6.5 Case 4

102% Power

4.4 ft^2 DER

Failure of Diesel Generator

Offsite Power NOT Available

The restart deck from case "SLBC2_1" was reproduced identically with the exception of the following changes:

Single Failure

The MSIV failure of the base deck is removed. No additional RELAP5/MOD2 failure is required of a DG failure with the minimum SI flow already modeled in the base deck.

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC4_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON2H" was duplicated with the following changes

Containment Coolers

Only two containment coolers were inadvertently credited in the base deck. This remains unchanged for this case.

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST4"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

No containment sprays are credited in the present evaluation with the peak containment pressure below 24.8 psig.

Results

The CONTEMPT run was titled "CON4H" with the peak containment pressure determined to be 21.8 psig at 247.5 seconds post break, and peak containment temperature of 282.0F at 14.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.6 Case 5

102% Power

4.4 ft^2 DER

Failure of Containment Spray System

Offsite Power Available

The restart deck from case "SLBC1_1" was reproduced identically with the exception of the following changes:

Single Failure

The MSIV failure of the base deck is removed. No additional RELAP5/MOD2 failure is required of a containment spray failure.

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC5_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON1H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST4"), and formatting the data for input into CONTEMPT by

summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

No containment sprays are credited in the present evaluation with the peak containment pressure below 24.8 psig.

Results

The CONTEMPT run was titled "CON5H" with the peak containment pressure determined to be 22.8 psig at 110.5 seconds post break, and peak containment temperature of 280.9F at 12.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.7 Case 6

102% Power

4.4 ft^2 DER

Failure of Containment Cooler System

Offsite Power Available

This RELAP5/MOD2 run is identical to case 5 with only a failure of a containment system.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON5H" was duplicated with the following changes

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is accomplished by changing word 11 of card 6 from 4 to 2.

Mass and Energy Release

The mass and energy release was unchanged from case 5.

Containment Sprays

No containment sprays are credited in the present evaluation with the peak containment pressure below 24.8 psig. This remains unchanged from the base deck.

Results

The CONTEMPT run was titled "CON6H" with the peak containment pressure determined to be 23.5 psig at 111.6 seconds post break, and peak containment temperature of 280.9F at 12.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.8 Case 7
102% Power
1.1 ft² SPLIT
Failure of Diesel Generator
Offsite Power NOT Available

The restart deck from case "SLBC4_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve configuration changes depending on break size and whether the break is a double ended rupture or a split break. For case 7, a split break requires that the communication valve between the two sides of the break (valve 851) remains open, and only the single break valve opens (valves 856). The second break valve remains closed through the transient (valve 858). The single break size must also be reduced to 1.1 ft^2. Note that the comment card stating break size is incorrect in the deck.

```
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
* BREAK MODEL
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
*
* Break size = 4.4 DER
8560000   A-BRK   VALVE
8560101   673010000   572000000   1.1   1.0   1.0E+6   00100
8560201   0     0.0     0.0     0.0        * 0.0
8560300   TRPVLV
8560301   551
*
```

```
8510000 DER  VALVE
8510101 673010000 674000000 4.929 0.0 0.0 01100
8510201 0 29.90708 93.44495 0.0
8510300 MTRVLV
8510301 501 502 100.0 1.0 * ALWAYS OPEN FOR SPLIT, 0.01 stroke
*
8580000  B-BRK  VALVE
8580101  674000000  571000000  4.4  1.0  1.0E+6  00100
8580201  0      0.0     0.0     0.0          * 0.0
8580300  TRPVLV
8580301  502  *FALSE, ALWAYS CLOSED FOR SPLIT
*
```

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC7_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON4" was duplicated with the following changes

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is unchanged in the base deck. The containment cooler start time for a LOOP is 65 seconds after LOOP if the containment pressure reaches 6.8 psig prior to 35.0 seconds. From the RELAP5/MOD2 run "SLBC7_1", the LOOP occurs at 8.04 seconds coincident with reactor trip. The containment cooler actuation time is therefore 73.04 seconds.

