ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Friday, March 06, 2009 11:56 AM
To: Getachew Tesfaye
Cc: NOXON David B (AREVA NP INC); DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 133, FSAR Ch 19, Supplement 3
Attachments: RAI 133 Supplement 3 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 7 of the 17 questions of RAI No. 133 on December 8, 2008. AREVA NP submitted Supplement 1 to the response on January 30, 2009 to address 3 of the remaining questions. AREVA NP submitted Supplement 2 to the response on February 11, 2009 to address 4 of the remaining questions.

Attached please find Supplement 3 to AREVA NP's response to RAI No. 133. The attached file, "RAI 133 Supplement 3 Response US EPR DC.pdf" provides technically correct and complete responses to one of the remaining questions.

The following table provides the pages in the response document, "RAI 133 Supplement 3 Response US EPR DC.pdf" containing the response to each question.

Question #	Start Page	End Page
RAI 133 — 19-244	2	52

A complete answer is not provided for 2 of the 17 questions. The schedule for a technically correct and complete response to the remaining 2 questions is unchanged and provided below.

Question #	Response Date
RAI 133 — 19-230	June 19, 2009
RAI 133 — 19-243	June 19, 2009

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, February 11, 2009 4:53 PM
To: 'Getachew Tesfaye'
Cc: NOXON David B (AREVA NP INC); DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 133, FSAR Ch 19, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 7 of the 17 questions of RAI No. 133 on December 8, 2008. AREVA NP submitted Supplement 1 to the response on January 30, 2009 to address 3 of the 17 questions.

The attached file, "RAI 133 Supplement 2 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the remaining 7 questions.

The following table indicates the respective pages in the response document, "RAI 133 Supplement 2 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 133 — 19-232	2	6
RAI 133 — 19-233	7	15
RAI 133 — 19-238	16	17
RAI 133 — 19-240	18	23

The schedule for technically correct and complete responses to the remaining 3 questions is unchanged and provided below.

Question #	Response Date
RAI 133 — 19-230	June 19, 2009
RAI 133 — 19-243	June 19, 2009
RAI 133 — 19-244	March 6, 2009

Sincerely,

Ronda Pederson
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From: WELLS Russell D (AREVA NP INC)
Sent: Friday, January 30, 2009 4:21 PM
To: 'Getachew Tesfaye'
Cc: Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); SLIVA Dana (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 133, FSAR Ch 19, Supplement 1

Getachew,

The proprietary and non-proprietary versions of the response to RAI No. 133, Supplement 1 are submitted via AREVA NP Inc. letter, "Response to U.S. EPR Design Certification Application RAI No. 133, Supplement 1 " NRC 09:008, dated January 30, 2009. The enclosure to that letter provides technically correct and complete responses to 3 of the remaining 10 questions in RAI No. 133. An affidavit to support withholding of information from public disclosure, per 10CFR2.390(b), is provided as an enclosure to that letter.

The schedule for technically correct and complete responses to the remaining questions in RAI No. 133 is provided below:

Question #	Response Date
RAI 133 — 19-230	June 19, 2009
RAI 133 — 19-232 (c)	February 13, 2009
RAI 133 — 19-233	February 13, 2009
RAI 133 — 19-238	February 13, 2009
RAI 133 — 19-240 (2)	February 13, 2009
RAI 133 — 19-243	June 19, 2009
RAI 133 — 19-244	March 6, 2009

Sincerely,

(Russ Wells on behalf of)

Ronda Pederson
ronda.pederson@areva.com
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From: WELLS Russell D (AREVA NP INC)
Sent: Monday, December 08, 2008 6:43 PM
To: 'Getachew Tesfaye'
Cc: 'John Rycyna'; Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 133, FSAR Ch 19

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 133 Response US EPR DC.pdf" provides technically correct and complete responses to 7 of the 17 questions.

The following table indicates the respective pages in the response document, "RAI 133 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 133 — 19-230	2	2
RAI 133 — 19-231	3	3

RAI 133 — 19-232	4	4
RAI 133 — 19-233	5	5
RAI 133 — 19-234	6	6
RAI 133 — 19-235	7	7
RAI 133 — 19-236	8	8
RAI 133 — 19-237	9	9
RAI 133 — 19-238	10	10
RAI 133 — 19-239	11	12
RAI 133 — 19-240	13	45
RAI 133 — 19-241	46	47
RAI 133 — 19-242	48	48
RAI 133 — 19-243	49	49
RAI 133 — 19-244	50	50
RAI 133 — 19-245	51	52
RAI 133 — 19-246	53	79

A complete answer is not provided for 10 of the 17 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 133 — 19-230	June 19, 2009
RAI 133 — 19-232 (c)	February 13, 2009
RAI 133 — 19-233	February 13, 2009
RAI 133 — 19-236	January 30, 2009
RAI 133 — 19-237	January 30, 2009
RAI 133 — 19-238	February 13, 2009
RAI 133 — 19-240 (2)	February 13, 2009
RAI 133 — 19-242	January 30, 2009
RAI 133 — 19-243	June 19, 2009
RAI 133 — 19-244	March 6, 2009

(Russ Wells on behalf of)
Ronda Pederson
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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, November 06, 2008 8:42 PM
To: ZZ-DL-A-USEPR-DL
Cc: Edward Fuller; Theresa Clark; Hanh Phan; Hossein Hamzehee; Lynn Mrowca; John Rycyna; Joseph Colaccino
Subject: U.S. EPR Design Certification Application RAI No. 133 (1456), FSARCh. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 29, 2008, and discussed with your staff on November 6, 2008. Draft RAI Questions 19-229 was deleted and Draft RAI Questions 19-238 was modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for

receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information wiwasll impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 291

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D31B89AB6)

Subject: Response to U.S. EPR Design Certification Application RAI No. 133, FSAR Ch 19, Supplement 3
Sent Date: 3/6/2009 11:56:28 AM
Received Date: 3/6/2009 12:01:48 PM
From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

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Tracking Status: None

Post Office: AUSLYNCMX02.adom.ad.corp

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MESSAGE	8282	3/6/2009 12:01:48 PM
RAI 133 Supplement 3 Response US EPR DC.pdf	2459378	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 133, Supplement 3

11/07/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19

QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 2
(ESBWR/ABWR Projects) (SPLB)

Question 19-244:

(Follow-up to Question 19-148) The response to Question 19-148 contained results for a single instrument tube failure. The NRC Staff is also interested in what would be the consequences of failing multiple instrument tubes, from oxidation of the Zircaloy cladding.

1. Please provide an analysis of the consequences of failing all of the AMS probes in the region of the core where the Zircaloy oxidation takes place, for each of the relevant scenarios. Discuss how the hydrogen, steam, and fission products would then flow through the AMS probes and out into the instrumentation rooms. Please identify the recipient containment node in the MAAP model, and discuss the potential for a large hydrogen deflagration or detonation there and in adjacent compartments. In addition, please describe the gas flows from there into the rest of the containment building. Please present similar plots (mole fractions of hydrogen, steam, oxygen, and nitrogen; containment pressures, and temperatures; and fission product releases into the containment) to those presented in the initial response to the question.
2. For both the single probe and multiple probe failure cases, provide plots of the core-to-upper plenum natural circulation, countercurrent natural circulation flow rates in the hot leg and steam generator tubes, and damage fractions in the hot leg and steam generator tubes.

Response to Question 19-244:

Response to Question 19-244 (1):

The ball transport and gas supply tubes of the Aeroball Measuring System (AMS) are routed from the top of the instrumentation tubes exiting the reactor pressure vessel (RPV) over cable bridges to the AMS instrumentation rooms residing on the periphery of the equipment room area within the biological shield. These tubes are the transportation infrastructure for the ball stacks and propulsion gas (nitrogen) and are connected to a measuring table and gas carrier supply system respectively.

