.0	258.7	865.0	223.8	52.0	1180.3	61.4
1721.0	232.5	837.3	194.7	12.7	1180.8	15.0
1761.0	219.7	890.0	195.5	25.4	1168.6	29.7
1801.0	215.3	921.5	198.4	0.2	269.9	0.1
1841.1	517.6	418.6	216.7	53.8	897.6	48.3
1881.1	212.3	823.0	174.7	56.1	1172.1	65.8
1921.1	178.0	907.3	161.5	8.5	1173.6	10.0
1961.1	151.5	974.9	147.7	34.9	1175.6	41.0
2001.1	943.9	275.0	259.6	93.3	1120.4	104.5
2041.2	125.8	1061.7	133.6	39.5	1175.4	46.4
2081.2	219.6	507.0	111.3	19.7	1181.2	23.3
2121.2	236.4	385.9	91.2	2.0	1179.1	2.4
2161.2	135.6	737.2	100.0	82.1	1141.7	93.7
2201.2	222.1	593.2	131.7	28.2	1181.2	33.3
2241.2	128.5	737.2	94.7	0.0	0.0	0.0
2281.3	403.6	345.1	139.3	24.2	1173.4	28.4
2321.3	387.3	359.3	139.2	27.2	1174.4	31.9
2361.3	188.5	588.3	110.9	10.6	1180.9	12.5
2401.3	162.8	596.0	97.0	1.8	1159.7	2.1
2441.3	143.6	584.1	83.9	2.9	1179.3	3.4
2481.3	133.8	685.6	91.7	25.7	1180.9	30.3
2521.4	127.5	708.1	90.3	78.1	1133.8	88.5
2561.4	234.3	436.5	102.3	22.5	1180.8	26.6

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 4 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
2601.4	122.7	876.1	107.5	19.3	1180.9	22.8
2641.4	329.9	376.5	124.2	26.3	1180.8	31.1
2681.4	204.7	550.3	112.6	14.1	1180.7	16.6
2721.4	201.5	552.5	111.3	14.3	1180.6	16.9
2761.4	204.5	541.2	110.7	14.8	1180.6	17.5
2801.4	201.5	541.8	109.2	14.9	1180.5	17.6
2841.4	205.6	527.7	108.5	15.0	1180.5	17.7
2881.4	203.5	528.3	107.5	14.6	1180.4	17.2
2921.5	197.6	536.8	106.1	13.7	1180.4	16.2
2961.5	304.1	373.6	113.6	24.7	1180.4	29.2
3001.6	368.9	339.3	125.2	28.2	1180.5	33.3
3201.6	152.9	648.0	99.1	22.4	1176.9	26.4
3401.9	463.1	272.3	126.1	3.5	1179.3	4.1
3602.0	294.1	408.0	120.0	34.4	1179.5	40.6
3802.1	276.8	408.2	113.0	11.6	1179.2	13.7
4002.2	208.4	441.0	91.9	20.5	1178.7	24.2
4202.4	193.7	438.0	84.8	0.0	0.0	0.0
4402.5	386.4	356.3	137.7	29.9	1178.4	35.2
4602.8	322.9	348.5	112.5	28.5	1178.3	33.6
4803.0	454.7	323.9	147.3	42.4	1177.9	49.9
5003.1	179.1	501.9	89.9	10.7	1177.5	12.6
5203.3	190.1	476.7	90.6	15.7	1177.5	18.5
5403.4	191.5	467.8	89.6	14.0	1176.4	16.5
5603.5	237.8	390.3	92.8	23.9	1175.6	28.1
5803.6	297.6	284.3	84.6	47.2	1107.3	52.3
6003.8	171.1	370.4	63.4	25.1	1176.0	29.5
6203.9	274.9	306.2	84.2	12.8	1174.6	15.0
6404.1	366.0	290.0	106.1	13.1	1176.1	15.4
6604.2	266.3	313.7	83.5	103.4	1048.9	108.5
6804.4	183.9	496.2	91.3	8.7	1176.0	10.2
7004.5	220.9	438.3	96.8	21.9	1175.9	25.8
7204.6	73.2	785.9	57.5	19.6	1175.8	23.0
7404.8	275.1	369.5	101.6	26.4	965.2	25.5
7605.0	182.9	479.9	87.8	7.7	1166.9	9.0
7805.2	211.2	370.4	78.2	0.0	0.0	0.0
8005.3	149.1	522.2	77.9	15.4	1175.2	18.1
8205.5	156.0	470.6	73.4	7.1	1174.9	8.3

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 5 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
8405.7	156.3	361.4	56.5	20.3	1174.9	23.9
8605.8	331.2	304.2	100.8	9.7	1174.0	11.4
8806.0	230.1	389.3	89.6	12.1	1110.4	13.4
9006.1	647.5	258.8	167.6	72.8	1173.9	85.5
9206.3	304.5	361.4	110.0	30.9	1173.8	36.3
9406.5	121.4	507.9	61.7	8.4	1165.8	9.8
9606.7	112.3	372.9	41.9	13.4	1173.9	15.7
9806.7	440.2	315.9	139.1	27.5	1173.9	32.3
10006.9	267.1	308.4	82.4	20.2	1165.8	23.5
12007.1	378.1	308.9	116.8	22.3	1172.6	26.1
14007.2	188.4	392.9	74.0	14.7	1105.2	16.2
16007.3	179.1	339.2	60.8	9.0	1159.5	10.4
18007.5	530.7	259.7	137.8	17.9	1170.1	20.9
20007.7	394.4	277.2	109.3	27.3	1164.9	31.8
22007.8	398.4	250.6	99.8	11.2	1168.0	13.1
24008.0	301.4	271.9	82.0	11.9	1068.0	12.7
26008.2	310.7	304.5	94.6	24.0	1165.8	28.0
28008.4	304.2	289.6	88.1	28.3	1139.7	32.3
30008.4	272.1	247.6	67.4	1.5	317.2	0.5
32008.6	200.9	301.6	60.6	14.2	1029.4	14.6
34008.7	40.7	580.2	23.6	0.1	218.1	0.0
36008.9	1096.6	210.1	230.4	5.6	1164.5	6.5
38009.1	76.0	581.2	44.2	8.6	1130.2	9.7
40009.3	434.7	207.5	90.2	11.3	1152.9	13.0
42009.4	128.3	366.3	47.0	4.1	1129.4	4.6
44009.6	933.0	210.4	196.3	1.7	1163.5	2.0
46009.7	0.0	0.0	0.0	26.5	894.8	23.7
48009.8	509.0	210.5	107.1	18.3	1105.4	20.2
50010.0	62.7	544.9	34.2	3.9	1162.5	4.5
52010.2	1164.9	202.6	236.0	6.9	1162.2	8.0
54010.3	394.7	206.1	81.3	24.4	1160.1	28.3
56010.5	181.1	319.0	57.8	10.1	1161.3	11.7
58010.6	259.6	205.5	53.3	12.3	1114.4	13.7
60010.9	78.5	368.4	28.9	1.8	1143.2	2.1
62011.0	297.4	204.5	60.8	7.9	1151.7	9.1
64011.2	0.0	0.0	0.0	76.2	906.3	69.1
66011.4	433.7	194.3	84.3	1.2	1160.9	1.4

Table 14-3 Break Mass and Energy Flow for the Long-term Cooling Phase of the DEPSG Break (Sheet 6 of 6)

Time (sec)	Break Flow (Reactor Vessel Side)			Break Flow (Steam Generator Side)		
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Energy (Thousand Btu/sec)
68011.4	404.2	204.3	82.6	5.5	1160.9	6.4
70011.6	608.6	183.8	111.9	1.5	1160.5	1.7
72011.8	190.9	206.1	39.3	2.5	1140.8	2.9
74011.9	101.0	295.1	29.8	0.1	1140.3	0.1
76012.0	1078.9	188.1	202.9	4.8	1160.1	5.6
78012.1	475.9	185.4	88.2	1.2	1159.8	1.4
80012.2	0.0	0.0	0.0	91.0	881.2	80.2
82012.3	517.3	189.6	98.1	21.6	1159.6	25.0
84012.5	470.0	185.8	87.3	6.0	1158.6	7.0
86012.6	168.4	183.8	31.0	3.8	1159.7	4.4
88012.8	197.0	225.8	44.5	4.1	1158.5	4.7
90013.1	83.7	332.5	27.8	3.0	1156.5	3.5
92013.3	545.3	192.9	105.2	9.8	1093.7	10.7
94013.4	94.1	386.1	36.3	6.2	1158.6	7.2
96013.6	157.3	229.6	36.1	0.1	200.9	0.0
98013.8	114.7	178.1	20.4	27.6	1145.6	31.6
100000.0	410.8	182.6	75.0	3.0	949.8	2.8

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 1 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
266.0	81.8	1184.6	41.3	270.4	185.6	1199.1	0.6	267.6
267.0	114.2	1192.6	1263.7	277.8	465.1	1205.9	12.3	269.3
268.0	68.1	1208.8	5362.7	278.3	376.2	1204.0	183.5	269.4
269.0	52.2	1206.2	3192.5	278.5	368.1	1203.3	435.3	269.4
270.0	82.3	1232.4	2074.6	278.4	359.8	1202.8	922.2	271.7
271.0	165.4	1239.4	1581.6	279.5	248.3	1193.4	6194.5	276.5
272.0	240.4	1268.3	972.3	281.2	295.8	1187.8	6842.2	273.9
273.0	288.4	1275.1	618.9	283.8	277.2	1188.1	5117.8	271.8
274.0	318.2	1274.3	446.1	287.0	257.6	1189.3	3677.4	270.7
275.0	329.6	1272.5	340.6	290.2	299.6	1191.2	2432.6	270.7
276.0	334.6	1271.0	254.2	294.0	372.8	1191.3	2645.3	271.9
277.0	330.5	1267.4	194.0	297.2	420.6	1190.2	2980.2	272.6
278.0	312.5	1266.1	150.4	297.7	417.2	1191.0	2323.9	271.8
279.0	301.2	1269.3	206.0	280.4	399.7	1191.4	2233.7	271.7
280.0	294.4	1272.4	299.0	268.4	386.4	1191.4	2361.2	271.8
281.0	281.4	1272.6	394.0	259.9	379.8	1191.3	2313.3	271.7
282.0	264.0	1271.0	427.1	255.3	407.8	1191.7	1800.5	271.6
283.0	249.8	1269.7	334.7	255.6	556.8	1195.1	52.2	271.2
284.0	245.4	1271.2	198.4	257.0	416.6	1195.5	1066.3	272.4
285.0	237.0	1272.3	127.3	257.1	366.8	1192.6	2103.5	271.9
286.0	225.2	1273.1	87.7	256.6	353.3	1192.5	1396.3	271.1
287.0	210.9	1271.4	63.5	253.3	403.7	1194.2	614.6	270.9
288.0	211.7	1236.6	63.0	218.1	408.6	1195.8	35.8	270.1
289.0	210.3	1210.6	79.2	203.8	358.4	1196.0	413.0	271.0
290.0	199.6	1203.9	98.2	199.9	325.4	1195.5	524.4	270.4
291.0	191.2	1200.4	118.7	200.0	320.7	1195.8	398.0	270.3
292.0	179.4	1198.8	136.8	201.0	299.3	1196.0	318.5	270.1
293.0	172.9	1197.5	157.4	201.7	284.4	1196.3	259.0	270.0
294.0	168.1	1196.0	178.4	202.2	266.0	1196.7	221.3	269.9
295.0	164.9	1195.0	200.7	202.7	245.7	1196.7	289.8	269.8
296.0	160.9	1195.4	221.6	203.0	225.8	1196.7	332.8	269.8
297.0	157.2	1195.7	241.3	203.5	238.8	1196.0	370.5	269.9
298.1	153.1	1195.7	257.7	204.1	254.2	1195.7	170.2	269.9
299.1	149.0	1195.2	270.5	204.6	243.4	1196.7	5.6	269.7
300.1	145.1	1194.6	279.7	205.0	230.9	1196.7	5.5	269.6