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST7"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1). The last mass and energy value was held

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 69.67 seconds. With this actuation setpoint reached after 35.0 seconds with a LOOP, the spray delay is 53.1 seconds for a spray start time of 122.77 seconds.

The spray flow rate is set to the low flow pump flow rate of 3285 GPM. This corresponds to a flow rate of 450.49 lbm/s as calculated in Reference 20.

Results

The CONTEMPT run was titled "CON7H" with the peak containment pressure determined to be 33.5 psig at 458.0 seconds post break, and peak containment temperature of 267.5F at 26.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.9 Case 8

102% Power

1.1 ft^2 SPLIT

Failure of Containment Spray System

Offsite Power Available

The restart deck from case "SLBC5_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve configuration changes depending on break size and whether the break is a double ended rupture or a split break. For case 8, a split break requires that the communication valve between the two sides of the break (valve 851) remains open, and only the single break valve opens (valves 856). The second break valve remains closed through the transient (valve 858). The single break size must also be reduced to 1.1 ft^2. Note that the comment card stating break size is incorrect in the deck.

```
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
*  BREAK MODEL
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
*
*  Break size = 4.4 DER
8560000   A-BRK    VALVE
8560101   673010000   572000000  1.1  1.0  1.0E+6  00100
8560201   0      0.0     0.0     0.0        * 0.0
8560300   TRPVLV
8560301   551
*
```

```
8510000 DER  VALVE
8510101 673010000 674000000 4.929 0.0 0.0 01100
8510201 0 29.90708 93.44495 0.0
8510300 MTRVLV
8510301 501 502 100.0 1.0 * ALWAYS OPEN FOR SPLIT, 0.01 stroke
*
8580000  B-BRK  VALVE
8580101  674000000  571000000  4.4  1.0  1.0E+6  00100
8580201  0      0.0     0.0     0.0          * 0.0
8580300  TRPVLV
8580301  502  *FALSE, ALWAYS CLOSED FOR SPLIT
*
```

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC8_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON5H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST8"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1). Note

that for all split breaks, liquid carryout is minimal, and no linear reduction in mass and flow rate to conditions just when liquid entrainment deminishes is required.

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 59.206 seconds. The spray delay is 53.1 seconds for a spray start time of 112.306 seconds.

The spray flow rate is set to the low flow pump flow rate of 3285 GPM. This corresponds to a flow rate of 450.49 lbm/s, identical to "CON7H".

Results

The CONTEMPT run was titled "CON8H" with the peak containment pressure determined to be 34.8 psig at 196.8 seconds post break, and peak containment temperature of 268.8F at 26.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.10 Case 9
102% Power
1.1 ft^2 Split
Failure of Containment Cooler System
Offsite Power Available

This RELAP5/MOD2 run is identical to case 8 with only a failure of a containment system.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON8H" was duplicated with the following changes

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is accomplished by changing word 11 of card 6 from 4 to 2.

Mass and Energy Release

The mass and energy release was unchanged from case 8.

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 58.72 seconds. The spray delay is 53.1 seconds for a spray start time of 111.9 seconds.

The spray flow rate is set to the full flow pump flow rate of 7080 GPM. This corresponds to a flow rate of 970.92 lbm/s as given in Reference 20.

Results

The CONTEMPT run was titled "CON9H" with the peak containment pressure determined to be 35.6 psig at 196.0 seconds post break, and peak containment temperature of 268.8F at 26.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.11 Case 10

102% Power

1.1 ft^2 Split

Failure of MFIV

Offsite Power Available

This case was not performed with a comparison between cases 1 and 3 demonstrating that a MSIV failure is more limiting.

6.12 Case 11
102% Power
1.1 ft^2 Split
Failure of MSIV
Offsite Power Available

The restart deck from case "SLBC1_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve configuration was changed identical to case "SLBC7_1" for a 1.1 ft2 split break.