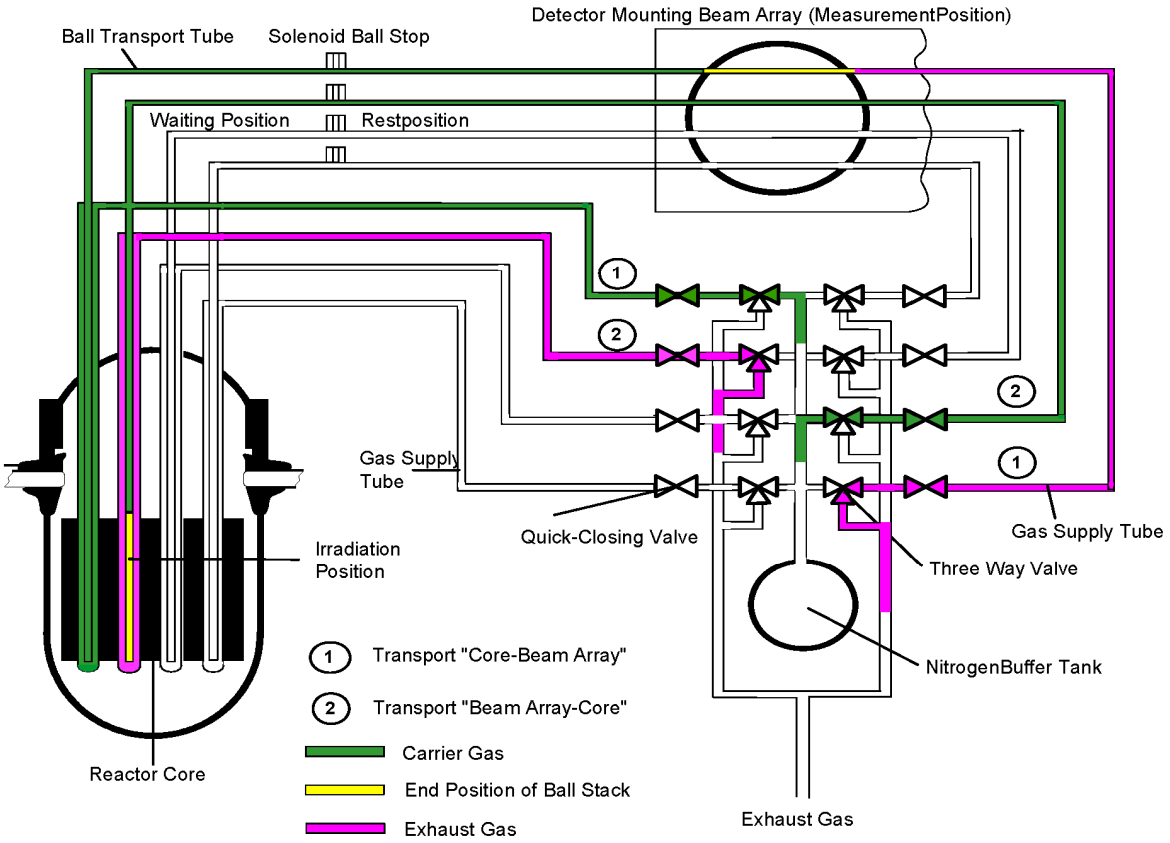
Within the RPV the AMS probe is suspended from a yoke that rests on the top plate of the upper core structure between the control rod shroud tubes. At the lower end of the AMS probe, the ball transport tube ends in a gas-permeable ball stop. Concentric to the ball transport tube, the gas supply tube is connected to the ball transport tube via the gas-permeable ball stop, allowing a counter pressure to be applied to eject the ball stacks from the core. There are forty AMS probes that penetrate various regions of the core. Groups of three or four are bundled together and associated with a single instrumentation tube leaving the RPV through an instrumentation nozzle. Downstream of the RPV, the AMS tubes are separated from the other instruments and grouped into four subsystems containing 10 AMS ball transport tubes. Figure 19-244-1 depicts the gas supply and ball transport tube layout of the four sub-systems. For more design information on in-core instrumentation, see the response to Question 19-149.

AMS components are monitored. Failures are indicated locally via signals in the main control room. The AMS is needed only during power operation of the plant. During abnormal plant conditions, the AMS will not be operated and there will be no automatic return to standard operation after accident conditions. The AMS has the ability to isolate a leak in an AMS probe by closing two magnetic valves on a pressure and/or humidity signal. Figure 19-244-1 shows the location of the magnetic valves for each subsystem. If an event occurs affecting all 40 probes, the magnetic valves would close to isolate the entire system. The portion of the AMS

located outside the RPV is designed to withstand a pressure of 435 psia (30 bar). If the AMS components fail to isolate, the primary coolant enters the ball transport and gas supply tubes from the AMS probe to the measuring table through the four sub-systems. The inner diameters of the ball transport and gas supply tubes are 0.0787 inch (2 mm). Therefore, a very small break (inner diameter 0.0787 inch) could occur in the instrumentation room if a significant pressure buildup occurs. Relief valves are included in this system to respond to overpressure conditions.

Monitoring and the automated isolation valve response preserves the reactor coolant system pressure boundary under abnormal plant conditions. Physical independence and separation of the 40 AMS ball transport and gas supply tubes significantly reduces the likelihood of a large scale failure of all AMS ball transport and gas supply tubes. Credible failure scenarios are considered to include only a simultaneous failure of all the probes and a single subsystem containing ten gas supply tubes.

Figure 19-244-1 – Depiction of Aeroball Measuring System



The U.S. EPR relevant severe accident scenarios such as loss of balance of plant (LBOP), loss of offsite power with a low pressure end state (LOOP PL), loss of offsite power with seal LOCA (LOOP SS), and loss of offsite power with a high pressure end state (LOOP TR) MAAP4.0.7 models were modified to simulate the simultaneous failure (1) of one AMS probe and its associated intake and exhaust gas supply tubes and (2) failure of all AMS probes and all

associated intake and exhaust gas supply tubes. Based on the information provided above if the AMS fails to isolate, the primary coolant (i.e., steam and hydrogen) enters the ball transport and gas supply tubes from the AMS probe(s) and flows to the measuring table located in the instrumentation room. For these simulations it was assumed that break flow area is equivalent to the combined area of the ball transport and gas supply tubes and the break appears in the instrumentation room. This is a conservative assumption because the intake and exhaust gas supply tubes are physically separated and flow will only be in one direction, resulting in a smaller failure flow area then the simulated flow area. The simulation of failing all 40 AMS probes assumed a failure area equivalent to forty times the flow area of one AMS probe.

The failure of all the AMS ball transport and gas supply tubes has an equivalent area of 6.76E-5 ft^2 (6.28E-6 m^2). In contrast, the failure area of a single instrumentation nozzle is 1.75E-2 ft^2 (1.63E-3 m^2). While the AMS ball transport and gas supply tubes pass through the RPV via the instrumentation nozzle, they are separate from the other instruments that share the instrumentation nozzle.

The recipient containment node in the MAAP simulations is node 17 (AMS instrumentation room). The compartments adjacent to instrumentation room are node 3 (broken loop lower equipment room), node 4 (unbroken loop lower equipment room), node 5 (broken loop middle equipment room), node 6 (unbroken loop middle equipment room), node 11 (surge line), node 12 (pressurizer), node 15 (lower annular room), node 18 (middle annular room), node 19 (upper annular room), node 21 (upper and lower containment dome), node 22 (access room), node 23 (staircase south), node 24 (staircase north), node 25 (elevator), and node 26 (hot piping).

The following sections provide the plots for the failure of one AMS probe and all AMS probes for each relevant scenario and the potential for hydrogen deflagration or detonation in the instrumentation room and adjacent compartments.

LBOP

Figures 19-244-2 and 19-244-3 plot the concentration of hydrogen in containment and concentration of hydrogen in the instrumentation room for the LBOP case simulating the failure of one AMS probe *(lbop_1tube)* and LBOP case simulating the failure of all AMS probes *(lbop_alltubes)*. Figures 19-244-4 and 19-244-5 plot the concentration of hydrogen in the adjacent compartments for the failure of one AMS probe *(lbop_1tube)* and failure of all AMS probes *(lbop_alltubes)*. The global hydrogen concentration is below the 10 CFR 50.44 limit of 10 percent as shown in Figure 19-244-2.

Figures 19-244-6 to 19-244-16 plot the concentration of steam, oxygen, nitrogen in containment, fractions of fission products in containment (CsI + RbI, SrO, CsOH + RbOH), containment and adiabatic isochoric complete combustion (AICC) pressures, primary system pressure, containment temperature, and instrumentation room temperature for the failure of one AMS probe *(lbop_1tube)* and failure of all AMS probes *(lbop_alltubes)*.

Figure 19-244-2 – Concentration of Hydrogen in Containment (Ibop)

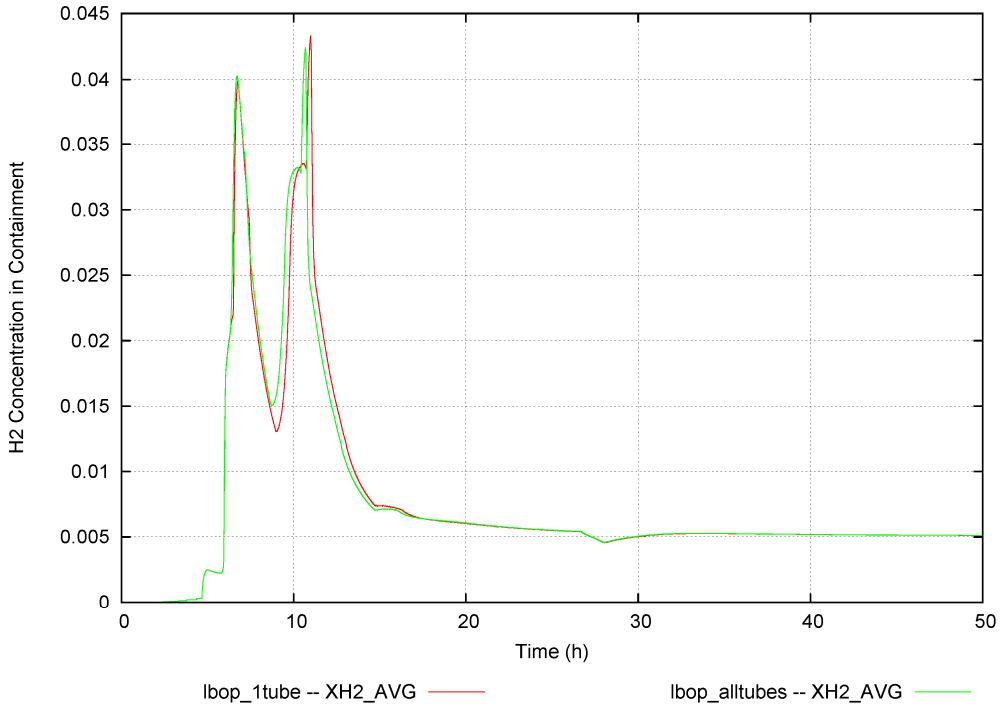


Figure 19-244-3 – Concentration of Hydrogen in Instrumentation Room (Ibop)