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 2 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
301.1	141.6	1194.5	286.2	205.3	219.8	1196.7	5.4	269.7
302.1	138.1	1194.5	290.3	205.5	210.1	1196.7	5.2	269.6
303.1	134.8	1194.5	292.8	205.6	201.2	1196.6	4.9	269.6
304.1	131.9	1194.5	295.1	205.7	193.0	1196.5	4.6	269.6
305.1	128.9	1194.5	296.9	205.7	184.7	1196.4	4.2	269.6
306.1	126.1	1194.4	298.5	205.7	176.2	1196.4	3.6	269.7
307.1	123.4	1194.3	300.2	205.7	166.1	1196.3	24.0	269.5
308.1	121.1	1194.3	301.9	205.5	157.3	1194.5	134.3	269.5
309.1	118.2	1194.2	302.1	205.3	145.5	1194.3	103.5	269.4
310.1	116.0	1194.0	303.0	204.9	141.4	1194.4	85.3	269.4
311.1	114.9	1193.8	303.8	204.3	139.2	1194.4	69.0	269.4
312.1	114.2	1192.9	306.2	203.8	135.7	1194.5	58.6	269.3
313.1	118.6	1195.1	311.3	202.8	128.1	1194.6	42.7	269.3
314.1	120.1	1192.0	306.1	202.5	137.4	1194.4	57.0	269.3
315.1	127.0	1193.0	309.3	202.1	133.7	1194.4	50.4	269.3
316.1	129.7	1191.2	301.8	202.0	139.4	1194.2	65.1	269.4
317.1	131.2	1190.9	294.5	202.1	142.8	1194.0	68.0	269.3
318.1	131.3	1190.9	289.0	202.3	143.1	1193.8	81.5	269.3
319.1	131.2	1191.0	286.6	202.7	141.4	1193.7	76.5	269.4
320.1	131.4	1190.9	286.6	203.2	139.0	1193.6	71.9	269.3
321.1	131.6	1190.9	287.1	203.7	137.9	1193.4	89.0	269.3
322.1	131.5	1190.9	287.3	204.3	137.4	1193.2	105.3	269.3
323.1	131.1	1191.0	287.3	204.8	136.7	1193.0	110.6	269.3
324.1	130.6	1190.9	287.6	205.2	135.0	1193.0	103.7	269.3
325.1	130.3	1190.9	288.2	205.6	132.9	1192.9	94.0	269.3
326.1	130.1	1190.8	289.0	206.0	131.4	1192.8	93.8	269.3
327.1	129.8	1190.8	289.5	206.3	130.4	1192.7	100.8	269.3
328.1	129.4	1190.8	289.8	206.7	129.2	1192.5	102.2	269.3
329.1	129.0	1190.8	289.9	206.9	127.3	1192.4	97.1	269.3
330.1	128.8	1190.8	290.1	207.1	125.4	1192.4	91.9	269.2
331.1	128.6	1190.7	290.0	207.2	123.9	1192.3	90.9	269.2
332.1	128.4	1190.7	289.5	207.3	122.6	1192.1	92.6	269.2
333.1	128.2	1190.7	288.7	207.4	121.2	1192.0	92.0	269.2
334.1	127.9	1190.7	288.0	207.4	119.5	1192.0	87.3	269.2
335.1	127.7	1190.7	287.3	207.4	117.7	1191.9	81.5	269.2

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 3 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
336.1	127.6	1190.6	286.7	207.4	116.0	1191.8	77.1	269.2
337.1	127.4	1190.6	285.9	207.3	114.5	1191.7	74.1	269.2
338.1	127.2	1190.6	285.1	207.3	112.9	1191.7	70.3	269.1
339.1	127.0	1190.6	284.4	207.3	111.1	1191.6	65.2	269.1
340.1	126.8	1190.6	283.7	207.2	109.3	1191.5	59.8	269.1
341.1	126.6	1190.6	283.1	207.2	107.6	1191.4	55.3	269.1
342.1	126.5	1190.6	282.5	207.2	106.1	1191.3	52.2	269.1
343.1	126.3	1190.6	281.8	207.1	104.6	1191.3	48.9	269.1
344.1	126.1	1190.5	281.1	207.1	103.1	1191.2	45.4	269.1
345.1	126.0	1190.5	280.5	207.1	101.3	1191.1	41.9	269.0
346.1	125.8	1190.5	279.9	207.1	99.7	1191.0	38.9	269.0
347.1	125.7	1190.5	279.3	207.0	98.1	1191.0	36.1	269.0
348.1	125.6	1190.5	278.7	207.0	96.4	1190.9	33.3	269.0
349.1	125.5	1190.5	278.0	207.0	94.7	1190.9	30.2	269.0
350.1	125.4	1190.5	277.5	207.0	92.9	1190.8	27.4	269.0
351.1	125.3	1190.5	276.9	207.0	91.2	1190.7	24.8	269.0
352.1	125.2	1190.5	276.3	207.0	89.6	1190.7	22.4	268.9
353.1	125.2	1190.5	275.6	207.0	87.9	1190.5	20.1	269.0
354.1	125.1	1190.5	275.0	207.0	86.2	1190.5	17.8	269.0
355.1	125.1	1190.5	274.4	207.0	84.1	1190.4	15.2	268.9
356.1	125.2	1190.5	273.9	207.0	82.3	1190.4	13.7	268.9
357.1	125.2	1190.5	273.2	207.0	80.7	1190.3	12.7	268.9
358.1	125.2	1190.6	272.5	207.1	78.7	1190.2	11.6	268.9
359.1	125.3	1190.6	272.0	207.1	77.0	1190.2	10.2	268.7
360.1	125.5	1190.6	271.6	207.2	75.9	1190.1	8.9	268.9
361.1	125.6	1190.6	270.8	207.2	74.8	1190.1	7.8	269.0
362.1	125.6	1190.6	269.8	207.3	73.5	1190.0	6.8	268.7
363.1	125.5	1190.7	269.0	207.3	71.3	1189.9	5.6	268.8
364.1	125.6	1190.7	268.6	207.4	69.1	1189.8	4.4	268.9
365.1	125.8	1190.7	268.1	207.4	67.7	1189.9	3.5	268.6
366.1	125.8	1190.7	267.2	207.5	66.5	1189.8	2.9	268.9
367.1	125.7	1190.7	266.2	207.5	64.8	1189.7	2.1	268.8
368.1	125.8	1190.7	265.6	207.6	62.4	1189.7	1.2	268.0
369.1	126.0	1190.8	265.3	207.6	60.7	1189.9	0.7	269.9
370.1	126.1	1190.8	264.6	207.7	59.9	1190.1	0.5	266.5

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 4 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
371.1	126.0	1190.8	263.5	207.7	58.7	1190.3	0.3	274.4
372.1	125.9	1190.8	262.7	207.8	57.0	1190.4	0.0	0.0
373.1	126.2	1190.8	262.4	207.8	55.2	1190.5	0.0	0.0
374.1	126.6	1190.9	262.0	207.9	53.9	1190.5	0.0	0.0
375.1	126.5	1190.9	260.9	208.0	53.2	1190.4	0.0	0.0
376.1	126.3	1190.9	259.7	208.0	52.3	1190.4	0.0	0.0
377.1	126.3	1190.9	259.1	208.1	50.3	1190.4	0.0	0.0
378.1	126.6	1190.9	258.9	208.1	49.2	1190.3	0.0	0.0
379.1	126.8	1190.9	258.2	208.2	49.1	1190.2	0.0	0.0
380.1	126.3	1190.9	256.6	208.2	48.8	1190.2	0.0	0.0
381.1	125.8	1190.9	255.4	208.2	47.5	1190.1	0.0	0.0
382.1	125.8	1190.8	255.2	208.1	45.7	1190.0	0.0	0.0
383.1	126.7	1190.9	255.9	208.1	45.8	1190.0	0.0	0.0
384.1	127.0	1191.0	255.3	208.2	46.6	1189.9	0.0	0.0
385.1	124.7	1190.8	251.5	208.3	46.6	1189.9	0.0	0.0
386.1	122.1	1190.6	248.2	208.0	42.6	1189.8	0.0	0.0
387.1	122.6	1190.4	250.4	207.7	42.2	1189.8	0.0	0.0
388.1	124.6	1190.6	253.1	207.4	42.1	1189.7	0.0	0.0
389.1	144.0	1193.7	277.2	208.3	58.9	1189.7	0.1	273.4
390.1	155.0	1196.0	272.8	211.3	99.6	1189.2	4.3	268.6
391.1	152.6	1196.5	252.0	214.4	125.8	1187.6	94.2	268.8
392.1	152.3	1195.9	242.0	216.3	137.9	1186.2	217.1	268.8
393.1	150.6	1195.3	234.3	217.5	128.5	1185.4	347.0	268.8
394.1	143.5	1194.3	225.0	217.7	117.8	1185.3	332.5	268.7
395.1	126.8	1191.8	208.2	216.3	95.3	1186.3	51.7	268.5
396.1	125.1	1190.9	212.5	213.3	43.7	1186.7	3.2	268.4
397.1	126.8	1190.5	222.6	211.2	36.3	1187.2	0.1	280.4
398.1	127.1	1190.7	228.0	209.8	35.5	1187.7	0.0	0.0
399.1	123.2	1190.6	227.2	208.7	36.2	1188.0	0.0	0.0
400.1	112.4	1189.6	216.4	207.2	38.8	1188.3	0.0	0.0
401.1	114.7	1189.6	224.7	205.4	40.9	1188.3	0.0	0.0
402.1	132.3	1191.2	256.2	204.9	43.3	1188.5	0.0	0.0
403.1	148.3	1194.3	269.7	206.9	82.3	1188.2	1.4	267.8
404.1	159.8	1197.6	261.6	210.8	110.8	1187.8	9.1	268.6
405.1	162.6	1200.3	243.3	215.8	126.1	1186.5	112.0	268.7

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 5 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
406.1	149.7	1199.4	216.9	218.8	128.3	1184.9	277.4	268.7
407.1	143.8	1195.8	209.4	218.8	105.4	1185.3	191.4	268.5
408.1	140.9	1193.7	209.8	218.0	85.0	1185.9	73.0	268.5
409.2	136.7	1192.9	209.9	217.0	68.9	1186.2	21.5	268.4
410.2	125.5	1191.7	203.0	215.3	18.3	1186.5	1.9	269.0
411.2	116.4	1190.3	198.4	212.4	24.8	1186.5	0.2	262.6
412.2	119.1	1189.7	211.7	209.9	36.2	1187.1	0.0	0.0
413.2	116.8	1189.1	214.9	207.9	33.0	1187.3	0.0	0.0
414.2	112.8	1189.0	215.7	206.1	32.6	1187.6	0.0	0.0
415.2	105.9	1188.6	209.8	204.3	32.7	1187.6	0.0	0.0
416.2	121.3	1190.6	241.7	203.2	31.8	1187.7	0.0	0.0
417.2	142.0	1193.0	267.8	204.6	68.1	1187.7	0.2	265.5
418.2	156.1	1196.0	263.0	208.4	103.9	1187.1	2.9	268.7
419.2	165.1	1200.8	246.5	214.0	114.3	1186.8	25.0	268.5
420.2	155.1	1204.9	216.1	219.3	110.8	1185.5	98.2	268.6
421.2	140.7	1200.3	193.8	219.9	103.4	1184.9	110.6	268.5
422.2	151.4	1195.8	206.2	219.3	94.1	1185.1	81.5	268.5
423.2	155.7	1196.8	209.3	220.3	101.5	1184.9	111.1	268.6
424.2	141.5	1196.5	192.3	220.9	80.1	1184.6	94.2	268.4
425.2	116.6	1192.0	168.7	217.6	50.4	1185.2	15.0	268.3
426.2	117.8	1189.7	178.5	213.0	37.8	1185.5	2.0	268.6
427.2	115.2	1188.5	186.0	209.7	31.4	1185.7	0.1	272.5
428.2	112.6	1188.7	192.1	207.0	28.9	1186.2	0.0	0.0
429.2	102.8	1188.1	188.2	204.7	27.7	1186.4	0.0	0.0
430.2	105.9	1188.9	200.7	202.3	25.7	1186.6	0.0	0.0
431.2	128.1	1191.1	240.1	201.9	33.8	1186.7	0.0	0.0
432.2	142.8	1193.4	256.9	204.0	78.1	1186.7	1.0	269.7
433.2	153.2	1196.2	250.0	208.1	103.7	1186.2	3.1	268.1
434.2	164.5	1201.3	235.9	214.1	111.5	1186.0	21.7	268.5
435.2	161.1	1211.6	210.5	220.7	103.7	1185.2	66.9	268.5
436.2	139.7	1216.2	177.7	223.1	52.8	1184.7	38.6	268.1
437.2	138.3	1199.3	173.0	220.6	31.2	1185.1	5.4	268.2
438.2	136.5	1193.0	175.3	218.2	22.2	1185.2	0.9	268.0
439.2	133.3	1192.6	179.2	216.3	21.8	1185.6	0.1	263.5
440.2	113.0	1190.8	165.9	213.7	29.6	1185.9	0.0	0.0