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC11_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON1H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST11"), and formatting the data for input into CONTEMPT by

summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 69.325 seconds. The spray delay is 53.1 seconds for a spray start time of 122.43 seconds.

Results

The CONTEMPT run was titled "CON11H" with the peak containment pressure determined to be 33.5 psig at 214.0 seconds post break, and peak containment temperature of 268.7 at 26.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.13 Case 12
102% Power
0.9 ft^2 SPLIT
Failure of Diesel Generator
Offsite Power NOT Available

The restart deck from case "SLBC7_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was reduced from 1.1 ft^2 to 0.9 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC12_1". It was later determined that the peak containment conditions had not been obtained by this time, so an additional 300-second run was performed in "SLBC12_2". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON7H" was duplicated with the following changes

Transient Time

The end time of the transient was extended to 900.0 seconds.

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is unchanged in the base deck. The containment cooler start time for a LOOP is 65 seconds after LOOP if the containment pressure reaches 6.8 psig prior to 35.0 seconds. From the RELAP5/MOD2 run "SLBC7_1", the LOOP occurs at 8.62 seconds coincident with reactor trip. The containment cooler actuation time is therefore 73.62 seconds.

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST12"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 90.642 seconds. With this actuation setpoint reached after 35.0 seconds with a LOOP, the spray delay is 53.1 seconds for a spray start time of 143.74 seconds. The spray flow rate is kept at the low flow pump flow rate.

Results

The CONTEMPT run was titled "CON12H" with the peak containment pressure determined to be 32.8 psig at 588.0 seconds post break, and peak containment temperature of 256.3 at 29.1

seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.14 Case 13

102% Power

0.9 ft^2 SPLIT

Failure of Containment Spray System

Offsite Power Available

The restart deck from case "SLBC8_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was reduced from 1.1 ft^2 to 0.9 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 600-second run was performed in "SLBC13_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON8H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST13"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 98.339 seconds. The spray delay is 53.1 seconds for a spray start time of 151.44 seconds. The spray flow rate is kept at the low flow pump flow rate.

Results

The CONTEMPT run was titled "CON13H" with the peak containment pressure determined to be 31.7 psig at 238.5 seconds post break, and peak containment temperature of 258.7F at 29.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.15 Case 14

102% Power

0.9 ft^2 Split

Failure of Containment Cooler System

Offsite Power Available

This RELAP5/MOD2 run is identical to case 13 with only a failure of a containment system.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON13H" was duplicated with the following changes

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is accomplished by changing word 11 of card 6 from 4 to 2.

Mass and Energy Release

The mass and energy release was unchanged from case 4.

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 92.35 seconds. The spray delay is 53.1 seconds for a spray start time of 145.44 seconds.

The spray flow rate is set to the full flow pump flow rate of 7080 GPM. This corresponds to a flow rate of 970.92 lbm/s as given in Reference 20.

Results

The CONTEMPT run was titled "CON14H" with the peak containment pressure determined to be 32.8 psig at 240.5 seconds post break, and peak containment temperature of 258.7F at 29.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.16 Case 15

102% Power

0.9 ft^2 Split

Failure of MFIV

Offsite Power Available

This case was not performed with a comparison between cases 1 and 3 demonstrating that a MSIV failure is more limiting.

6.17 Case 16
102% Power
0.9 ft^2 SPLIT
Failure of MSIV
Offsite Power Available

The restart deck from case "SLBC11_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was reduced from 1.1 ft^2 to 0.9 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 600-second run was performed in "SLBC16_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON11H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST16"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 76.343 seconds. The spray delay is 53.1 seconds for a spray start time of 129.44 seconds. The spray flow rate is kept at the low flow pump flow rate.