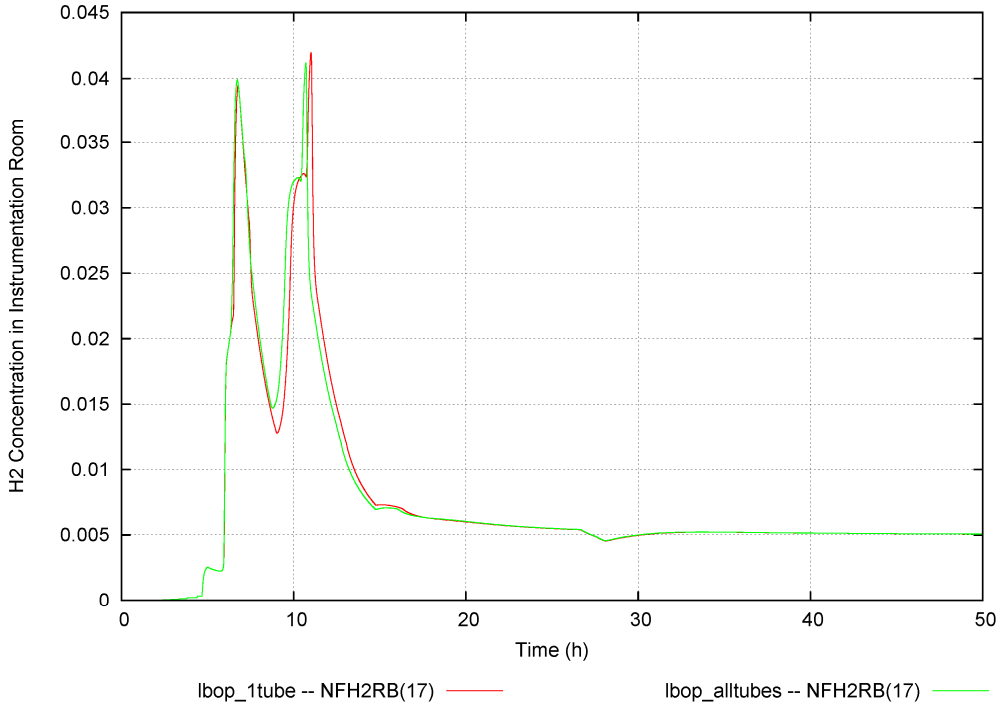


Figure 19-244-4 – Hydrogen Concentration in Adjacent Compartments (lbop_1tube)

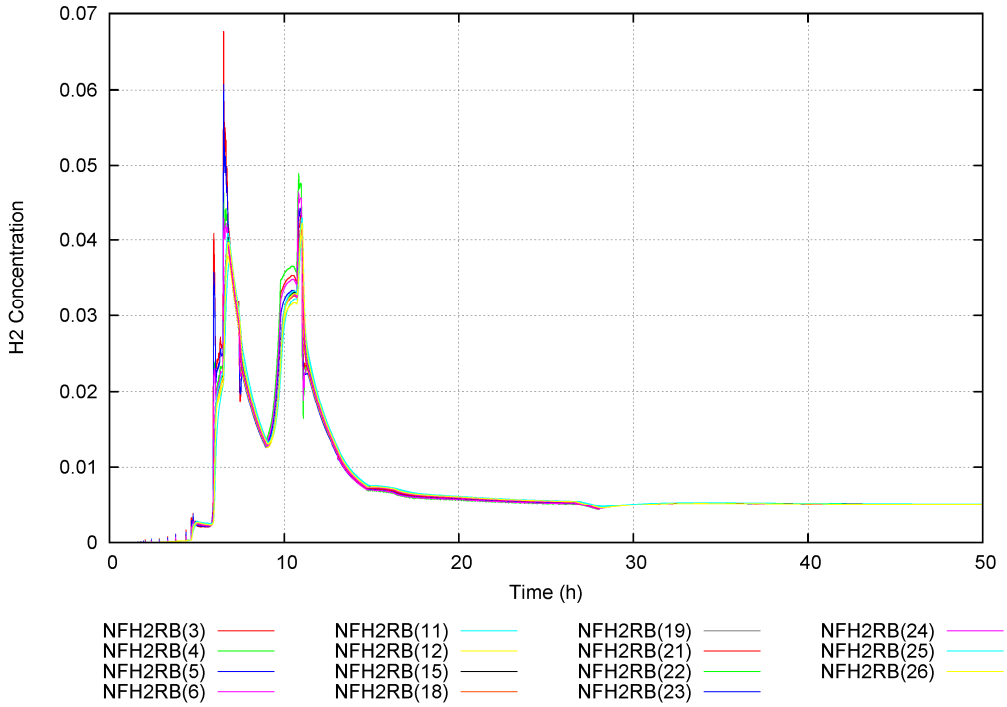


Figure 19-244-5 – Hydrogen Concentration in Adjacent Compartments (lbop_alltubes)

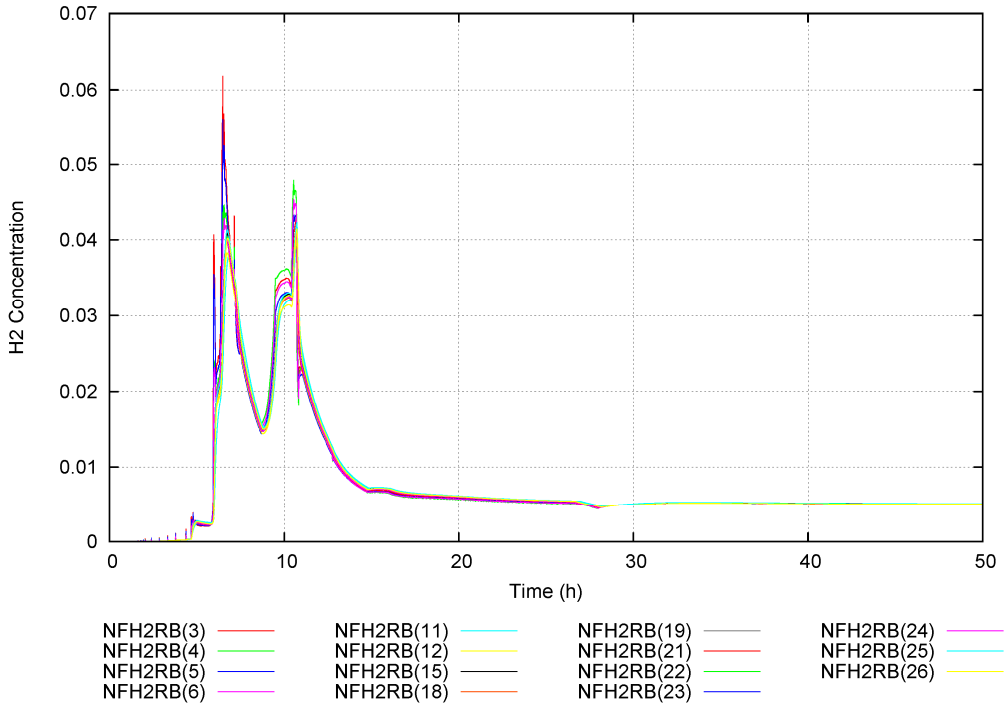


Figure 19-244-6 – Concentration of Steam in Containment (lbop)

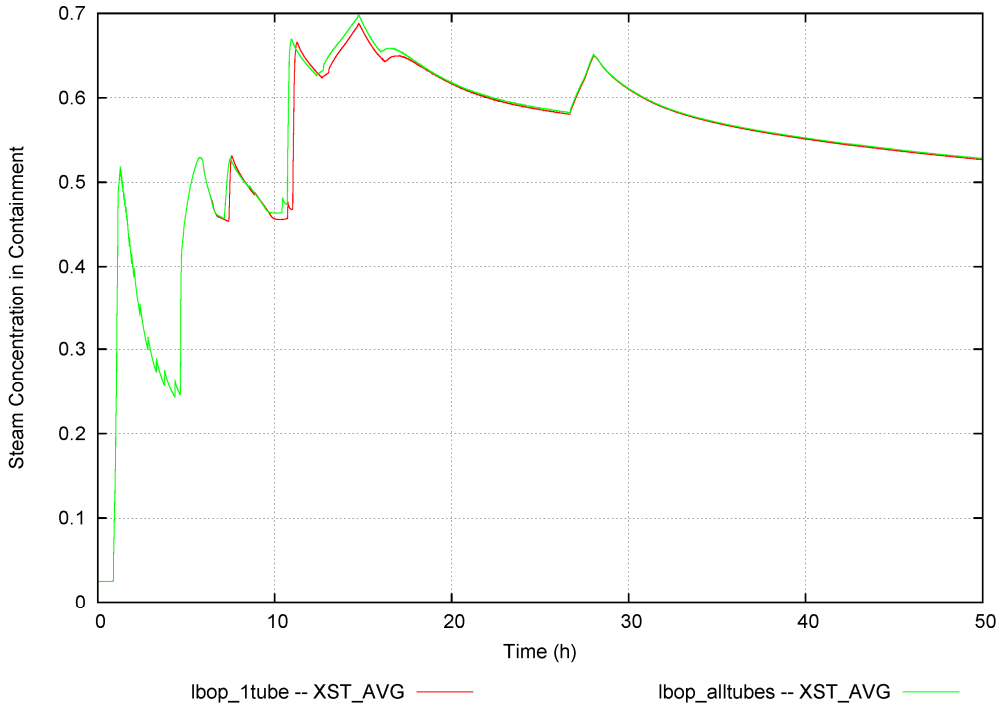


Figure 19-244-7 – Concentration of Oxygen in Containment (lbop)