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 6 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
441.2	117.9	1191.1	179.4	210.1	29.3	1186.0	0.0	0.0
442.2	136.3	1192.0	213.2	209.3	25.3	1186.3	0.0	0.0
443.2	149.7	1195.1	227.6	211.1	60.1	1186.3	0.0	0.0
444.2	162.1	1199.5	228.2	215.2	94.2	1186.2	4.0	268.3
445.2	164.9	1211.3	205.8	221.3	99.3	1185.3	35.3	268.4
446.2	142.8	1233.4	169.1	225.7	51.2	1184.7	26.8	268.2
447.2	134.3	1212.3	152.2	222.3	14.7	1185.1	2.9	268.4
448.2	134.1	1194.1	153.3	218.2	20.5	1185.1	0.5	266.0
449.3	129.6	1191.8	156.5	214.9	26.2	1185.3	0.1	266.2
450.3	130.9	1192.6	166.4	212.4	22.7	1185.7	0.0	0.0
451.3	145.9	1194.6	189.2	212.0	27.6	1185.8	0.0	0.0
452.3	159.5	1197.6	201.6	214.7	67.5	1186.0	0.0	0.0
453.3	168.3	1206.8	195.5	220.1	92.2	1185.5	16.0	268.4
454.3	143.9	1230.2	157.3	226.1	44.7	1184.8	14.2	268.3
455.3	133.8	1215.4	141.1	222.9	16.3	1185.0	1.2	267.9
456.3	136.4	1196.0	145.5	218.9	18.6	1184.9	0.2	272.0
457.3	142.1	1195.4	157.8	216.3	21.9	1185.3	0.0	0.0
458.3	159.1	1200.3	177.8	217.5	56.3	1185.6	0.1	269.5
459.3	164.7	1212.9	175.6	221.5	86.0	1185.3	13.6	268.4
460.3	160.7	1242.4	157.1	228.2	88.4	1184.4	49.1	268.3
461.3	130.3	1251.0	122.3	230.9	26.7	1184.2	13.6	268.3
462.3	134.9	1209.3	120.6	223.0	16.6	1184.5	2.2	268.4
463.3	138.1	1195.7	129.5	217.6	21.2	1184.7	0.5	266.0
464.3	160.8	1197.8	154.7	217.5	29.0	1185.0	0.1	273.1
465.3	164.8	1207.1	160.1	223.4	71.4	1185.1	2.7	268.4
466.3	138.1	1225.9	133.8	225.6	23.4	1184.8	1.7	267.7
467.3	132.6	1205.6	125.0	219.3	16.1	1185.0	0.1	267.1
468.3	134.4	1195.5	131.1	214.0	20.9	1185.1	0.0	0.0
469.3	157.7	1197.0	157.3	214.2	30.4	1185.4	0.0	0.0
470.3	166.7	1205.2	165.8	220.7	73.0	1185.3	2.2	268.5
471.3	140.9	1227.8	138.3	225.5	33.7	1184.8	2.7	267.7
472.3	132.2	1212.4	124.8	220.4	19.8	1185.0	0.1	275.0
473.3	135.4	1196.8	129.9	215.1	15.1	1185.1	0.0	0.0
474.4	160.0	1197.7	154.6	215.3	31.7	1185.3	0.0	0.0
475.4	167.6	1208.3	161.3	222.4	72.0	1185.2	2.2	267.6

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 7 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
476.4	140.4	1233.8	132.0	228.1	31.6	1184.6	2.6	268.4
477.4	132.1	1215.7	118.8	222.6	13.0	1185.0	0.1	276.5
478.4	137.9	1197.4	124.9	216.6	19.4	1184.9	0.0	0.0
479.4	160.0	1197.8	148.3	217.0	26.2	1185.2	0.0	0.0
480.4	165.2	1208.6	152.8	223.7	68.6	1185.2	1.1	268.4
481.4	140.8	1234.1	126.6	228.6	69.9	1184.7	8.1	268.3
482.4	139.1	1215.8	117.5	223.0	57.4	1184.5	2.3	268.6
483.4	155.1	1202.0	129.5	220.2	59.0	1184.8	0.4	268.7
484.4	171.0	1209.5	138.1	225.1	73.3	1184.6	9.5	268.1
485.4	151.2	1235.5	118.3	232.5	65.3	1184.0	24.0	268.2
486.4	127.3	1228.0	98.3	228.4	13.8	1184.0	5.5	268.1
487.4	129.4	1199.1	101.6	218.8	23.2	1184.1	1.1	268.6
488.4	144.0	1195.6	121.2	213.7	15.6	1184.1	0.2	260.5
489.4	160.1	1197.9	141.3	216.4	17.1	1184.5	0.0	0.0
490.4	163.2	1210.2	142.5	223.2	63.1	1184.7	0.6	268.3
491.4	152.8	1241.5	126.7	229.7	69.2	1184.4	6.4	268.2
492.4	140.8	1246.7	108.7	231.1	70.8	1184.1	10.9	268.2
493.4	155.3	1212.4	110.5	227.7	68.7	1184.1	7.8	268.4
494.4	170.0	1214.0	114.9	230.1	69.6	1184.1	9.6	268.3
495.4	161.8	1239.2	103.4	237.1	66.5	1183.8	16.9	268.3
496.4	131.7	1250.8	82.3	237.8	22.6	1183.6	6.2	268.1
497.4	130.1	1212.2	80.8	224.3	22.4	1183.6	1.3	268.7
498.4	134.4	1195.6	90.2	214.0	16.9	1183.5	0.6	266.6
499.4	152.4	1195.5	112.1	212.1	9.7	1183.4	0.4	269.9
500.4	166.9	1202.2	126.2	217.7	35.6	1183.6	0.7	267.4
510.4	151.0	1241.4	86.1	230.7	54.1	1182.8	225.1	268.5
520.4	158.7	1241.8	81.2	230.5	55.1	1182.5	64.1	268.4
530.4	159.0	1240.1	63.6	231.9	50.3	1182.2	80.4	268.4
540.4	152.2	1248.9	53.4	233.2	47.6	1182.2	131.0	268.5
550.4	155.3	1250.4	57.0	236.9	52.5	1181.9	196.3	268.7
560.5	155.8	1246.6	61.5	233.4	49.5	1181.9	61.4	268.6
570.5	153.4	1239.7	63.3	229.7	42.5	1181.9	51.6	268.5
580.5	153.1	1238.8	63.9	229.1	42.6	1181.6	91.2	268.5
590.5	159.3	1252.8	37.1	248.8	36.5	1181.6	67.7	268.6
600.5	155.5	1240.3	39.6	215.4	38.4	1181.1	331.2	269.1

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 8 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
610.5	154.3	1248.1	38.8	248.1	25.8	1181.7	5.6	268.6
620.5	163.3	1249.0	17.3	231.4	37.5	1181.4	179.0	268.8
630.5	151.3	1237.7	30.9	222.6	26.8	1181.4	6.2	268.7
640.5	157.7	1258.3	30.4	247.3	42.3	1181.3	270.7	269.0
650.5	161.7	1250.9	30.0	241.0	33.4	1181.3	9.8	268.7
660.5	154.8	1242.3	26.3	220.0	33.0	1180.9	214.3	269.0
670.5	151.6	1237.5	40.1	222.9	32.8	1180.9	119.7	268.8
680.5	160.5	1251.7	40.8	251.8	41.9	1181.0	17.0	268.9
690.5	166.0	1262.7	6.3	263.9	34.6	1180.9	316.3	269.6
700.5	155.6	1255.6	4.3	248.0	28.6	1180.9	50.3	269.0
710.5	152.3	1237.2	31.4	210.2	32.0	1180.5	126.9	269.0
720.5	163.6	1260.0	24.2	261.8	35.4	1181.0	135.1	269.4
730.5	152.4	1245.5	10.1	243.1	25.4	1180.6	159.9	269.5
740.5	160.0	1248.0	9.5	218.0	32.3	1180.8	230.5	269.4
750.5	155.0	1234.5	39.6	235.0	25.9	1180.6	3.0	269.0
760.6	161.3	1251.2	20.6	258.3	34.0	1181.1	2.8	268.9
770.6	155.4	1237.6	16.8	194.3	24.6	1180.6	474.7	269.9
780.6	145.7	1243.3	37.0	240.2	30.8	1180.8	1.4	269.3
790.6	150.6	1240.6	52.5	245.4	34.2	1180.9	2.7	269.3
800.6	153.4	1236.8	55.2	245.1	30.4	1180.9	8.9	269.4
810.6	161.7	1246.1	30.4	256.3	29.7	1180.7	142.1	269.7
820.6	154.2	1236.4	16.4	209.7	24.5	1180.4	552.3	270.0
830.6	159.9	1255.0	23.8	259.6	37.0	1180.8	13.6	269.4
840.6	145.0	1233.5	26.2	224.5	21.7	1180.4	123.5	269.5
850.6	149.6	1235.4	31.9	240.2	24.9	1180.6	0.4	270.1
860.6	158.8	1249.7	21.0	253.9	39.8	1180.8	387.9	270.0
870.6	149.4	1235.1	39.5	235.7	27.4	1180.5	0.7	269.0
880.6	150.2	1235.0	23.3	234.6	21.0	1180.6	68.4	269.6
890.6	153.1	1237.0	33.5	250.2	30.1	1180.6	214.8	269.8
900.6	151.6	1243.2	39.3	255.9	34.0	1180.4	37.6	269.6
910.6	155.5	1237.9	49.0	248.4	31.8	1180.4	52.3	269.8
920.6	148.7	1235.3	45.3	248.5	22.3	1180.3	29.2	269.7
930.6	143.4	1232.0	44.7	243.2	20.4	1180.4	0.1	271.9
940.6	160.3	1246.3	31.6	260.4	28.5	1180.8	467.6	270.5
950.7	158.1	1247.1	12.8	275.2	32.4	1180.4	44.0	270.0

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 9 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
960.7	161.9	1241.5	10.5	276.7	31.0	1180.4	213.6	270.3
970.7	148.0	1236.1	10.6	272.3	19.1	1180.1	209.3	270.6
980.7	150.0	1233.5	13.7	230.9	16.6	1180.9	66.5	270.1
990.7	147.8	1241.8	30.0	263.1	28.4	1180.2	12.2	269.8
1000.7	150.9	1232.7	35.5	251.3	26.4	1180.3	0.2	264.0
1010.7	157.5	1240.0	23.8	265.5	21.9	1180.7	432.1	270.6
1020.7	161.3	1236.2	29.3	256.7	36.0	1180.3	145.9	270.4
1030.7	148.8	1233.6	18.4	259.1	20.6	1180.1	66.4	270.3
1040.7	155.3	1240.8	32.2	243.9	18.2	1180.6	76.0	270.4
1050.7	159.8	1239.6	22.3	258.7	33.8	1180.2	132.2	270.5
1060.7	156.9	1241.5	3.3	264.6	27.5	1180.1	103.0	270.4
1070.7	153.9	1230.6	7.0	257.5	15.2	1180.6	525.8	271.1
1080.7	143.0	1231.8	35.5	248.9	27.2	1180.2	0.5	270.0
1090.7	147.9	1227.6	48.0	249.7	26.6	1180.2	0.1	267.3
1100.7	154.8	1236.0	13.4	266.1	20.8	1180.8	200.9	270.7
1110.7	164.0	1233.5	20.3	268.7	35.9	1180.2	119.9	270.9
1120.7	146.5	1229.1	16.9	268.8	21.3	1180.1	103.2	270.8
1130.7	158.9	1235.7	4.6	258.9	24.9	1180.6	374.1	271.1
1140.7	147.4	1221.2	35.7	245.2	30.1	1180.2	2.1	270.0
1150.7	141.5	1221.8	34.2	255.8	11.8	1179.8	26.5	270.8
1160.8	147.8	1226.4	42.3	249.0	21.0	1180.8	36.4	270.9
1170.8	144.9	1232.6	40.4	256.1	20.5	1179.9	9.6	270.4
1180.8	150.5	1233.1	54.9	246.0	23.4	1180.4	20.6	270.9
1190.8	161.3	1234.0	45.5	247.2	35.1	1180.2	83.5	271.1
1200.8	147.4	1233.0	42.2	243.6	21.0	1180.0	125.9	271.1
1210.8	163.4	1231.9	45.4	251.7	21.8	1180.3	314.2	271.5
1220.8	150.7	1231.2	43.8	242.2	18.2	1180.2	45.1	271.2
1230.8	155.7	1231.1	37.1	250.1	24.6	1180.5	82.4	271.3
1240.8	168.3	1230.9	39.3	263.8	39.2	1180.2	377.0	271.8
1250.8	151.5	1229.7	24.9	257.4	24.6	1180.2	12.8	271.4
1260.8	144.7	1226.3	30.2	256.6	16.7	1180.0	2.0	269.7
1270.8	149.9	1222.9	44.6	246.6	17.5	1180.9	131.4	271.6
1280.8	157.6	1226.2	42.3	258.7	32.6	1180.1	47.4	271.5
1290.8	149.5	1227.1	49.1	245.1	20.1	1179.9	43.4	271.5
1300.8	138.5	1217.9	55.5	249.9	14.8	1179.9	0.1	267.3