Results

The CONTEMPT run was titled "CON16H" with the peak containment pressure determined to be 33.9 psig at 258.0 seconds post break, and peak containment temperature of 258.6F at 29.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.18 Case 9a
102% Power
1.2 ft^2 SPLIT
Failure of Containment Cooler System
Offsite Power Available

Following the evaluation of the 102% power cases, it was determined that the limiting failure was of the containment cooler system. To define the peak containment temperature and pressure results, several additional cases were performed with a containment cooler system failure to bracket the most limiting break size. The break sizes evaluated were 1.2 ft^2, 1.6 ft^2, 1.0 ft^2 , and 1.3 ft^2 (cases 9a, 9b, 9c and 9d respectively).

The restart deck from case "SLBC9_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was increased from 1.1 ft^2 to 1.2 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 300-second run was performed in "SLBC9A_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON9H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST9A"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 53.51 seconds. The spray delay is 53.1 seconds for a spray start time of 106.61 seconds.

Results

The CONTEMPT run was titled "CON9AH" with the peak containment pressure determined to be 35.8 psig at 184.7 seconds post break, and peak containment temperature of 275.5F at 25.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.19 Case 9b
102% Power
1.2 ft^2 SPLIT
Failure of Containment Cooler System
Offsite Power Available

The restart deck from case "SLBC9_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was increased from 1.1 ft^2 to 1.6 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 300-second run was performed in "SLBC9B_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON9H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST9B"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 105.505 seconds. The spray delay is 53.1 seconds for a spray start time of 158.605 seconds.

Results

The CONTEMPT run was titled "CON9BH" with the peak containment pressure determined to be 25.2 psig at 115.9 seconds post break, and peak containment temperature of 283.8F at 23.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.20 Case 9c
102% Power
1.0 ft^2 SPLIT
Failure of Containment Cooler System
Offsite Power Available

The restart deck from case "SLBC9_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was decreased from 1.1 ft^2 to 1.0 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 300-second run was performed in "SLBC9C_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON9H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST9C"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 79.97 seconds. The spray delay is 53.1 seconds for a spray start time of 133.07 seconds.

Results

The CONTEMPT run was titled "CON9CH" with the peak containment pressure determined to be 33.0 psig at 215.0 seconds post break, and peak containment temperature of 262.4F at 28.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

6.21 Case 9d

102% Power

1.3 ft^2 SPLIT

Failure of Containment Cooler System

Offsite Power Available

The restart deck from case "SLBC9_1" was reproduced identically with the exception of the following changes:

Break Model

The break valve size was decreased from 1.1 ft^2 to 1.3 ft^2 (valve 856).

RELAP5/MOD2 Results

With the documented change, a 300-second run was performed in "SLBC9D_1. Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON9H" was duplicated with the following changes

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST9C"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 54.79 seconds. The spray delay is 53.1 seconds for a spray start time of 107.89 seconds.

Results

The CONTEMPT run was titled "CON9DH" with the peak containment pressure determined to be 34.11 psig at 179.0 seconds post break, and peak containment temperature of 281.6F at 23.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

7.0 70% Power Evaluation

The base RELAP5/MOD2 deck used is the 102% power case "SLBIC1". The only changes required of this deck are those required for a reduction in power and are as follows.

MFW Pump Suction Conditions

For a reduction in power, the MFW pump suction temperature is reduced. From Reference 5, the feedwater suction temperatures are 361.5F at 64%FP and 385.0F at 82.6%FP (The percent full power for these figures was calculated in Section 8 of Reference 6. Interpolating between these values gives a suction temperature of 369.1F.

```
8000201  0.0  367.4  402.6  *"SUCTION" "P" & "T"
```

Note: The suction conditions of the MFW pump were applied incorrectly with a reduction in the containment pressure and not temperature. The suction pressure is immaterial with the correct MFW flow obtained with the combination of suction pressure and MFW control valve position. The decrease in suction pressure and not temperature will cause a conservative overprediction of the MFW temperature entering the SG.