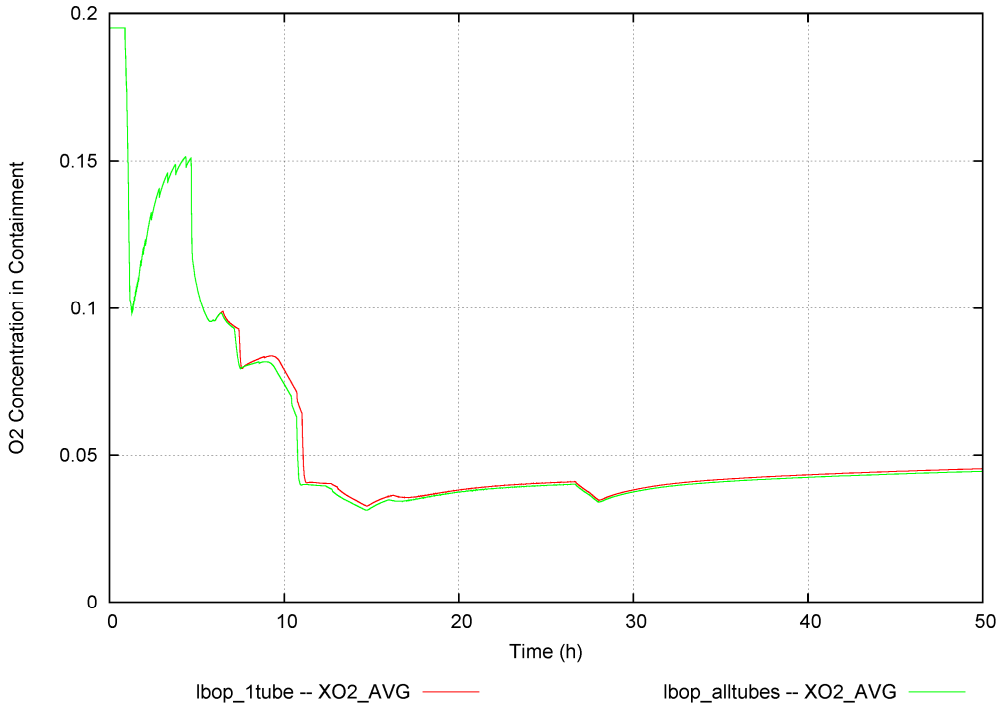


Figure 19-244-8 – Concentration of Nitrogen in Containment (Ibop)

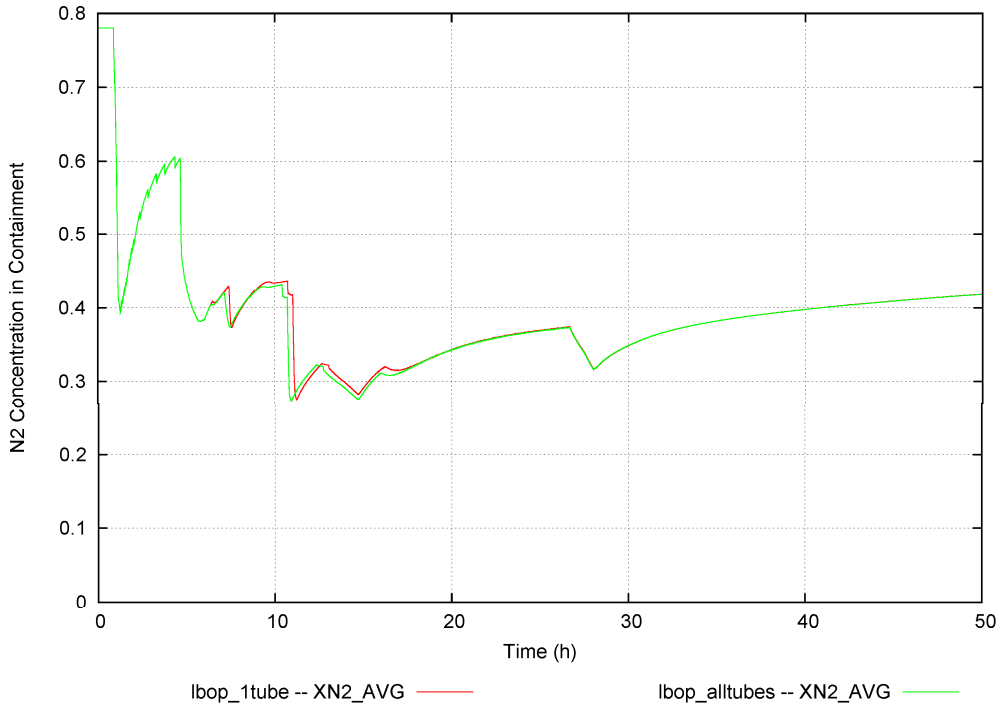


Figure 19-244-9 – CsI + RbI Mass in Containment (Ibop)

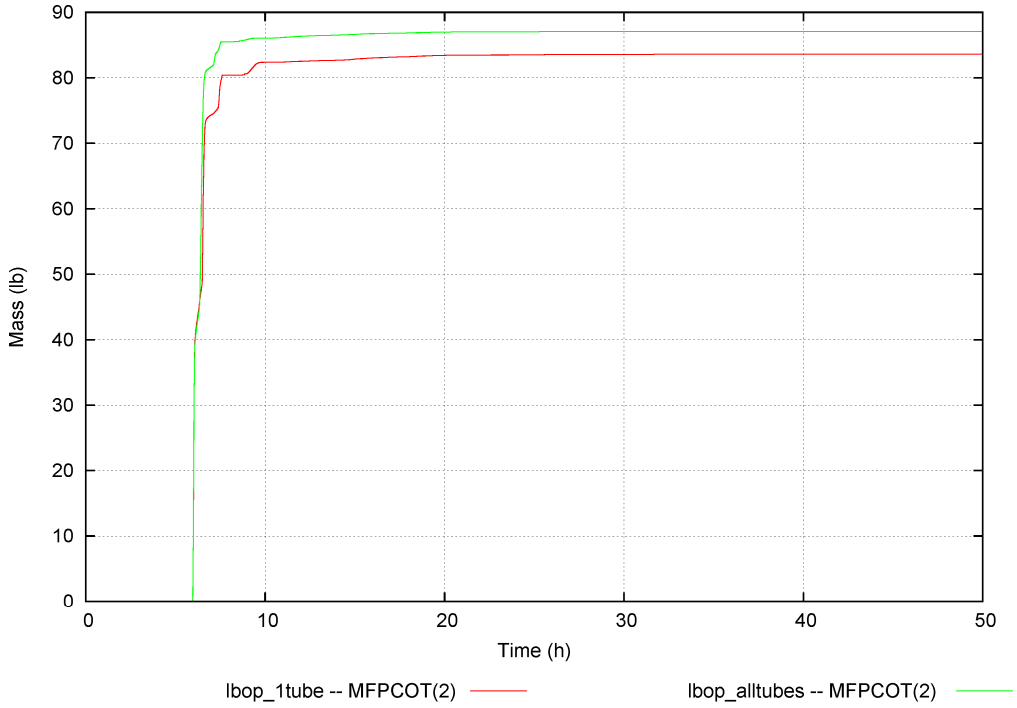


Figure 19-244-10 – SrO Mass in Containment (lbop)