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 10 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
1310.8	147.2	1220.7	51.0	259.6	24.4	1180.2	0.0	0.0
1320.8	166.4	1224.4	82.1	241.2	17.2	1180.6	195.8	271.8
1330.8	161.5	1224.8	86.4	240.2	26.7	1180.2	70.4	271.8
1340.8	149.5	1223.7	57.5	241.8	20.1	1180.1	234.9	272.1
1350.8	165.1	1222.6	60.2	243.7	20.7	1180.5	116.9	272.0
1360.8	158.8	1223.1	65.6	245.6	24.4	1180.1	57.2	271.9
1370.8	154.1	1221.9	65.8	247.5	22.0	1180.1	24.9	271.9
1380.8	156.0	1220.8	66.2	241.2	7.4	1180.0	0.5	272.1
1390.9	151.1	1220.0	80.4	238.7	21.0	1180.1	0.0	0.0
1400.9	149.9	1219.9	81.7	244.1	20.9	1180.1	0.0	0.0
1410.9	149.2	1219.3	91.2	241.3	14.7	1180.1	7.3	271.6
1420.9	155.6	1218.1	95.5	239.6	18.0	1180.7	62.8	272.2
1430.9	164.9	1218.9	94.2	241.5	28.8	1180.1	70.9	272.3
1440.9	157.8	1217.2	84.6	239.5	19.7	1180.2	252.3	272.7
1450.9	161.0	1216.7	79.5	242.4	18.9	1180.2	0.0	0.0
1460.9	154.7	1216.0	80.5	241.1	19.0	1180.2	35.6	272.4
1470.9	158.8	1215.4	81.3	241.2	16.1	1180.1	1.4	271.4
1480.9	154.7	1214.6	85.9	242.1	13.1	1180.1	0.9	270.2
1490.9	150.4	1213.9	91.8	241.4	14.9	1180.4	0.1	269.0
1500.9	157.5	1213.9	98.4	242.8	19.7	1180.1	0.0	0.0
1510.9	157.0	1212.3	108.7	239.9	17.9	1180.5	45.4	272.8
1520.9	165.8	1212.8	112.0	241.4	28.8	1180.3	89.8	272.9
1530.9	162.8	1210.9	96.9	239.8	18.3	1180.5	376.9	273.3
1540.9	163.2	1210.5	78.6	243.9	16.6	1180.5	99.8	273.0
1550.9	159.0	1210.0	76.5	246.3	18.7	1180.4	20.3	272.8
1560.9	170.7	1209.8	86.8	247.1	27.1	1180.5	30.3	273.1
1570.9	160.3	1208.4	79.1	244.1	19.5	1180.4	180.1	273.2
1580.9	165.4	1208.0	77.6	245.9	18.6	1180.4	57.8	273.2
1590.9	166.6	1207.1	72.9	245.5	17.8	1180.6	172.8	273.4
1600.9	168.0	1206.2	62.3	249.5	21.4	1180.8	143.7	273.5
1611.0	168.4	1206.1	63.4	246.1	22.3	1180.4	46.4	273.4
1621.0	171.2	1205.8	62.9	248.3	26.7	1180.6	85.3	273.6
1631.0	163.2	1204.0	53.8	247.6	10.0	1180.2	106.9	273.7
1641.0	162.3	1204.3	70.0	242.3	15.3	1180.3	1.0	272.8
1651.0	157.7	1203.0	68.8	242.8	8.2	1180.8	1.0	273.7

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 11 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
1661.0	168.8	1203.5	77.2	244.7	29.9	1180.5	11.4	273.4
1671.0	158.5	1202.0	72.1	243.6	13.1	1180.3	64.0	273.8
1681.0	158.9	1201.5	74.6	243.7	14.7	1180.3	1.1	273.3
1691.0	162.6	1199.9	85.3	243.1	16.7	1180.9	38.5	274.0
1701.0	159.4	1200.4	82.3	243.3	18.6	1180.3	20.6	273.8
1711.0	160.6	1199.5	93.7	241.8	14.1	1180.4	0.2	275.0
1721.0	153.6	1199.2	90.3	244.5	16.3	1180.3	0.0	0.0
1731.0	155.3	1197.8	80.1	249.0	3.9	1180.6	0.0	0.0
1741.0	154.2	1198.1	78.9	251.9	10.9	1180.0	0.0	0.0
1751.0	151.6	1197.1	72.7	253.5	10.8	1180.5	0.1	275.1
1761.0	152.9	1196.6	78.7	250.5	13.3	1180.6	0.1	282.1
1771.0	160.7	1196.3	76.0	251.6	21.4	1180.4	0.1	269.1
1781.0	176.0	1195.1	60.5	246.5	35.6	1181.0	242.4	274.6
1791.0	162.8	1194.0	50.1	248.7	28.9	1180.9	30.5	274.6
1801.0	155.6	1192.7	33.8	242.4	33.1	1181.3	77.9	274.8
1811.1	134.2	1194.0	242.6	225.8	50.8	1180.9	14.9	274.8
1821.1	100.9	1189.9	278.4	230.4	28.5	1181.4	20.3	274.9
1831.1	133.0	1191.8	95.8	249.2	24.9	1180.6	0.2	266.7
1841.1	75.0	1192.8	913.1	239.9	62.0	1181.2	22.6	274.8
1851.1	130.4	1191.0	160.0	250.9	16.9	1180.8	0.7	274.5
1861.1	85.0	1189.7	397.5	252.3	48.6	1181.2	15.7	274.9
1871.1	111.0	1190.6	117.2	257.8	52.0	1181.1	8.3	274.9
1881.1	103.5	1190.2	230.8	259.7	28.4	1181.0	3.5	274.8
1891.1	126.5	1190.0	62.2	269.2	38.9	1181.1	3.0	274.8
1901.1	130.0	1189.4	55.4	267.0	24.4	1181.1	0.2	276.8
1911.1	129.3	1188.9	54.4	262.3	22.8	1181.1	0.1	274.5
1921.1	127.7	1188.6	53.2	259.5	20.7	1181.1	0.1	272.3
1931.1	125.2	1188.3	51.3	256.5	19.1	1181.1	0.1	279.2
1941.1	124.2	1188.3	45.1	254.9	20.7	1181.1	0.1	270.5
1951.1	121.9	1188.2	28.3	255.3	19.2	1181.1	0.1	280.7
1961.1	116.5	1188.0	27.7	245.0	18.9	1181.1	0.1	270.4
1971.1	105.8	1187.6	58.9	233.1	21.9	1181.1	1.1	275.0
1981.1	52.8	1188.7	595.3	224.5	66.6	1181.3	7.8	275.0
1991.1	70.5	1183.2	179.6	226.7	9.7	1180.4	0.0	0.0
2001.1	33.6	1187.1	1126.6	240.1	55.2	1181.3	6.9	274.8

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 12 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
2011.2	80.1	1186.9	353.8	243.8	50.6	1181.3	1.5	274.8
2021.2	105.3	1187.2	64.2	257.1	22.5	1181.2	0.2	274.2
2031.2	106.2	1187.0	41.1	263.6	20.0	1181.2	0.0	0.0
2041.2	105.5	1186.9	25.3	265.4	22.3	1181.2	0.0	0.0
2051.2	103.3	1186.8	18.2	264.7	22.9	1181.2	0.1	273.2
2061.2	94.7	1184.7	23.2	254.7	21.0	1181.2	0.2	274.3
2071.2	84.2	1184.0	79.7	232.5	20.0	1181.3	0.4	275.1
2081.2	58.7	1184.2	232.5	221.2	42.2	1181.2	1.9	274.5
2091.2	74.8	1183.2	102.9	217.7	30.8	1181.2	0.2	273.2
2101.2	85.3	1186.3	63.9	231.4	22.9	1181.2	0.0	0.0
2111.2	75.2	1184.1	127.2	230.6	18.5	1181.0	0.2	275.6
2121.2	48.7	1183.0	393.0	225.3	37.9	1181.2	2.7	274.5
2131.2	33.2	1183.0	745.7	232.7	46.2	1181.1	3.7	274.3
2141.2	64.4	1184.9	308.8	237.6	30.6	1181.3	0.0	0.0
2151.2	77.5	1183.7	126.7	243.3	18.6	1181.2	0.0	0.0
2161.2	74.3	1183.0	101.5	235.3	38.2	1181.2	1.1	274.4
2171.2	63.2	1181.9	175.4	223.6	31.4	1181.1	0.7	273.8
2181.2	58.3	1182.7	256.5	224.0	34.2	1181.2	0.9	274.2
2191.2	65.1	1182.9	182.2	232.6	27.3	1181.1	0.4	274.5
2201.2	64.6	1183.3	263.3	235.4	31.2	1181.2	0.4	274.2
2211.2	69.0	1183.7	157.1	235.3	29.4	1181.2	0.6	273.9
2221.2	67.7	1183.2	228.5	231.0	38.1	1181.1	0.9	273.5
2231.2	63.2	1185.0	251.1	230.5	32.9	1181.2	1.1	273.9
2241.2	69.0	1185.0	167.6	229.7	45.3	1181.1	2.2	273.9
2251.3	50.6	1185.2	292.6	227.8	44.1	1181.1	1.7	273.6
2261.3	50.7	1185.9	366.7	230.3	30.0	1181.1	0.1	276.3
2271.3	72.9	1184.7	113.6	238.8	25.2	1181.1	0.1	273.0
2281.3	65.5	1183.8	121.1	235.6	20.2	1181.1	0.5	273.9
2291.3	37.9	1185.3	670.5	230.1	52.4	1181.0	2.2	273.4
2301.3	61.3	1184.1	200.7	234.1	27.8	1181.2	0.1	271.9
2311.3	72.9	1184.6	64.8	243.4	26.0	1181.1	0.0	0.0
2321.3	63.1	1183.2	69.4	240.2	19.6	1181.0	0.8	273.1
2331.3	27.7	1185.7	878.0	233.0	55.3	1181.0	2.2	273.3
2341.3	64.2	1184.2	269.3	235.8	27.6	1181.1	0.0	0.0
2351.3	75.8	1184.2	57.7	246.2	27.7	1181.1	0.2	272.1

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 13 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
2361.3	72.1	1184.2	119.8	236.4	26.8	1181.0	0.1	271.2
2371.3	67.1	1184.4	140.3	232.9	27.6	1181.1	0.1	275.9
2381.3	67.4	1184.2	102.6	234.3	29.8	1181.0	0.5	273.0
2391.3	48.3	1184.2	266.2	229.6	46.8	1181.0	1.4	273.0
2401.3	46.6	1184.5	270.5	230.8	36.8	1181.0	0.7	273.0
2411.3	59.1	1184.3	208.6	232.9	31.8	1181.0	0.5	272.7
2421.3	61.9	1184.2	229.2	231.6	32.4	1181.0	0.5	273.0
2431.3	62.3	1183.9	220.4	229.0	30.0	1181.0	0.4	273.1
2441.3	61.3	1183.8	134.5	229.5	30.0	1181.0	0.5	272.0
2451.3	50.1	1184.4	299.8	228.1	45.2	1180.9	1.2	272.8
2461.3	53.2	1184.0	174.3	229.1	32.6	1181.0	0.5	272.6
2471.3	57.7	1184.0	232.7	228.8	30.9	1180.9	0.3	272.7
2481.3	60.9	1184.1	215.5	227.5	33.6	1181.0	0.1	271.2
2491.4	54.1	1182.9	165.7	229.8	20.4	1180.8	0.0	0.0
2501.4	30.0	1183.6	610.5	228.2	46.6	1180.9	1.7	272.3
2511.4	52.3	1183.5	216.2	232.3	33.0	1180.9	0.1	276.0
2521.4	68.5	1183.4	77.1	238.0	30.0	1181.0	0.3	272.3
2531.4	47.1	1182.6	292.7	232.9	16.4	1180.4	0.1	273.0
2541.4	29.5	1183.4	590.9	232.6	48.3	1180.9	1.6	272.2
2551.4	63.9	1183.0	118.8	237.5	19.7	1180.9	0.0	0.0
2561.4	63.4	1183.2	166.3	236.1	28.0	1180.9	0.1	270.6
2571.4	35.0	1183.9	278.8	233.5	42.9	1180.8	1.1	272.4
2581.4	43.8	1183.9	341.1	238.0	38.3	1180.8	2.2	272.0
2591.4	57.2	1183.9	76.0	238.0	33.0	1180.8	0.0	0.0
2601.4	74.7	1183.5	42.8	235.3	20.4	1180.9	0.0	0.0
2611.4	81.7	1182.9	32.9	233.1	19.3	1180.8	0.0	0.0
2621.4	79.3	1183.1	17.5	232.3	20.6	1180.9	0.0	0.0
2631.4	75.1	1183.2	51.7	208.7	22.0	1180.8	0.0	0.0
2641.4	66.1	1183.3	208.2	205.1	24.8	1180.8	0.0	0.0
2651.4	67.2	1183.3	206.0	204.1	26.1	1180.7	0.0	0.0
2661.4	64.5	1183.3	222.6	202.3	27.1	1180.8	0.0	0.0
2671.4	69.1	1183.0	268.6	201.1	24.4	1180.7	0.0	0.0
2681.4	70.7	1182.8	220.0	200.4	22.1	1180.8	0.0	0.0
2691.4	67.5	1182.9	238.1	199.8	24.5	1180.7	0.0	0.0
2701.4	67.5	1183.1	249.3	199.3	27.9	1180.7	0.0	0.0