MFW Control Valves

The MFW Control valves were closed to 34% open as an initial guess to obtain the correct MFW flow rate.

```
8200301  593  502  0.05  .34
8700301  593  502  0.05  0.34
```

MFIV Valve

The base deck modeled a nearly instantaneous close time of the MFIVs. The change of this valve stroke time was neglected in the base deck run, and was only incorporated on break restart. Consistant with Reference 4, the MFIV valve closure time is changed to 5-seconds.

8300301 502 593 0.2 1.0
8800301 502 593 0.2 1.0

Power Level

The power level was reduced to 70% of 3411 Mwt, or 2387.7 Mwt.

30000001 "GAMMA-AC" .23877E+10 .00000 243.094 1.2 1.0000

Turbine Pressure

The turbine pressure was increased to 1140.8 as an initial guess to obtain the correct RCS Tavg of 588.5F

7960201 0.0 1140.8 540.0 *"SG" "P" & "T"

7.1 RELAP5/MOD2 70% Power Steady State

The changes outlined in section 7.0 were administered to case "SLBIC1" of Section 4.1. A 100-second run titled "SLB70IC1" was performed that resulted in a RCS Tavg of 588.8°F. To obtain a suitable steady state, several changes were applied to the deck on a restart titled "SLB70IC2".

The turbine pressure was lowered from 1140.8 psia to 1140.0 psia.

```
*
7960000  "TURBINE"  "TMDPVOL"
7960101  1.e6 1.e6 0.0  0.0  0.0  0.0  0.0  0.0  10
7960200  003
7960201  0.0   1140.8   540.0   *"SG" "P" & "T"
7960202  100.0  1140.8   540.0
7960203  101.0  1140.0   540.0
*
```

From Table H2 of Reference 12, for SG levels above 70% NRS for power levels near 70% power, the velocity error in the NRS is 2.6%. The SG level is initialized to 65.6% NRS (Reference 12, Item 3.2.11) plus 2.5% NRS control band tolerance, 5.0% instrument error, and 2.6% velocity error for a total level of 75.7% NRS. The void fractions of the steam generator separator region were adjusted such that at the end of this run, the correct SG levels are obtained. The following void fraction changes were applied to the separator region in restart run "SLB70IC2":

```
6550200  0      1149.8  548.95  1109.4  0.045
7550200  0      1149.7  548.98  1108.8  0.087
```

The MFW flow rate was required to be increased to match the steam flow rate. The MFW control valves were both opened slightly.

8200301 593 502 0.05 .372

8700301 593 502 0.05 0.369

These changes were applied on restart "SLB70IC2", with the steady state run continued for another 50 seconds. The results of this run show that the RCS Tavg and SG levels are steady and correct. The conditions at the end of this run are as given in Table 7.1.

Table 7.1

70% Power Steady State Conditions

Average RCS Liquid Temperature (°F) (CVAR 906)	588.5 (588.5)*
Pressurizer Pressure (psia) (410-1)	2241.5
RCS Flow Per Loop, Single/Triple (lbm/s) (100-1, 200-1)	10370/31116
SG Dome Pressure, Single/Triple (psia) (670-1, 770-1)	1146.5/1146.7
Single SG Level (%NRS) (CVAR 792)	75.9 (75.7)*
Triple SG Level (%NRS) (CVAR 992)	75.4
Feedwater Flow, Single/Triple (lbm/s) (832-1, 882-1)	693.2/2059.1
Steam Flow, Single/Triple (lbm/s) (670-1, 770-1)	688.1/2068.1

bracketed are desired values

7.2 Case 17

70% Power

4.4 ft^2 DER

Failure of Diesel Generator

Offsite Power NOT Available

The following changes were applied on the RELAP5/MOD2 break restart input deck. Most of these changes are applied to all cases at transient initiation. The base restart deck on which the following changes were applied was the case 4 restart deck of "SLBC4_1". Note that most parameters defined on the restart deck will remain unchanged from "SLBC4_1".