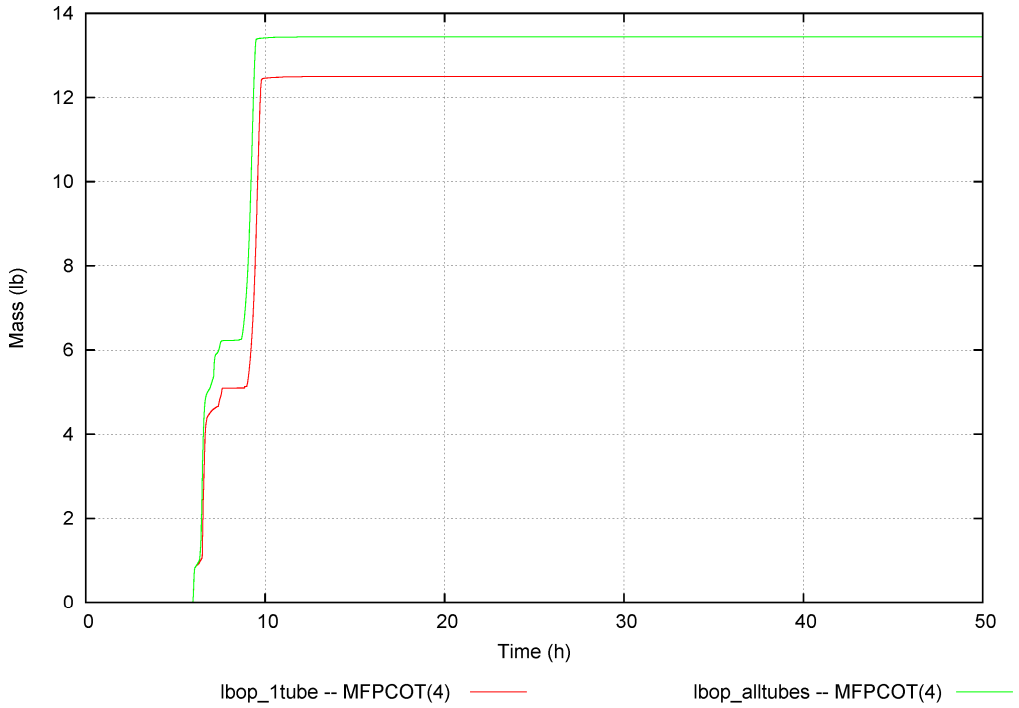


Figure 19-244-11 – CsOH + RbOH Mass in Containment (lbop)

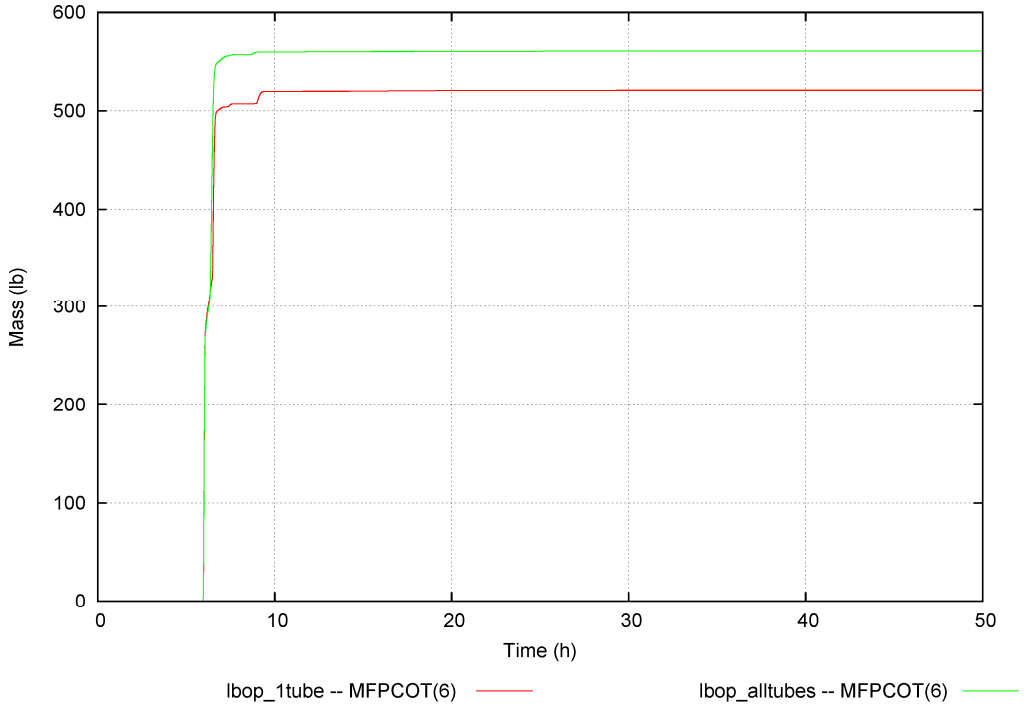


Figure 19-244-12 – Containment and AICC Pressures (lbop_1tube)

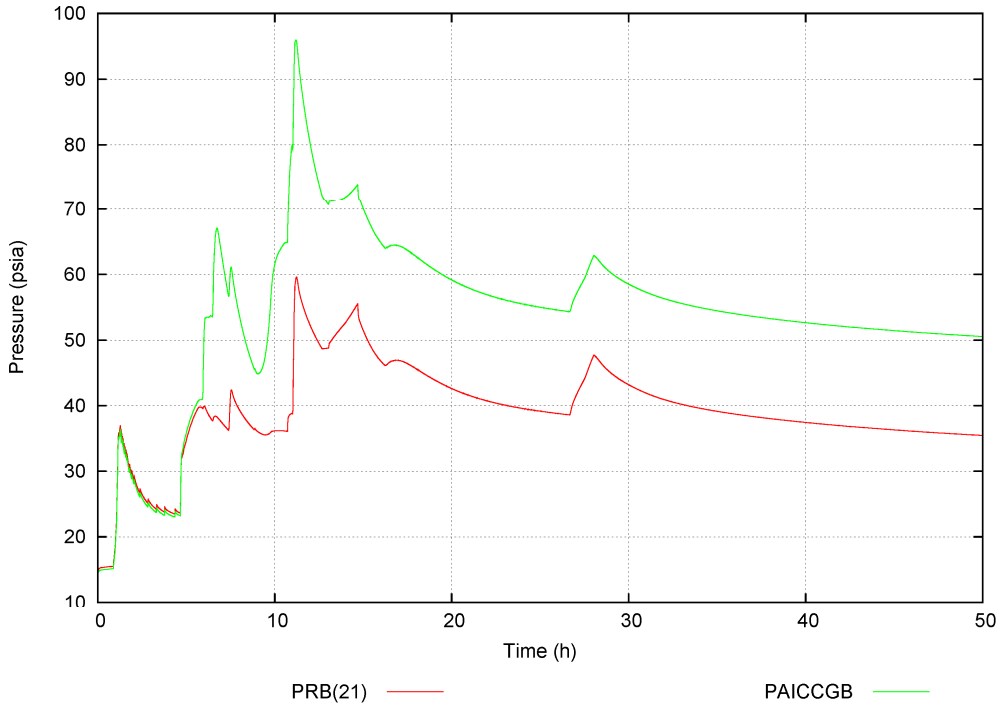


Figure 19-244-13 – Containment and AICC Pressures (lbop_alltubes)