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 14 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
2711.4	68.8	1182.8	232.9	198.8	25.0	1180.7	0.0	0.0
2721.4	69.4	1182.8	213.3	198.3	22.4	1180.6	0.0	0.0
2731.4	67.0	1182.8	228.6	197.7	24.3	1180.7	0.0	0.0
2741.4	67.0	1183.0	249.6	197.4	28.0	1180.6	0.0	0.0
2751.4	67.9	1182.8	234.8	197.1	24.8	1180.6	0.0	0.0
2761.4	68.2	1182.8	212.8	197.0	22.6	1180.6	0.0	0.0
2771.4	65.8	1182.7	229.2	196.7	24.5	1180.6	0.0	0.0
2781.4	65.9	1182.9	248.7	196.5	27.9	1180.6	0.0	0.0
2791.4	67.0	1182.7	237.8	196.3	24.6	1180.6	0.0	0.0
2801.4	67.2	1182.7	216.9	196.2	22.5	1180.5	0.0	0.0
2811.4	64.6	1182.6	233.2	196.1	24.7	1180.6	0.0	0.0
2821.4	64.6	1182.9	251.7	196.1	28.1	1180.5	0.0	0.0
2831.4	65.9	1182.7	239.3	196.0	24.6	1180.6	0.0	0.0
2841.4	66.4	1182.5	218.5	195.9	22.3	1180.5	0.0	0.0
2851.4	63.7	1182.6	236.5	195.9	24.6	1180.5	0.0	0.0
2861.4	63.7	1182.8	252.2	195.9	28.2	1180.5	0.0	0.0
2871.4	64.8	1182.6	239.2	195.9	24.8	1180.5	0.0	0.0
2881.4	65.2	1182.5	217.7	195.9	22.5	1180.5	0.0	0.0
2891.5	63.0	1182.5	234.0	195.9	24.4	1180.5	0.0	0.0
2901.5	62.6	1182.6	256.5	195.9	28.1	1180.5	0.0	0.0
2911.5	63.7	1182.5	244.0	195.9	24.9	1180.4	0.0	0.0
2921.5	64.2	1182.3	222.1	196.0	22.5	1180.5	0.0	0.0
2931.5	61.7	1182.4	237.5	196.0	24.7	1180.4	0.0	0.0
2941.5	62.5	1182.6	247.3	196.0	26.9	1180.4	0.0	0.0
2951.5	63.8	1182.3	235.4	196.0	23.9	1180.4	0.0	0.0
2961.5	62.3	1182.3	229.7	196.0	22.7	1180.4	0.0	0.0
2971.5	60.5	1182.5	243.2	196.1	25.7	1180.5	0.0	0.0
2981.5	62.3	1182.4	257.5	196.2	27.1	1180.5	0.0	0.0
2991.5	62.7	1182.3	226.4	196.2	21.7	1180.5	0.0	0.0
3001.6	61.3	1182.3	231.2	196.3	23.9	1180.6	0.0	0.0
3051.6	33.6	1182.6	441.1	211.2	29.7	1180.3	2.5	270.1
3101.6	26.4	1182.7	498.5	235.0	28.7	1180.3	0.7	269.7
3151.6	65.7	1181.8	21.8	245.2	19.1	1180.2	0.0	0.0
3201.7	45.3	1181.8	114.5	232.7	28.6	1180.1	0.2	270.0
3251.7	56.0	1181.4	210.1	220.4	23.7	1180.1	0.0	0.0

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 15 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
3301.7	52.9	1181.7	246.4	224.6	23.2	1180.0	0.1	269.0
3351.8	58.0	1181.3	219.7	210.8	23.8	1180.0	0.0	0.0
3401.9	38.6	1181.6	266.3	219.2	17.2	1179.8	0.6	268.0
3451.9	32.2	1181.7	510.7	241.1	33.7	1179.8	1.5	267.9
3502.0	35.8	1181.3	263.4	243.0	37.1	1179.7	0.9	267.4
3552.0	54.5	1181.0	87.1	241.1	22.0	1179.7	0.0	0.0
3602.0	56.1	1180.8	132.0	227.4	22.6	1179.6	0.0	0.0
3652.0	54.3	1180.6	235.6	212.5	23.1	1179.6	0.0	0.0
3702.1	40.4	1180.8	292.1	217.9	30.7	1179.4	0.6	266.7
3752.1	48.8	1180.5	259.6	222.0	25.4	1179.3	0.5	266.6
3802.1	53.8	1180.5	232.4	213.6	23.5	1179.4	0.0	0.0
3852.1	42.3	1180.3	317.9	213.8	27.3	1179.2	0.6	266.0
3902.1	38.4	1180.8	296.0	227.7	25.7	1179.2	0.4	266.1
3952.2	54.0	1180.4	177.6	218.6	21.9	1179.2	0.0	0.0
4002.3	49.1	1180.1	251.0	216.4	22.3	1179.0	0.1	268.6
4052.3	51.2	1180.2	234.9	214.6	21.8	1179.0	0.3	265.0
4102.3	39.3	1181.2	321.4	217.0	27.2	1178.9	2.1	264.8
4152.3	40.8	1180.8	277.4	226.0	26.2	1178.8	0.9	264.8
4202.4	39.0	1179.9	235.3	229.8	24.0	1178.7	0.3	264.6
4252.4	41.8	1179.8	246.5	229.3	26.3	1178.7	0.3	264.2
4302.5	44.6	1179.8	238.4	228.3	23.6	1178.7	0.1	264.8
4352.5	49.9	1179.7	246.2	221.1	22.1	1178.6	0.1	264.1
4402.5	49.8	1179.7	235.3	216.9	21.3	1178.5	0.0	0.0
4452.6	50.7	1179.6	262.1	215.1	21.4	1178.5	0.0	0.0
4502.6	47.2	1179.5	233.7	216.1	23.6	1178.4	0.5	263.3
4552.7	36.1	1179.9	295.3	222.1	26.1	1178.3	2.1	263.1
4602.8	42.5	1179.8	246.0	225.9	23.4	1178.3	0.4	263.3
4652.8	43.0	1179.9	260.2	221.0	22.3	1178.2	1.5	262.4
4702.8	39.5	1179.9	285.4	229.1	21.6	1178.1	0.3	262.7
4752.9	39.8	1180.1	252.0	230.4	27.7	1178.1	1.6	262.4
4803.0	47.6	1179.2	229.3	222.5	22.2	1178.1	0.1	262.3
4853.0	46.4	1179.1	232.8	219.6	21.2	1178.0	0.2	261.7
4903.0	46.2	1179.1	288.7	218.5	23.0	1178.0	0.2	262.1
4953.1	48.0	1178.9	254.0	217.0	22.2	1178.0	0.0	0.0
5003.1	49.8	1178.9	239.5	216.1	19.9	1177.8	0.0	0.0

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 16 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
5053.2	47.4	1179.0	240.6	215.6	21.1	1177.8	0.0	0.0
5103.2	43.2	1178.7	285.2	218.8	17.4	1177.6	0.3	261.8
5153.3	47.4	1178.8	242.8	222.0	18.4	1177.5	0.1	261.9
5203.3	46.2	1178.7	261.1	218.7	23.3	1177.6	0.7	261.0
5253.3	41.5	1178.8	257.7	219.1	22.1	1177.6	0.4	260.1
5303.3	34.0	1179.5	294.4	226.2	24.5	1177.5	1.7	260.6
5353.4	43.6	1178.5	251.2	228.0	19.8	1177.3	0.0	0.0
5403.4	47.9	1178.5	223.9	221.9	20.5	1177.5	0.0	0.0
5453.5	43.7	1178.5	262.4	219.4	20.9	1177.4	0.0	0.0
5503.5	43.4	1178.4	268.1	223.1	19.8	1177.3	0.2	259.4
5553.5	41.1	1178.4	276.7	221.1	22.9	1177.3	0.6	259.8
5603.5	46.6	1178.3	237.4	221.1	19.4	1177.2	0.0	0.0
5653.5	42.6	1178.3	263.9	220.1	20.6	1177.1	0.0	0.0
5703.5	33.8	1178.1	284.3	225.9	25.2	1177.0	1.5	259.2
5753.5	43.5	1178.1	215.1	225.2	20.0	1177.2	0.3	259.5
5803.6	36.5	1178.1	297.7	225.4	24.4	1177.0	1.7	258.7
5853.7	39.3	1178.0	250.4	228.8	20.0	1176.9	0.6	258.8
5903.7	36.6	1178.0	270.7	231.5	23.8	1177.0	1.1	258.6
5953.8	40.3	1178.0	252.1	227.8	21.6	1176.9	0.2	258.4
6003.8	46.6	1177.8	230.1	222.7	17.6	1176.8	0.0	0.0
6053.8	31.4	1178.2	364.6	224.9	23.9	1176.7	1.0	258.2
6103.9	44.2	1177.9	197.9	231.0	19.6	1176.8	0.0	0.0
6153.9	44.5	1177.8	232.2	223.9	19.8	1176.8	0.0	0.0
6203.9	39.5	1177.6	275.2	222.7	19.5	1176.7	0.2	257.7
6254.0	28.5	1177.5	316.7	230.8	25.2	1176.6	1.7	257.5
6304.1	36.2	1178.2	272.3	234.1	23.1	1176.6	0.5	257.1
6354.1	44.6	1177.5	219.2	228.2	19.0	1176.6	0.0	0.0
6404.1	41.3	1177.4	251.3	224.2	18.3	1176.5	0.0	0.0
6454.1	30.8	1177.9	352.8	231.4	25.6	1176.3	1.5	257.0
6504.1	45.8	1177.4	169.0	228.4	18.8	1176.5	0.0	0.0
6554.1	44.4	1177.3	218.4	223.8	17.8	1176.3	0.0	0.0
6604.2	36.2	1177.3	298.2	224.5	21.4	1176.3	1.0	256.6
6654.3	37.8	1177.3	278.4	228.4	21.6	1176.1	1.0	256.1
6704.3	41.3	1177.2	254.0	224.7	17.1	1176.2	0.0	0.0
6754.3	35.6	1177.3	291.2	225.6	23.9	1176.2	1.2	256.2