Kinetics

All kinetics control variables are in place for the steady state runs (and therefore initialized correctly). On break restart the kinetics control variables are applied with use of the 3000000 series cards, with the power level updated to 70% full power from the base deck.

30000001 GAMMA-AC .23877E+10 .00000 243.094 1.2 1.0000

MFW Heaters

The MFW heater models developed in reference 6 were developed from steady state information. During upset conditions, the heaters may perform unrealistically. To avoid possible difficulties, the heater performance is fixed at the steady state conditions. It is conservative to hold shell side temperature and heat transfer to the pre-transient conditions with the shell side steam flow expected to decrease of stop once the steam line break occurs and the turbine trips. The temperature and UA terms applied to the following tables were obtained from the lookup control variables that use these tables at the end of the steady state run.

```
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
* MFW HEATER SHELL SIDE CONDITIONS HELD CONSTANT
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
*
20201000   REAC-T
*          POWER,MW      SHELL SIDE TEMP, F
20201001     0.          404.421
20201002     4000.        404.421
*
20201100   REAC-T
*          POWER,MW      SHELL SIDE TEMP, F
20201101     0.00         379.050
20201102     4000.        379.050
*
20201200   REAC-T
*          POWER,MW      UA, WATTS/F
20201201     0.00        13273380.
20201202     4000.        13273380.
*
```

Turbine

To avoid an unrealistic back flow from the turbine to the break once the steam lines depressurize, the choking option is applied to the turbine valve, with the time dependent volume downstream of the valve changed to atmospheric pressure, and the valve area adjusted such that the flow through the valve matches the steady state value. From the last major edit of run "SLB70IC2", the flow through the TSV is 2754.9 lbm/s, with a steam internal energy just upstream (branch 792) of 1106.1 Btu/lbm, and pressure just upstream of 1140.1 psia. Internal energy of the node is used to calculate the flow area of the choked junction rather then enthalpy. Use of the internal energy will result in a slight underproduction of the

choked flow area (increased lbm/s-ft**2 term), reducing the flow to the turbine and therefore conservatively increasing the flow to the break. From the HEM choked flow tables of Reference 21, a double interpolation is performed to obtain the correct flow area to maintain the steady state flow through the TSV.

For 1000.0 psia inlet pressure:

H (Btu/lbm)	G (lbm/s-ft**2)
1062.86	2203.95
1106.1	? = 2136.10
1127.90	2101.89

For 1200.0 psia inlet pressure:

H (Btu/lbm)	G (lbm/s-ft**2)
1031.57	2723.25
1106.1	? = 2570.83
1123.52	2535.20

For 1140.1 psia inlet pressure:

P (psia)	G (lbm/s-ft**2)
1000.0	2136.10
1140.1	? = 2440.6
1200.0	2570.83

The required area to obtain the correct choked flow mass flow rate is:

Area = (2754.9 lbm/s)/(2440.6 lbm/s-ft**2) = 1.13

*

7940000 SNG-TSV VALVE

```
7940101  792010000 796000000 1.13  0.0  1.0E+10     30000
7940201  1   0.00   2754.9   0.0
7940300  TRPVLV
7940301  660
*
```

MFIV Valve

The correct stroke time was modeled in "SLB70IC1", the MFIV model was therefore removed from the base restart deck.

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC17_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON4H" was duplicated with the following changes

Containment Coolers

Only two containment coolers are credited in the present evaluation. This is unchanged in the base deck. The containment cooler start time for a LOOP is 65 seconds after LOOP if the containment pressure reaches 6.8 psig prior to 35.0 seconds. From the RELAP5/MOD2 run "SLBC7_1", the LOOP occurs at 2.89 seconds coincident with reactor trip. The containment cooler actuation time is therefore 67.89 seconds.

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST17"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

The peak containment pressure is determined to be below the containment spray setpoint. Containment sprays are therefore not credited. This is consistent with the base deck.