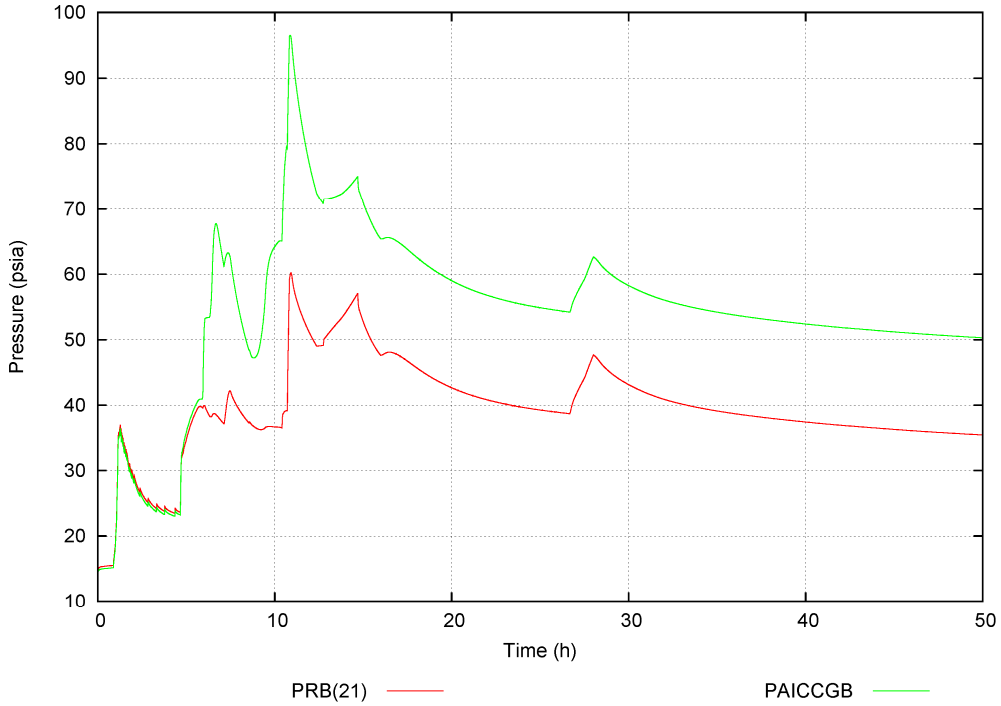


Figure 19-244-14 – Primary System Pressure

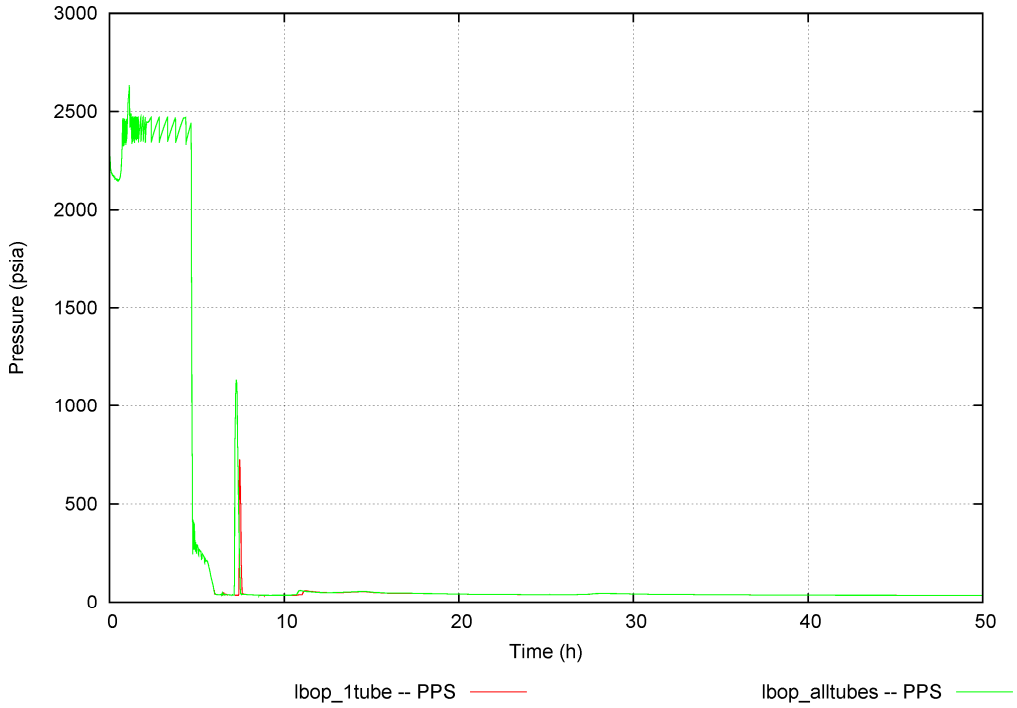


Figure 19-244-15 – Containment Temperature

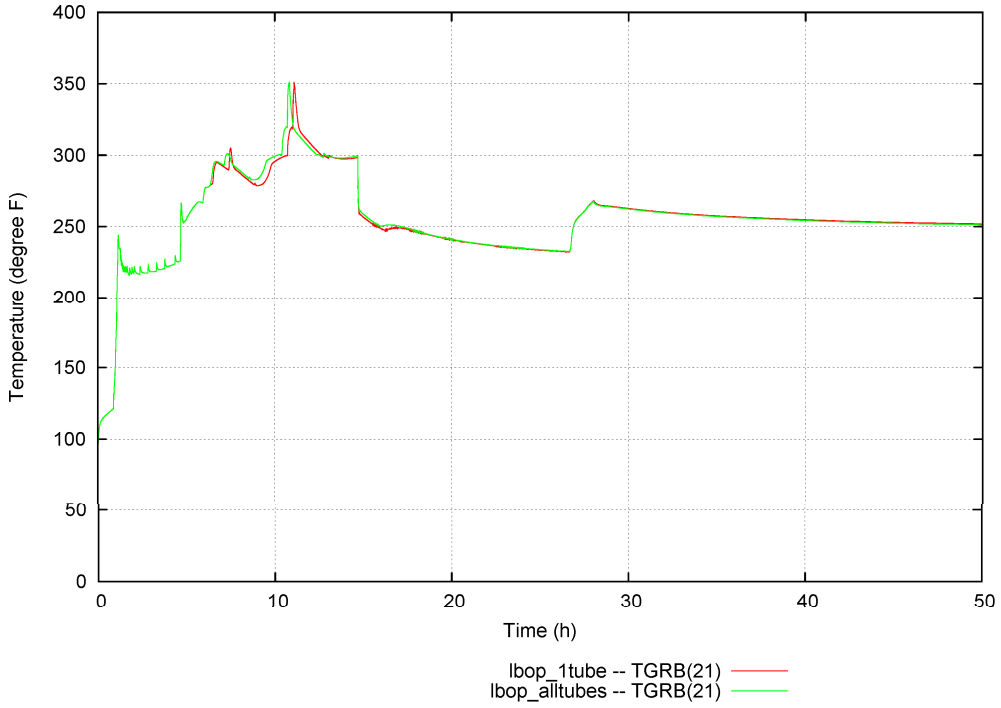
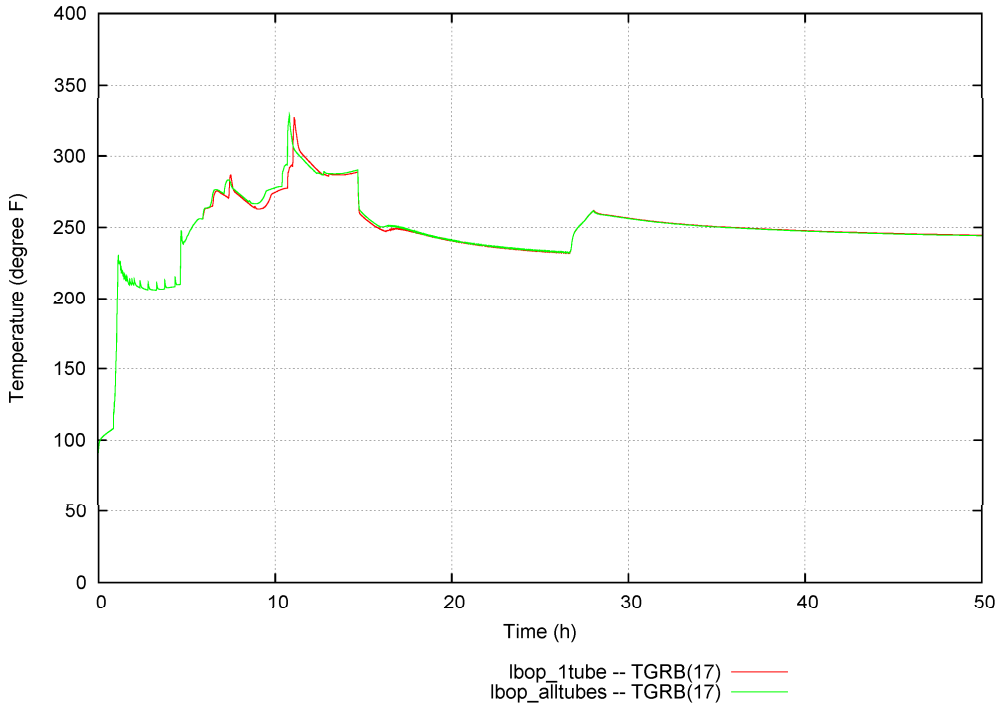


Figure 19-244-16 – Instrumentation Room Temperature



LOOP PL

Figures 19-244-17 and 19-244-18 plot the concentration of hydrogen in containment and concentration of hydrogen in the instrumentation room for the LOOP PL case simulating the failure of one AMS probe *(loop_pl_1tube)* and LBOP case simulating the failure of all AMS probes *(loop_pl_alltubes)*. Figures 19-244-19 and 19-244-20 plot the concentration of hydrogen in the adjacent compartments for the failure of one AMS probe *(loop_pl_1tube)* and failure of all AMS probes *(loop_pl_alltubes)*. The global hydrogen concentration is below the 10 CFR 50.44 limit of 10 percent as shown in Figure 19-244-17.

Figures 19-244-21 to 19-244-31 plot the concentration of steam, oxygen, nitrogen in containment, fractions of fission products in containment (CsI + RbI, SrO, CsOH + RbOH), containment and AICC pressures, primary system pressure, containment temperature, and instrumentation room temperature for the failure of one AMS probe *(loop_pl_1tube)* and failure of all AMS probes *(loop_pl_alltubes)*.