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 17 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
6804.4	42.4	1177.3	246.3	229.2	17.3	1176.1	0.1	255.7
6854.4	43.7	1177.1	237.4	224.6	18.4	1176.1	0.0	0.0
6904.4	38.5	1177.1	258.7	223.3	20.0	1176.1	0.7	255.9
6954.4	32.5	1177.5	343.3	229.4	22.1	1175.9	1.8	255.4
7004.5	43.9	1177.1	190.0	228.5	18.4	1176.0	0.0	0.0
7054.6	41.7	1176.9	225.0	224.7	18.1	1175.9	0.0	0.0
7104.6	32.4	1176.9	303.9	227.4	22.6	1175.8	0.9	255.3
7154.6	18.0	1177.2	564.5	235.4	25.8	1175.8	2.3	255.0
7204.7	45.4	1176.8	49.8	241.7	19.7	1175.7	0.2	254.7
7254.7	43.4	1176.8	157.7	228.7	17.5	1175.8	0.0	0.0
7304.7	41.6	1176.6	231.8	225.2	18.3	1175.8	0.0	0.0
7354.8	32.2	1176.6	302.3	226.9	20.2	1175.7	0.8	254.6
7404.8	35.3	1176.6	350.4	228.9	23.9	1175.6	1.8	254.4
7454.8	39.1	1176.6	224.5	227.9	19.7	1175.7	0.2	254.4
7504.8	41.1	1176.6	253.5	224.8	17.4	1175.5	0.0	0.0
7554.9	32.1	1176.6	362.0	226.4	20.3	1175.5	1.2	254.1
7605.0	39.2	1176.5	191.3	231.4	20.3	1175.6	0.6	254.0
7655.0	41.4	1176.4	235.9	226.1	17.0	1175.3	0.0	0.0
7705.1	36.8	1176.3	285.4	225.9	19.2	1175.3	0.8	253.7
7755.2	40.7	1176.4	261.9	226.7	18.4	1175.4	0.0	0.0
7805.2	39.9	1176.3	261.8	224.3	18.3	1175.4	0.0	0.0
7855.2	36.0	1176.3	272.9	225.7	21.3	1175.3	1.2	253.4
7905.2	32.1	1176.4	269.5	227.0	23.4	1175.2	3.1	253.1
7955.3	33.6	1176.4	250.2	229.0	21.1	1175.3	1.2	253.2
8005.3	34.8	1176.2	273.5	227.2	22.4	1175.2	1.0	253.0
8055.3	27.9	1176.6	292.1	230.4	22.5	1175.2	2.1	252.9
8105.4	33.0	1176.3	279.6	232.3	20.4	1175.1	1.4	252.8
8155.5	40.3	1176.4	210.9	232.3	17.5	1175.0	0.0	0.0
8205.5	39.9	1176.1	226.9	226.6	17.4	1175.0	0.0	0.0
8255.6	34.1	1175.9	291.0	227.2	16.9	1175.0	0.1	253.3
8305.6	29.1	1176.5	344.1	231.7	24.5	1175.0	3.9	252.3
8355.6	33.0	1176.4	263.2	233.3	21.3	1175.0	1.6	252.1
8405.7	32.5	1176.2	210.8	233.8	22.4	1175.0	1.8	252.1
8455.7	30.4	1176.0	292.5	232.7	21.9	1174.9	1.2	252.0
8505.7	25.7	1175.7	342.5	235.8	25.8	1174.9	1.6	251.8

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 18 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
8555.8	35.0	1175.8	210.5	233.3	21.2	1174.9	0.6	251.7
8605.9	28.0	1175.8	313.0	232.6	21.6	1174.8	1.4	251.6
8655.9	35.4	1175.8	214.5	235.9	20.3	1174.7	0.3	251.4
8706.0	39.4	1175.6	243.6	228.7	17.4	1174.8	0.0	0.0
8756.0	37.7	1175.6	262.5	226.2	16.3	1174.6	0.0	0.0
8806.0	38.1	1175.5	281.6	225.7	17.0	1174.7	0.1	251.6
8856.0	38.8	1175.5	269.9	225.1	16.6	1174.5	0.1	251.3
8906.1	34.6	1175.5	268.5	226.6	17.9	1174.4	0.8	250.9
8956.1	29.7	1175.5	280.2	231.4	22.4	1174.5	1.2	250.9
9006.1	32.6	1175.5	309.5	230.5	18.5	1174.5	0.6	250.8
9056.2	35.4	1175.7	222.8	232.6	21.7	1174.4	0.9	250.7
9106.2	38.8	1175.4	231.0	227.2	16.9	1174.5	0.0	0.0
9156.2	35.2	1175.4	271.3	225.5	17.3	1174.4	0.0	0.0
9206.3	28.2	1175.7	330.8	230.2	23.3	1174.5	2.1	250.4
9256.4	40.1	1175.3	212.3	227.8	16.0	1174.3	0.0	0.0
9306.4	37.8	1175.3	263.5	225.3	16.6	1174.3	0.0	0.0
9356.4	29.8	1175.2	313.4	227.1	23.2	1174.3	2.0	250.2
9406.5	30.0	1175.2	272.3	231.4	20.1	1174.3	0.8	249.9
9456.5	31.6	1175.2	264.8	229.3	20.9	1174.2	1.5	249.9
9506.5	27.8	1175.4	287.5	234.1	19.4	1174.2	1.0	249.6
9556.6	39.5	1175.1	217.9	230.2	17.3	1174.2	0.0	0.0
9606.7	36.1	1175.1	253.0	226.4	16.9	1174.1	0.0	0.0
9656.7	29.3	1175.1	307.2	228.7	20.5	1174.1	1.6	249.6
9706.7	33.6	1175.0	228.5	230.7	18.4	1174.0	0.6	249.1
9756.7	27.5	1175.5	299.2	230.7	23.2	1174.0	1.5	248.9
9806.7	37.5	1175.0	259.2	229.2	16.7	1174.0	0.2	249.1
9856.8	38.4	1174.8	236.0	225.8	17.0	1174.0	0.0	0.0
9906.8	32.2	1174.9	316.7	225.6	18.3	1173.9	1.3	249.2
9956.9	27.1	1174.9	302.6	230.9	20.7	1174.0	0.7	248.8
10006.9	23.7	1175.3	349.8	235.4	23.1	1173.9	2.7	248.7
10507.0	32.5	1174.8	260.3	229.6	19.0	1173.7	0.7	248.2
11007.0	32.3	1174.5	270.3	227.5	18.2	1173.5	1.0	247.3
11507.1	32.3	1174.2	270.3	226.8	17.7	1173.2	0.7	246.5
12007.1	30.6	1173.9	272.2	227.3	18.7	1172.9	1.1	245.8
12507.1	29.4	1173.8	277.1	228.1	18.3	1172.7	1.1	244.9

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 19 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
13007.1	31.0	1173.5	271.5	224.8	17.5	1172.4	0.8	244.0
13507.1	28.2	1173.3	282.6	226.4	18.1	1172.2	1.4	243.3
14007.2	28.6	1173.0	274.9	225.4	17.9	1172.0	1.1	242.6
14507.2	27.0	1172.9	278.1	226.8	18.1	1171.7	1.4	241.8
15007.2	26.5	1172.6	273.9	227.3	18.0	1171.5	1.3	241.0
15507.3	27.2	1172.3	280.0	223.5	17.4	1171.3	1.2	240.3
16007.3	27.5	1172.1	271.5	223.2	17.1	1171.1	1.0	239.7
16507.4	25.2	1171.9	290.1	222.9	17.5	1170.9	1.4	239.1
17007.4	26.9	1171.7	272.3	220.2	16.8	1170.7	1.1	238.4
17507.4	26.7	1171.5	273.7	220.2	16.2	1170.4	1.0	237.8
18007.5	23.5	1171.4	288.5	223.0	17.4	1170.3	1.8	237.2
18507.6	24.2	1171.1	279.4	222.1	17.3	1170.1	1.4	236.4
19007.6	25.5	1170.9	282.8	217.1	16.3	1169.8	1.5	235.9
19507.7	23.4	1170.8	289.7	220.1	16.4	1169.6	1.3	235.3
20007.7	25.0	1170.4	263.0	219.9	16.1	1169.5	1.2	234.7
20507.7	23.9	1170.4	302.8	214.5	16.0	1169.3	1.5	234.1
21007.8	21.9	1170.2	279.3	218.6	17.2	1169.2	1.8	233.6
21507.8	22.9	1170.0	285.0	216.1	16.0	1168.9	1.3	233.0
22007.8	21.5	1169.9	300.2	216.6	16.9	1168.8	2.2	232.4
22507.9	24.4	1169.6	273.7	215.1	14.4	1168.6	1.0	231.9
23008.0	22.0	1169.5	291.1	214.4	16.0	1168.5	2.0	231.5
23508.0	23.6	1169.3	263.6	216.0	14.5	1168.3	1.2	230.8
24008.0	22.6	1169.1	284.3	210.5	15.7	1168.1	2.0	230.6
24508.1	22.4	1169.0	294.3	215.4	13.8	1167.9	1.6	230.1
25008.1	21.8	1168.9	291.7	210.5	15.2	1167.8	2.0	229.6
25508.1	20.8	1168.8	292.7	210.7	15.9	1167.7	2.3	229.2
26008.2	20.3	1168.6	286.6	214.4	15.4	1167.6	2.0	228.6
26508.3	19.6	1168.5	291.7	210.8	16.3	1167.4	2.6	228.3
27008.4	20.3	1168.3	270.9	210.0	16.1	1167.3	2.0	227.9
27508.4	20.6	1168.1	297.0	206.6	15.1	1167.1	2.1	227.6
28008.4	20.8	1168.1	285.6	205.5	15.4	1167.0	2.0	227.2
28508.4	22.0	1167.9	281.7	205.0	13.7	1166.9	2.1	226.8
29008.4	20.8	1167.9	299.8	203.8	13.9	1166.7	2.2	226.5
29508.4	20.1	1167.7	304.9	203.1	15.3	1166.7	2.6	226.1
30008.4	21.8	1167.5	264.2	200.8	13.9	1166.6	2.1	225.8

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 20 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
30508.5	20.3	1167.5	311.2	202.2	13.8	1166.4	2.0	225.4
31008.5	20.4	1167.3	271.7	204.6	14.1	1166.3	2.1	225.0
31508.5	18.4	1167.2	299.5	203.2	15.3	1166.2	2.4	224.8
32008.6	18.0	1167.0	289.0	202.7	15.2	1166.1	2.5	224.4
32508.6	20.4	1166.9	281.8	199.6	13.6	1166.0	2.2	224.0
33008.6	17.9	1167.0	328.9	203.7	13.4	1165.8	2.0	223.5
33508.6	18.1	1166.8	280.8	200.6	14.7	1165.7	2.2	223.2
34008.7	18.4	1166.7	297.7	201.7	14.0	1165.6	2.5	222.8
34508.7	18.4	1166.5	283.2	199.5	13.7	1165.5	2.0	222.5
35008.7	17.4	1166.4	300.2	200.4	14.4	1165.4	2.5	222.2
35508.8	15.3	1166.3	297.1	206.1	14.4	1165.3	2.6	221.8
36008.9	17.9	1166.0	299.3	200.7	12.6	1165.1	1.7	221.4
36508.9	19.1	1166.0	277.3	195.8	13.8	1165.1	2.2	221.2
37009.0	17.8	1166.0	297.6	198.7	12.8	1165.0	2.0	220.9
37509.0	16.6	1165.8	287.1	199.7	14.0	1164.9	2.4	220.5
38009.1	16.0	1165.7	315.8	199.1	12.8	1164.8	2.0	220.2
38509.1	15.5	1165.7	317.9	201.5	13.2	1164.6	1.9	219.8
39009.2	15.8	1165.5	300.8	198.6	13.2	1164.5	2.0	219.3
39509.3	17.1	1165.5	285.0	197.7	11.1	1164.4	1.3	219.1
40009.3	16.3	1165.3	284.5	199.5	13.5	1164.3	1.9	218.9
40509.3	16.6	1165.3	279.7	198.4	12.3	1164.1	2.0	218.5
41009.3	14.4	1165.1	325.8	197.2	12.9	1164.1	2.1	218.4
41509.3	15.9	1165.0	291.0	193.9	12.8	1164.0	2.3	218.1
42009.4	16.3	1164.9	289.5	198.7	11.3	1163.9	1.6	217.7
42509.4	14.3	1164.9	333.4	196.1	12.1	1163.8	2.2	217.5
43009.5	14.6	1164.7	287.5	195.5	13.2	1163.8	2.6	217.3
43509.5	13.7	1164.6	336.2	201.2	11.6	1163.7	1.8	217.1
44009.6	14.3	1164.4	270.7	199.3	11.4	1163.6	1.7	216.6
44509.6	15.2	1164.3	271.8	202.6	12.2	1163.4	1.9	216.2
45009.6	13.3	1164.4	307.7	194.7	13.1	1163.4	2.3	216.0
45509.7	12.1	1164.4	327.7	194.1	13.5	1163.4	3.1	216.0
46009.7	14.3	1164.3	292.2	194.0	12.2	1163.2	1.8	215.7
46509.7	13.8	1164.2	292.2	193.0	12.8	1163.2	2.5	215.5
47009.8	10.2	1163.9	307.0	201.0	14.5	1163.2	3.3	215.3
47509.8	13.1	1163.8	294.2	198.5	12.0	1163.0	1.7	214.9