Results

The CONTEMPT run was titled "CON17H" with the peak containment pressure determined to be 22.4 psig at 288.5 seconds post break, and peak containment temperature of 296.881F at 14.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

7.3 Case 18
70% Power
4.4 ft^2 DER
Failure of Containment Cooler System
Offsite Power Available

The restart deck from case "SLBC17_1" was reproduced identically with the exception of the following changes:

Single Failure

The additional SI delay of the base deck is removed with offsite power available. The RC pump model is returned to the base deck logic with offsite power available and the pumps operating throughout the transient. No additional RELAP5/MOD2 failure is required of a containment cooler failure.

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC18_1". Plots showing the behavior of the transient are shown in Appendix C.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON1H" was duplicated with the following changes

Containment Coolers

The number of fan coolers was reduced from 4 to 2 consistant with a cooler failure. This was accomplished by changing word 11 of card 6 from 4 to 2.

Mass and Energy Release

The mass and energy release from both sides of the break are formatted for input into CONTEMPT and are input as Table 501 in the input deck. This is performed by creating a strip file from the RELAP5/MOD2 deck (strip file titled "ST18"), and formatting the data for input into CONTEMPT by summing the mass releases from both sides of the break, and summing the energy release rates from both sides of the break and input these values into Table 501 (See example for case 1).

Containment Sprays

Following this input, a preliminary run was performed to determine the time the containment building reached 24.8 psig (containment spray actuation setpoint) which was determined to be at 98.106 seconds. The spray delay remains 53.1 seconds for a spray start time of 151.206 seconds. This activation time was incorporated into Table 801.

Results

The CONTEMPT run was titled "CON18H" with the peak containment pressure determined to be 25.3 psig at 118.0 seconds post break, and peak containment temperature of 302.2F at 12.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

7.4 Case 19

70% Power

4.4 ft^2 DER

Failure of Containment Spray System

Offsite Power Available

This RELAP5/MOD2 run is identical to case 18 with only a failure of a containment system.

CONTEMPT Evaluation

The CONTEMPT input deck from case "CON18H" was duplicated with the following changes

Containment Coolers

four containment coolers are credited in the present evaluation. This is accomplished by changing word 11 of card 6 from 2 to 4.

Mass and Energy Release

The mass and energy release was unchanged from case 18.

Containment Sprays

No containment sprays are credited in the present evaluation with the peak containment pressure below 24.8 psig. The mass flow rate was removed from table 801.

Results

The CONTEMPT run was titled "CON19H" with the peak containment pressure determined to be 24.5 psig at 111.5 seconds post break, and peak containment temperature of 302.2F at 12.1 seconds post break. Plots of the containment pressure and temperature response are included in Appendix C.

7.5 Case 20

70% Power

4.4 ft^2 DER

Failure of MFIV

Offsite Power Available

This case was not performed with a comparison between cases 1 and 3 demonstrating that a MSIV failure is more limiting.

7.6 Case 21

70% Power

4.4 ft^2 DER

Failure of MSIV

The restart deck from case "SLBC18_1" was reproduced identically with the exception of the following changes.

Single Failure

The base deck had no single RELAP5/MOD2 failure. The MSIV failure is added holding open the MSIV on the broken SG resulting in the blowdown of the residual steam in the steam lines between the MSIV and the turbine.

```
*
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
* FAILURE
**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_**_
*
6820000  MSIV-1    VALVE
6820101  674010000 684000000  4.929  0.096   0.096  30100  1.0  1.0
6820201  0         29.90708  93.44495 0.0           * 1075.841
6820300  MTRVLV
6820301  501  502   0.1666   1.0 *TRIPS HOLD VALVE OPEN
*
```

RELAP5/MOD2 Results

With the documented changes, a 600-second run was performed in "SLBC21_1". Plots showing the behavior of the transient are shown in Appendix C.