Figure 19-244-17 – Concentration of Hydrogen in Containment (loop_pl)

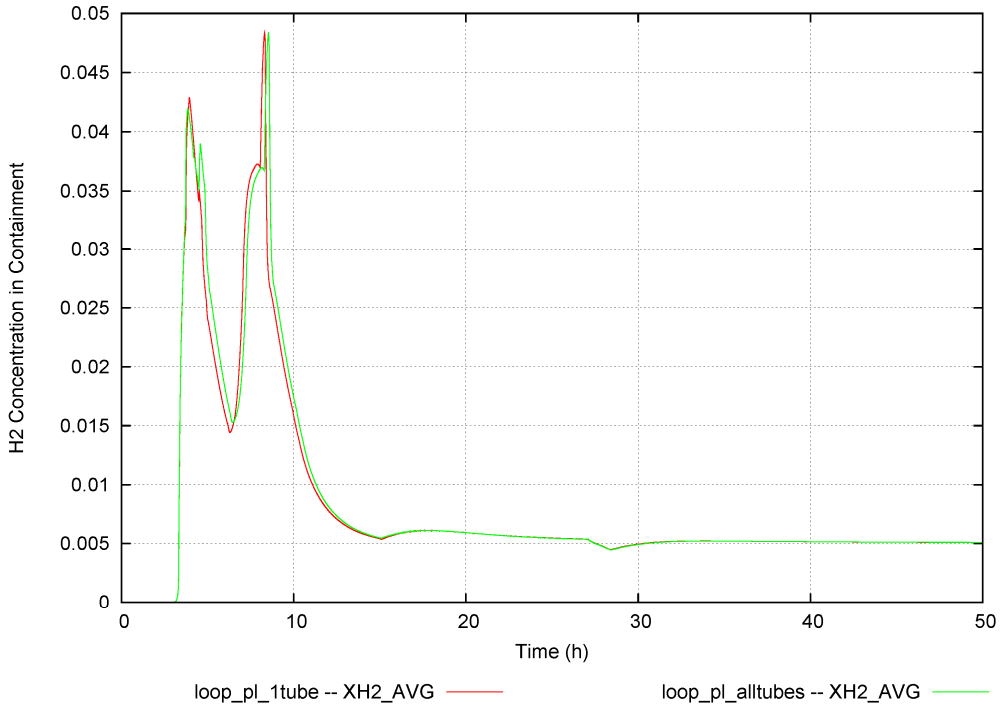


Figure 19-244-18 – Concentration of Hydrogen in Instrumentation Room (loop_pl)

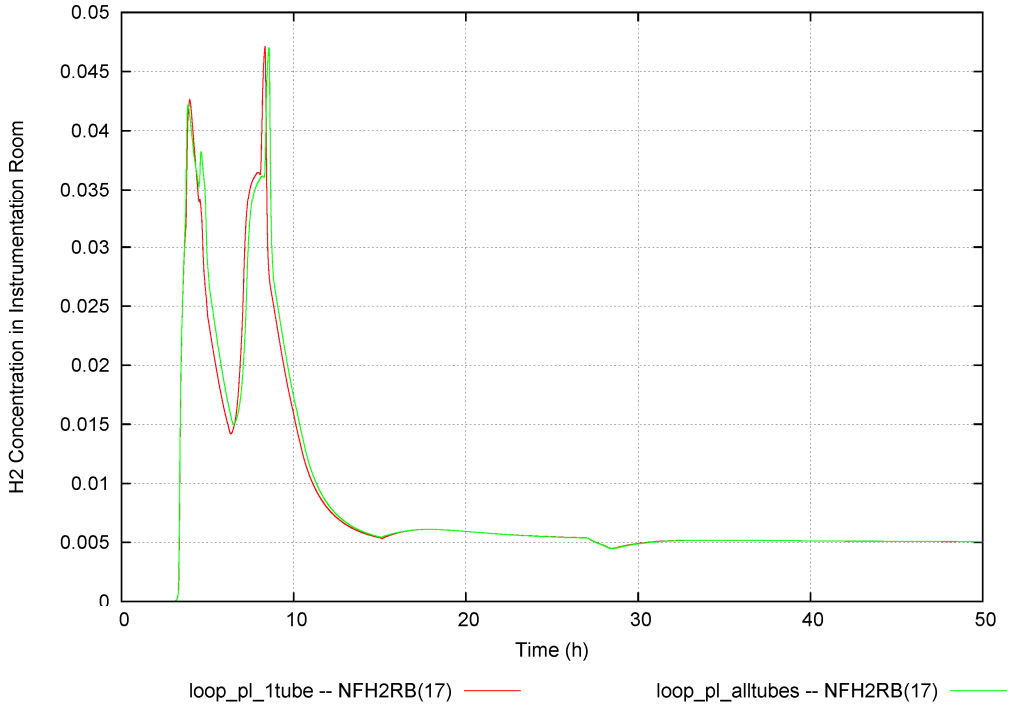


Figure 19-244-19 – Hydrogen Concentration in Adjacent Compartments (loop_pl_1tube)

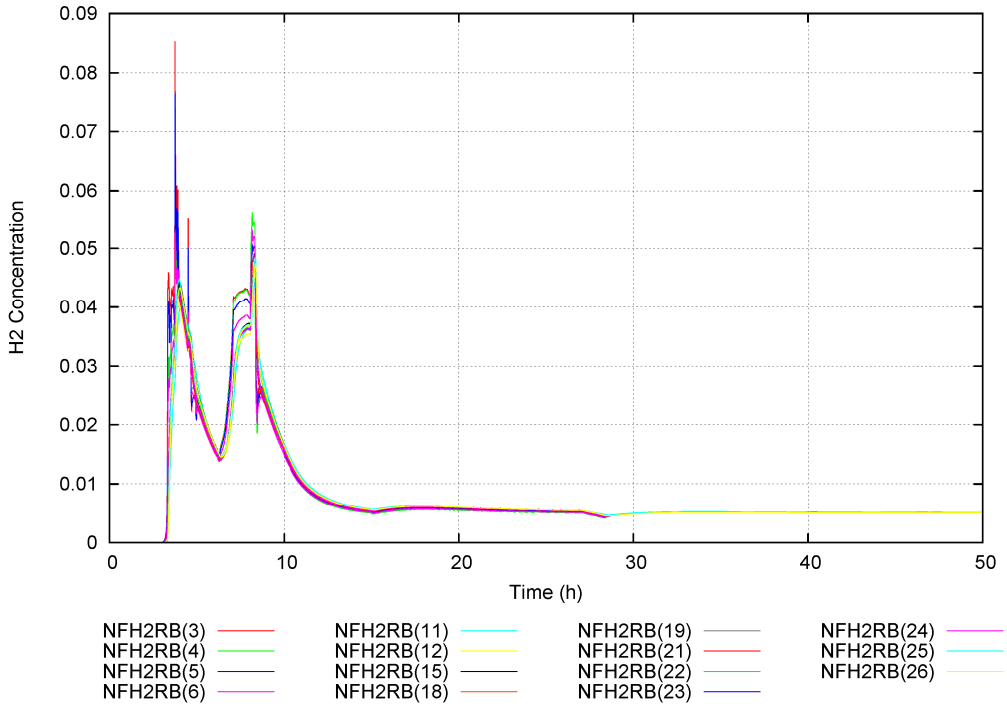


Figure 19-244-20 – Hydrogen Concentration in Adjacent Compartments (loop_pl_alltubes)

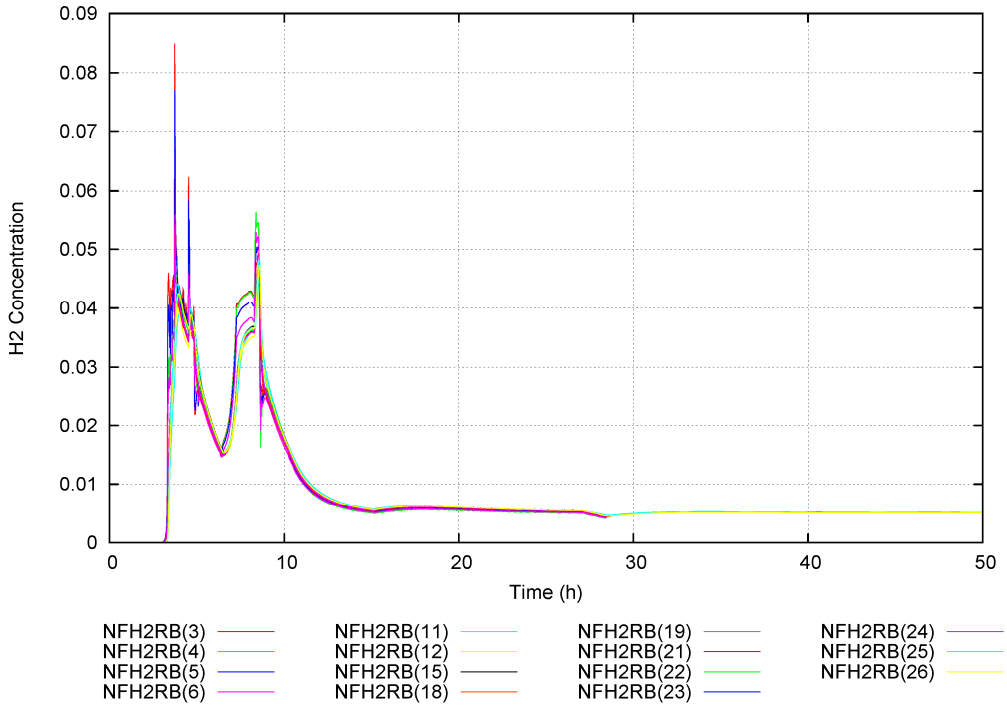


Figure 19-244-21 – Concentration of Steam in Containment (loop_pl)