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 21 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
48009.8	10.2	1163.8	318.8	196.1	13.2	1163.0	2.3	214.7
48509.9	13.3	1163.6	297.1	197.7	11.0	1162.8	1.8	214.4
49009.9	14.5	1163.7	284.8	190.4	11.0	1162.6	1.9	214.2
49509.9	12.2	1163.7	323.8	199.0	11.6	1162.6	1.7	214.0
50010.0	12.4	1163.7	317.1	190.7	12.2	1162.6	2.4	214.0
50510.0	12.6	1163.5	278.3	193.6	12.6	1162.7	2.3	213.8
51010.1	11.2	1163.4	318.2	197.0	11.3	1162.5	1.6	213.4
51510.2	10.9	1163.3	333.9	198.6	10.8	1162.3	1.5	213.1
52010.2	13.4	1163.3	284.7	192.1	10.9	1162.3	1.9	213.0
52510.2	12.7	1163.3	276.2	195.1	11.4	1162.3	2.1	212.8
53010.2	9.9	1162.9	339.7	199.5	10.5	1162.2	1.8	212.5
53510.3	10.3	1162.8	306.5	200.0	11.2	1162.2	1.8	212.2
54010.3	11.0	1162.7	277.5	198.4	11.8	1162.0	2.0	212.0
54510.4	10.4	1162.9	336.1	193.1	10.5	1162.0	2.1	211.8
55010.4	11.4	1162.8	309.6	196.0	10.6	1161.8	1.3	211.6
55510.4	12.1	1162.9	289.1	193.1	9.7	1161.8	1.3	211.5
56010.5	11.9	1162.8	316.6	192.0	10.0	1161.7	2.1	211.5
56510.5	11.6	1162.5	280.2	195.9	11.3	1161.8	2.2	211.3
57010.5	8.6	1162.6	324.8	190.5	12.9	1161.8	2.6	211.3
57510.6	11.8	1162.7	310.2	192.1	9.2	1161.6	1.0	211.0
58010.6	11.1	1162.5	288.1	194.3	10.8	1161.6	1.7	210.8
58510.7	10.8	1162.3	325.8	196.2	8.6	1161.4	1.2	210.5
59010.8	9.8	1162.3	304.9	191.2	11.8	1161.5	2.1	210.6
59510.8	9.2	1162.4	319.2	193.5	10.3	1161.4	2.0	210.2
60010.9	10.3	1162.4	298.0	187.5	12.1	1161.4	2.9	210.3
60510.9	8.9	1162.5	304.4	189.7	12.4	1161.5	2.4	210.2
61011.0	9.1	1162.3	314.8	186.6	12.1	1161.4	2.5	210.3
61511.0	9.0	1162.2	290.3	187.4	11.8	1161.4	2.4	210.2
62011.0	8.5	1162.1	310.4	188.5	13.2	1161.4	2.9	210.0
62511.1	8.3	1162.1	309.0	189.4	12.2	1161.3	2.7	209.8
63011.1	11.4	1162.2	298.3	185.6	9.8	1161.2	1.3	209.7
63511.2	9.7	1162.2	315.2	185.2	11.6	1161.2	2.5	209.6
64011.2	8.2	1162.1	330.6	187.5	11.3	1161.2	2.7	209.6
64511.2	9.4	1162.0	297.7	187.6	11.3	1161.2	1.7	209.4
65011.3	9.7	1162.0	293.1	187.3	10.7	1161.0	2.1	209.1

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 22 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
65511.3	7.3	1161.9	322.3	187.9	12.4	1161.1	2.7	209.1
66011.4	10.4	1161.8	310.7	187.1	9.2	1160.9	1.1	208.9
66511.4	7.5	1161.6	313.4	187.3	12.3	1161.0	2.6	208.9
67011.4	10.6	1161.6	288.4	188.6	9.1	1160.9	1.3	208.6
67511.4	7.0	1161.9	328.5	188.5	11.2	1160.9	2.2	208.5
68011.4	7.3	1161.6	312.6	187.6	12.4	1160.9	2.3	208.4
68511.5	7.2	1161.7	305.5	187.7	12.0	1160.8	2.1	208.2
69011.5	8.9	1161.7	298.7	185.4	11.5	1160.8	2.2	208.3
69511.5	7.9	1161.6	339.8	189.7	8.0	1160.5	0.9	207.8
70011.6	10.7	1161.3	294.3	189.5	8.5	1160.5	1.2	207.7
70511.6	7.8	1161.6	335.0	184.5	10.5	1160.5	2.0	207.8
71011.6	8.9	1161.6	297.6	184.0	10.8	1160.6	2.2	207.7
71511.7	7.2	1161.5	328.0	187.1	10.5	1160.6	1.8	207.7
72011.8	7.8	1161.6	302.6	187.9	10.7	1160.5	2.0	207.4
72511.8	6.3	1161.3	315.1	187.0	11.7	1160.6	2.5	207.4
73011.8	8.8	1161.0	296.3	184.2	10.2	1160.5	1.6	207.3
73511.9	8.1	1161.2	296.0	184.3	11.2	1160.5	1.7	207.4
74011.9	8.2	1161.5	327.8	183.3	8.4	1160.3	1.4	207.2
74511.9	9.1	1161.3	294.9	185.9	10.5	1160.3	2.2	207.1
75012.0	8.7	1161.4	334.9	184.5	8.3	1160.2	1.3	206.9
75512.0	8.0	1161.3	319.4	183.1	9.8	1160.3	1.9	206.9
76012.0	9.0	1161.2	302.6	182.3	9.1	1160.2	1.5	206.8
76512.1	7.8	1161.2	303.2	184.3	11.2	1160.3	2.4	206.8
77012.1	7.2	1160.9	321.4	184.5	9.9	1160.2	1.7	206.7
77512.1	8.0	1161.5	303.2	184.6	8.8	1160.1	1.5	206.4
78012.1	9.2	1161.2	311.1	181.5	8.7	1160.0	1.4	206.3
78512.2	7.0	1161.2	321.7	181.8	10.9	1160.1	1.9	206.5
79012.2	7.2	1161.2	317.8	183.0	11.0	1160.2	2.0	206.5
79512.2	8.5	1161.3	306.4	179.5	8.4	1160.0	1.3	206.3
80012.2	8.7	1161.3	326.5	180.9	9.4	1159.9	2.2	206.2
80512.2	8.2	1160.8	295.9	181.3	10.3	1160.0	1.7	206.2
81012.3	7.5	1161.0	319.6	179.9	9.1	1160.0	1.5	206.2
81512.3	7.0	1161.3	324.8	184.1	9.5	1159.9	1.2	205.8
82012.3	9.4	1161.0	303.3	182.4	7.8	1159.7	0.7	205.7
82512.3	8.5	1161.0	325.2	180.3	8.2	1159.7	1.4	205.8

Table 14-4 Break Mass and Energy Flow for the Long-term Cooling Phase of the Limiting DEPSG Break (Sheet 23 of 23)

Time (sec)	Break Flow (Reactor Vessel Side)				Break Flow (Steam Generator Side)			
	Steam		Liquid		Steam		Liquid	
	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)	Mass (lbm/sec)	Enthalpy (Btu/lbm)
83012.4	7.6	1160.8	323.0	185.6	8.3	1159.8	1.1	205.6
83512.4	6.1	1160.7	312.6	186.5	10.0	1159.8	1.8	205.4
84012.5	8.1	1160.6	284.1	179.7	9.7	1159.8	1.8	205.6
84512.5	6.8	1160.8	330.2	177.7	10.2	1159.9	2.2	205.6
85012.5	8.1	1160.8	295.6	177.8	10.0	1159.8	1.9	205.6
85512.5	7.4	1160.6	323.0	180.0	9.7	1159.9	1.9	205.7
86012.6	6.4	1160.7	325.6	177.8	9.5	1159.8	1.6	205.5
86512.6	8.5	1160.7	290.3	178.2	9.1	1159.7	1.5	205.4
87012.7	6.2	1160.7	318.7	177.6	10.8	1159.8	2.1	205.4
87512.8	8.7	1160.6	311.1	174.2	8.7	1159.7	1.4	205.3
88012.8	7.7	1161.0	334.9	179.9	8.6	1159.6	1.5	205.3
88512.9	8.5	1160.8	311.5	179.9	6.9	1159.4	0.8	205.0
89013.0	8.3	1160.7	323.9	180.3	8.2	1159.5	1.2	205.0
89513.0	8.3	1160.7	311.3	179.4	7.5	1159.5	0.9	205.1
90013.1	6.8	1160.8	312.5	183.4	8.9	1159.5	1.3	204.7
90513.1	7.4	1160.6	309.4	177.1	9.2	1159.5	1.5	204.7
91013.2	6.0	1160.8	326.2	181.6	8.5	1159.5	1.7	204.7
91513.2	7.8	1160.5	318.1	178.2	8.4	1159.4	1.3	204.6
92013.3	8.0	1160.6	308.9	181.9	6.7	1159.1	0.5	204.1
92513.3	7.1	1160.6	323.1	180.4	8.6	1159.4	2.0	204.4
93013.4	6.9	1160.4	304.0	180.4	8.7	1159.3	1.2	204.4
93513.4	5.9	1160.2	323.9	179.0	9.8	1159.4	1.6	204.3
94013.4	8.3	1160.2	301.5	176.4	7.3	1159.3	1.2	204.4
94513.5	7.1	1160.4	328.1	175.9	8.5	1159.2	1.3	204.4
95013.5	8.3	1160.5	309.5	178.8	7.1	1159.1	0.6	204.2
95513.5	9.2	1160.6	318.1	175.0	6.7	1158.9	0.7	204.0
96013.6	8.6	1160.7	322.2	177.6	6.6	1159.0	0.7	204.2
96513.7	9.3	1160.7	311.3	174.4	6.8	1159.0	1.1	204.0
97013.7	7.8	1160.7	328.0	181.0	6.9	1159.1	0.8	204.0
97513.8	9.0	1160.3	294.4	174.3	7.9	1159.1	1.5	204.1
98013.8	6.4	1160.2	336.5	174.8	9.4	1159.4	2.2	204.3
98513.8	6.0	1160.1	312.2	174.9	9.4	1159.3	1.6	204.2
99013.9	8.3	1160.3	302.2	175.1	8.0	1159.2	1.0	204.0
99514.0	6.9	1160.4	320.9	174.8	7.7	1159.1	1.0	203.9
100000.0	7.6	1160.4	324.2	178.1	6.7	1158.9	0.6	203.6

Item 15

On page 3-15 it is stated that steam condensation in the downcomer and the broken loop cold leg volume is prevented in the GOTHIC analysis of the post-reflood period by setting the liquid/vapor interface areas in those regions to zero. Page 3-5 states that no mixing of steam and safety injection water in the downcomer is assumed for the reflood analysis. Please describe how this type of condensation is prevented during the reflood period when mass and energy release is being calculated by WREFLOOD.

RESPONSE

As described in the response to Item 6, the following modification is made to WREFLOOD:

DVI flow is directly accounted for in the mass and energy balances for the accumulated water in the downcomer. Complete mixing of DVI flow and water flow from the intact loop is assumed before they enter the downcomer. All flow from DVI and the intact loop is added to the downcomer water when the downcomer is not full. When the downcomer is full, the combined DVI and intact loop flow that is in excess of the core inlet flow is spilled to the containment. The enthalpy of this spillage is the mixture enthalpy of the combined DVI and intact loop water flow. Steam flow from the intact loop passes the downcomer with no interaction with DVI flow. Condensation due to direct contact of DVI water flow with steam flow from the intact loop in the downcomer is disregarded.

Item 16

The treatment of spilled accumulator water from the broken cold leg is not discussed for the blowdown period. Please provide the assumptions for containment analysis and justify that they are conservative.

Item 17

The treatment of the spilled accumulator water from the broken cold leg is not discussed for the reflood calculation. Please provide these assumptions and justify that they are conservative. If the accumulators will still be discharging during the post-reflood period please describe and justify the assumptions for treatment of this water that will affect the containment analysis.

RESPONSE to Item 16 and 17

The LOCA mass and energy topical report is focused on the limiting pump suction break, where accumulator water injected into the pump-discharge side does not spill directly from the break. In case of a cold leg (pump-discharge) break, spillage of the broken loop accumulator is possible. The cold-leg break is much less limiting in terms of the overall containment peak pressure than the pump suction break and is not evaluated for peak containment pressure analysis.

The relation between the pump-suction break and the cold-leg break for the blowdown and reflood phases has been demonstrated for current 4-loop plants with the approved methodology described in WCAP-10325-P-A. This relation should be the same for the US-APWR due to almost the same plant configuration and the analytical methodology.

[ ]

Therefore, in order to demonstrate the conservativeness of the GOTHIC model and the actual relation between both break cases, additional calculations for both break cases have been performed using a more realistic GOTHIC model within the expected parameter ranges.

1. Realistic GOTHIC Model

[ ]

[ ]

2. Analyses

The containment analyses for the limiting pump-suction break and the cold leg (pump discharge) break have been performed using above mentioned GOTHIC realistic model. The relevant modeling assumptions for each model are summarized in Table 16-1. Figures 16-4 and 16-5 illustrate GOTHIC noding diagrams for the more realistic analyses for the pump suction break and the cold leg (pump discharge), respectively. The methodology for the blowdown and reflood phase is the same as the evaluation model.

Initial containment conditions, chosen conservatively for the evaluations, are listed in Table 16-2. Assumptions for the containment heat removal and the SI system operability are shown in Table 16-3.

Summary results for each LOCA analyzed are presented in Table 16-4 and compared with the limiting pump suction break case with the evaluation model. The containment pressures and vapor temperatures are compared in Figures 16-6 and 16-7, respectively.
Comparison of results for the limiting pump suction break using the evaluation model and the realistic model demonstrates large conservatism in the evaluation model. Also, comparison of results for the pump suction break and the cold leg (pump discharge) break using the more realistic model demonstrates that the pump suction is the limiting break location.

During the post-reflood period, the cold leg break is found to give higher containment pressure rise than the pump suction break because of earlier heat release from the secondary side of the intact loop SG. However, since the increase of the containment pressure is small enough, the peak pressure for the cold leg break is still less than the peak pressure at the end of reflood for the pump suction break.

3. Conclusion

For the limiting pump suction break, accumulator water injected into the pump-discharge side does not spill directly from the break. It has been demonstrated with the analyses simulating realistic phenomena that the cold leg (pump-discharge) break, where spillage of the broken loop accumulator is possible, is much less limiting in terms of the overall containment peak pressure than the pump suction break.

4. References

(1) H. C. Yeh, "Modification of Void Fraction Correlation", Proceedings of 4th International Topical Meeting on Nuclear Thermal Hydraulics, Operations and Safety, Volume 1, Taipei, Taiwan, April 5-9, 1994.ANS Transactions, Vol. 17, 1973, p369-370.

Table 16-1 Comparison between Evaluation Model and Realistic Model with GOTHIC

Table 16-2 Initial Conditions for Containment Pressure Analytical Model

Parameters	Value	Setting for Conservatism
A. Reactor Coolant System		
1. Reactor Power Level, MWt	4,451×1.02	Max (102%)
2. Average Coolant Temperature, °F	587.8	Max
3. Mass of Reactor Coolant System Liquid, lbm	7.42×10^{5}	Max
4. Mass of Reactor Coolant System Steam, lbm	1.02×10^{4}	
5. Liquid Plus Steam Energy,* Btu	4.41×10^{8}	Max
B. Containment		
1. Pressure, psig	2	Max
2. Temperature, °F	120	Max
3. Relative Humidity, %	0	Min
4. Service Water Temperature, °F	95	Max
5. Refueling Water Temperature, °F	120	Max
6. Outside Temperature, °F	Not Considered	Thermal Insulation is Assumed.
C. Stored Water (as applicable)		
1. RWSP water volume, ft^{3}** (gallon)	44,000 (329,000)	Min
2. Accumulators water volume, ft^{3}	1.03×10^{4}	Min

Notes:

* All energies are relative to 32°F [0°C].

** This includes RWSP minimum inventory and return water, plus a safety margin, but does not include the ineffective pool volume.

Table 16-3 Engineered Safety Feature Systems Information

US APWR Specification	Value	
	Full Capacity	Value Used for Containment Design Evaluation
I. Passive Safety Injection System		
A. Number of Accumulators	4	4
B. Pressure, psig	695	586
II. Active Safety Injection Systems		
A. High Head Injection System (HHIS)		
1. Number of Lines	4	2
2. Number of Pumps	4	2
3. Flow Rate, gpm/train *	1,540	1,259
4. Response Time, sec (after analytical limit of SI signal reached)	3 (Offsite Power Available)	118
III. Containment Spray System (CSS)		
A. Number of Lines	4	2
B. Number of Pumps	4	2
C. Number of Headers	1	1
D. Flow Rate, gpm	9,800 (4 pumps)	5,290 (2 pumps)
E. Response Time, sec (after analytical limit of SI signal reached)	5 (Offsite Power Available)	243
IV. Refueling Water Storage Pit (RWSP)		
A. Liquid volume. Gallons	651,000	329,000
B. Liquid surface area ,ft^2	4,985	Interface Area is Ignored
V. Containment		
A. Free Volume (Air Volume), ft^3	2,800,000	2,743,000

Notes:
* HHIS flow rate is the value when RCS pressure is at 0psig.
Hot leg switch-over is conservatively not assumed, which leads to ignoring steam condensation with the hot leg injection.

Table 16-4 Summary of Analysis Results

Figure 16-1 Concept of Two-phase Level of the Vessel by GOTHIC

Figure 16-2 Core Power Shape for the Realistic Analysis

Figure 16-3 Core Void Profile

[ ]

Figure 16-4 Noding Diagram of GOTHIC for Realistic Analysis Pump Suction Break Case

**Figure 16-5 Noding Diagram of GOTHIC for Realistic Analysis
Cold Leg (Pump Discharge) Break Case**

Figure 16-6 Comparison of Containment Pressure vs. Time

Figure 16-7 Comparison of Containment Atmospheric Temperature vs. Time

Item 18

The equation for carryout rate fraction on page 3-8 contains a quench front level term Zq. Based on FLECHT data, the correlation was found to be valid until the quench front level neared but did not reach the top of the core. At that elevation the core was found to be quenched from the top so that water was no longer carried out the top of the core. The FLECHT data was obtained from a facility simulating a 12 foot reactor core. Please describe the assumptions used in modeling the 14 foot fuel of US-APWR with regard to termination of liquid carryout as the quench front level reaches the top of the core. Justify that this assumption is conservative for containment analysis.

RESPONSE

Liquid entrainment is assumed to continue until the water level in the core is 2 feet from the top of the core in modeling the 14-foot fuel of US-APWR, in conformance with Acceptance Criterion 1.C.iii. of SRP 6.2.1.3. The same approach is being used for the 14-foot core as was used previously for the 12-foot core. The description of this assumption will be included in the revised topical report.

2.0 Response to Follow-up Request dated January 30, 2008

Item 19

Please provide the NRC staff with an electronic file of the US-APWR GOTHIC input for the double ended pump suction break. The staff would like to use this input to develop a description of the US-APWR containment using the MELCOR computer code for the purpose of performing confirmatory analysis. We also would like to share it with NRC research staff as they are developing a MELCOR containment model for the Chapter 6.2 evaluation.

RESPONSE

The GOTHIC containment model is combined with the GOTHIC reactor cooling system (RCS) model for long-term cooling phase. It is also coupled with WREFLOOD (M1.0) for reflood phase. Therefore the US-APWR GOTHIC input does not include mass and energy tables for the reflood phase and the long-term cooling phase.

In order to provide a complete GOTHIC containment model for the confirmatory analysis, the GOTHIC input has been changed from that for the double ended pump suction break case as follows:

- The RCS model is removed.
- Mass and Energy table for the reflood phase is added. The table is the same as one provided as Table 14-2 for the response to Item 14.
- Mass and Energy table for the long-term cooling phase is added.

The mass and energy table for the long-term cooling phase has been made so as to conserve integral values for the mass and energy release since the data transference from the RCS to the containment in the combined GOTHIC calculation is done on every time step and the interval is too short.

As shown in Figure 19-1 the containment pressure with the provided data here is almost the same as that for the US-APWR double ended pump suction break case.

Electronic files for the US-APWR GOTHIC input and the input listing are provided as the following files.

Electronic file :{ }
Input Listing :{ }

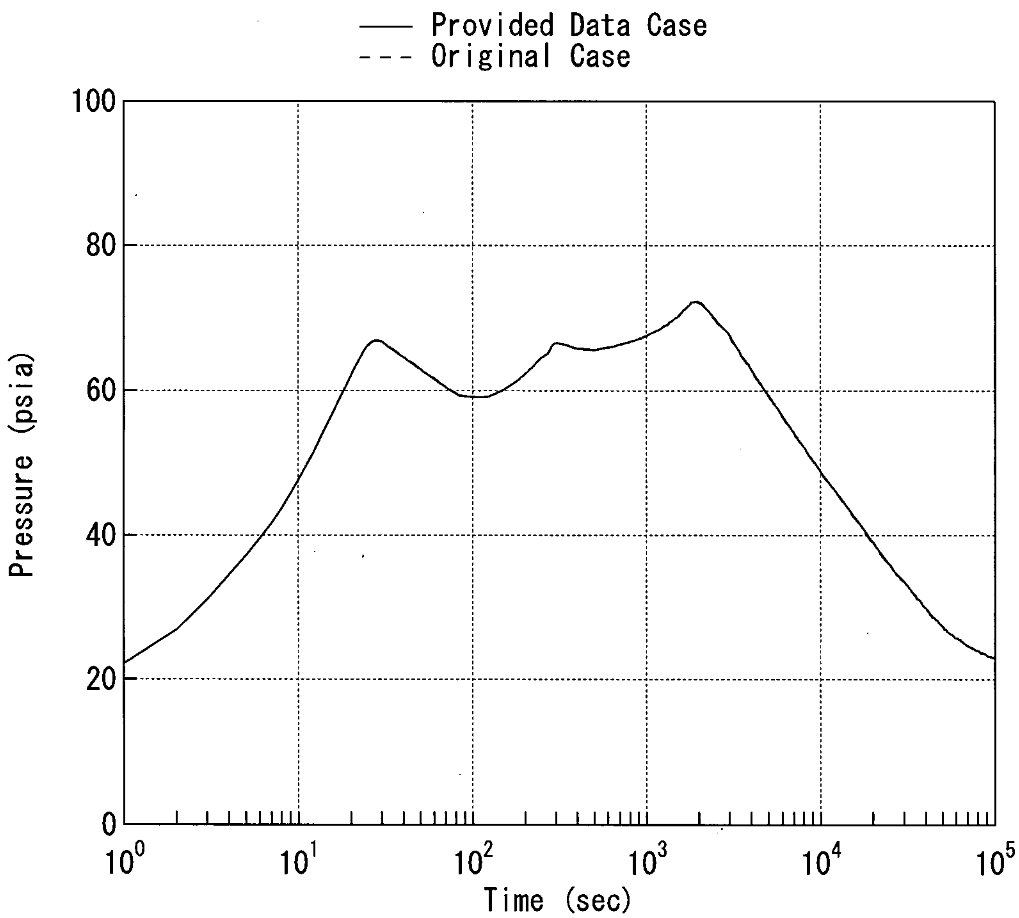


Figure 19-1 Containment Pressure

3.0 Response to Request in Mach 2008

Item 20

Based on the response to Item 14 (Tables 14-1,14-2 and 14-3 in the January responses), it is noted that the post-reflood steam release to the containment as calculated by the GOTHIC reactor system simulation is oscillatory as compared with the previously approved methodology in WCAP-10325 which MHI references. In addition, after approximately 30,000 seconds, the steam release to the containment is less than that which one would expect from continued core boil-off. The staff is concerned that the oscillations may be an artifact of the GOTHIC code and may cause unrealistic steam condensation to be calculated within the core and lower plenum of the reactor vessel. The staff does not understand why the long term steam release rate predicted by GOTHIC would be less than that resulting from decay heat boiling.

We note that Standard Review Plan 6.2.1.3 recommends the following:
"Steam from decay heat boiling in the core should be assumed to flow to the containment by the path which produces the minimum amount of mixing with the ECCS injection water." For a postulated break at the reactor system pump suction, compliance with this recommendation would mean that steam from the core is assumed to flow directly to the break without passing any of the ECCS injection locations.

RESPONSE

(1) Long-term Steam Release Rate

In the GOTHIC primary system model, steam-water interfacial areas at the cold leg and the downcomer are set to zero to avoid mixing of the steam from decay heat boiling in the core and the SI water in accordance with SRP 6.2.1.3.

Figure 20-1 compares the integral of the steam release rate calculated by GOTHIC with steaming rate due to decay heat calculated using the following expression.

(2) Effects of Oscillation

Sensitivity study related to the effects of the flow oscillation will be performed based on the limiting case of the US-APWR containment analyses and will be submitted as a revision of this response package. In eliminating the effects of flow oscillation, the evaluation model using GOTHIC will be modified, without causing significant change. Hence, the revised version of the topical report will address the solution of the issue of oscillation.

Figure 20-1 Integral of Steam Release Rate after Peak Pressure

Item 21

Describe the treatment of N_2 gas of the accumulator.

RESPONSE

For the US-APWR, N_2 gas of the accumulator is released to the containment via reactor coolant loops after the low flow injection mode is terminated during post-reflood phase. The release of the N_2 gas is accounted in the GOTHIC evaluation model using boundary conditions that inject the N_2 gas directly into the containment. Parameters related to the gas injection are given conservatively as follows:

ATTACHMENT TO ENCLOSURE 2

FILES CONTAINED IN CD 1

CD 1: "US-APWR GOTHIC Input for the Double Ended Pump Suction Break"

Contents of CD

File Name	Size	Sensitivity Level
001 1n-dc_rm-c9_cv.GTH	0.9MB	Proprietary
002 1n-dc_rm-c9_cv_input.pdf	0.3MB	Proprietary