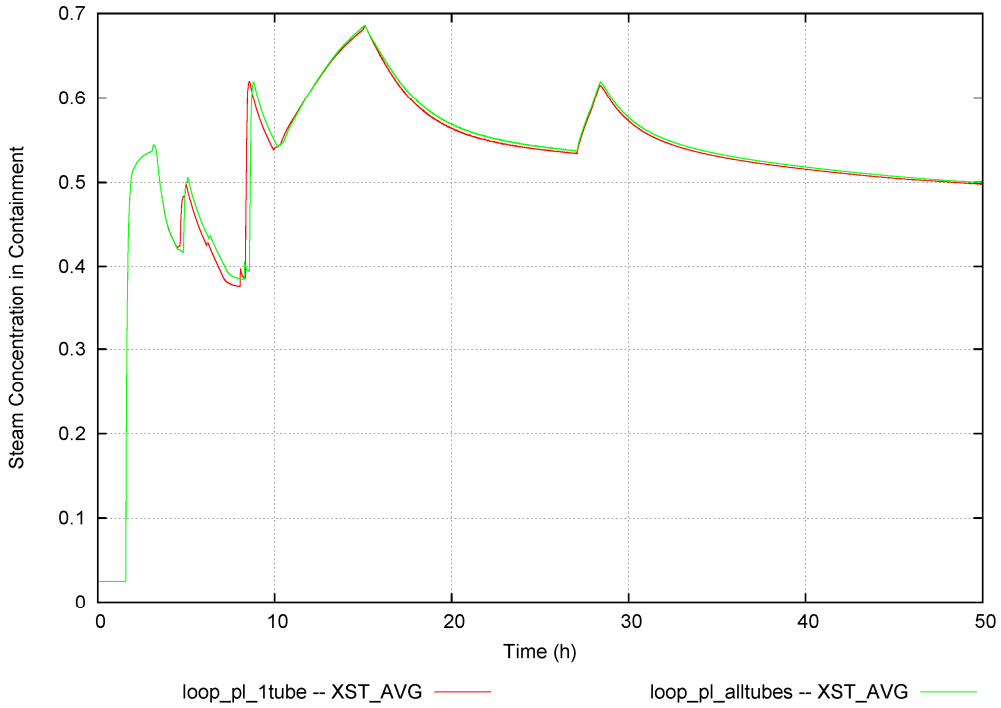


Figure 19-244-22 – Concentration of Oxygen in Containment (loop_pl)

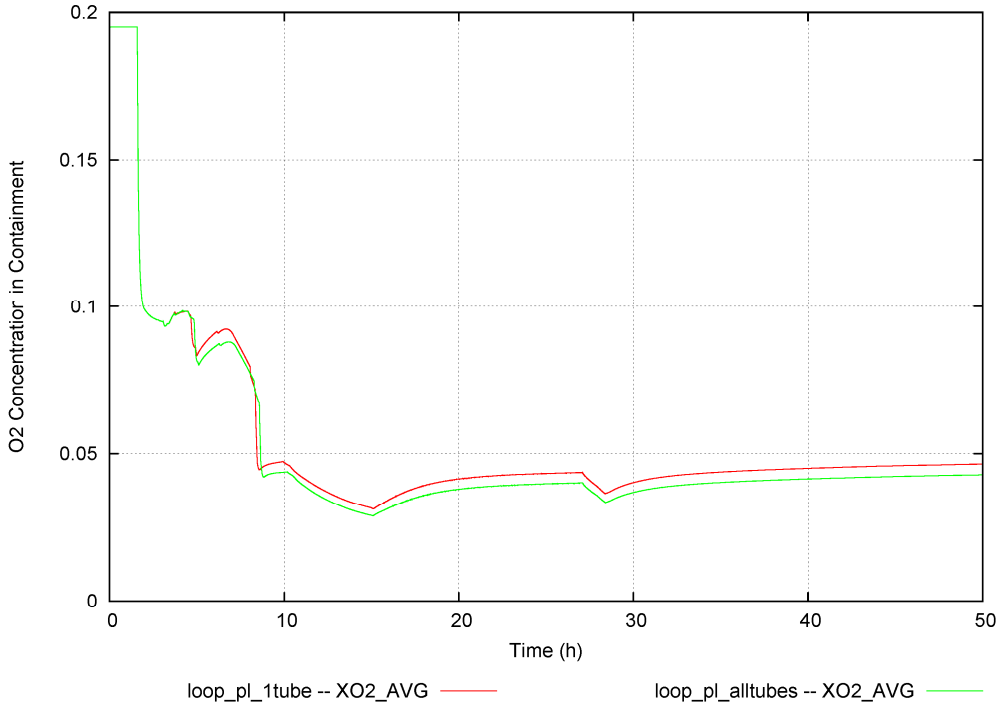


Figure 19-244-23 – Concentration of Nitrogen in Containment (loop_pl)

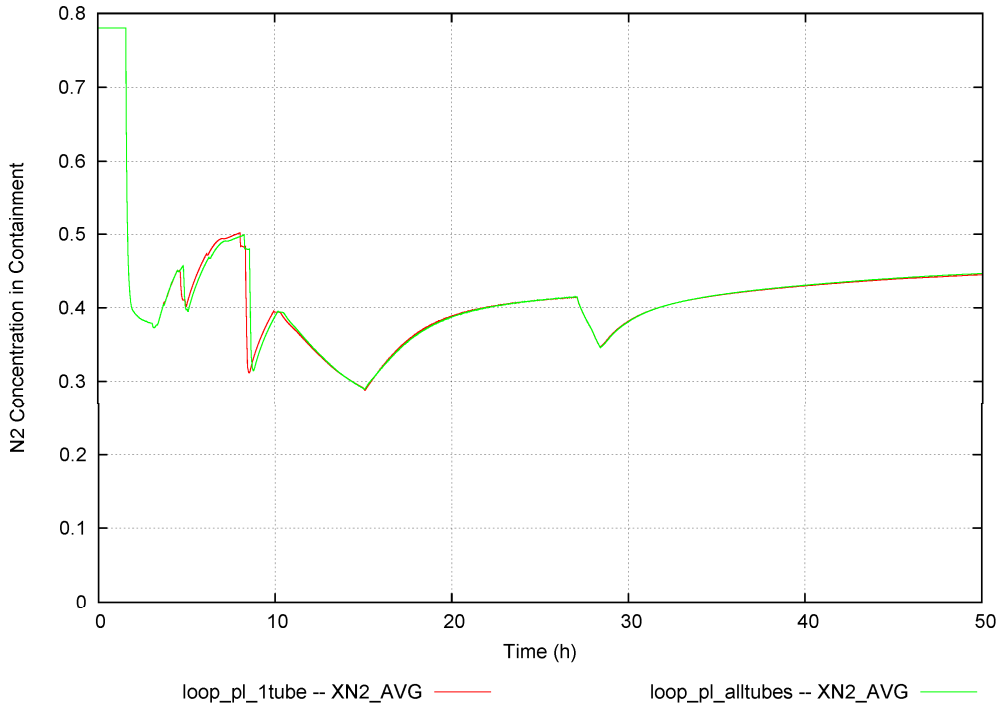


Figure 19-244-24 – CsI + RbI Mass in Containment (loop_pl)

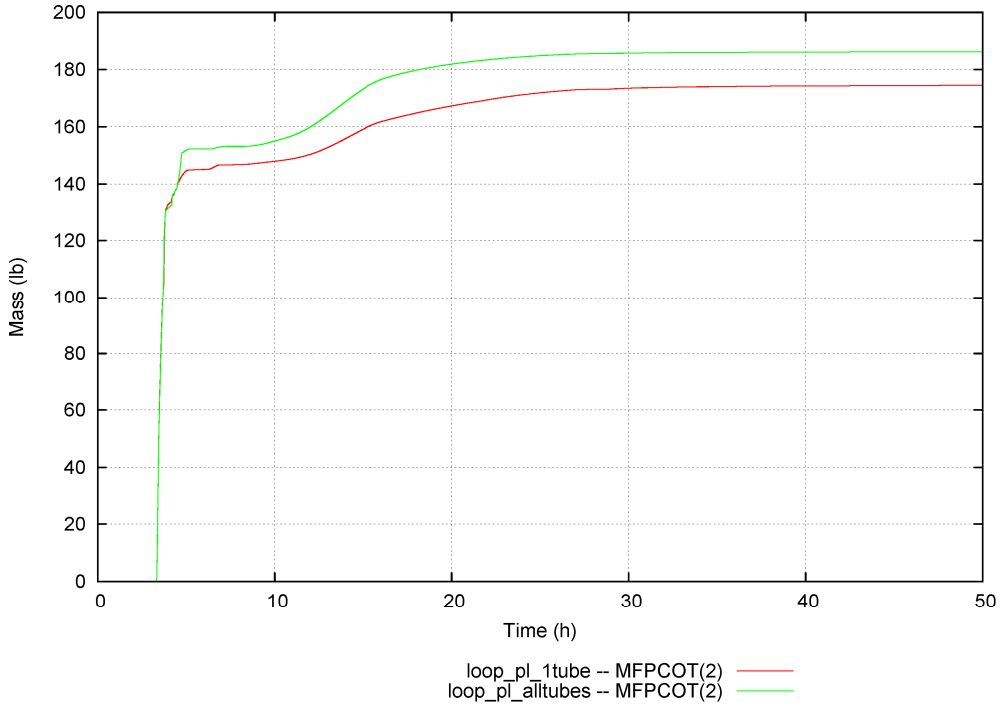


Figure 19-244-25 – SrO Mass in Containment (loop_pl)

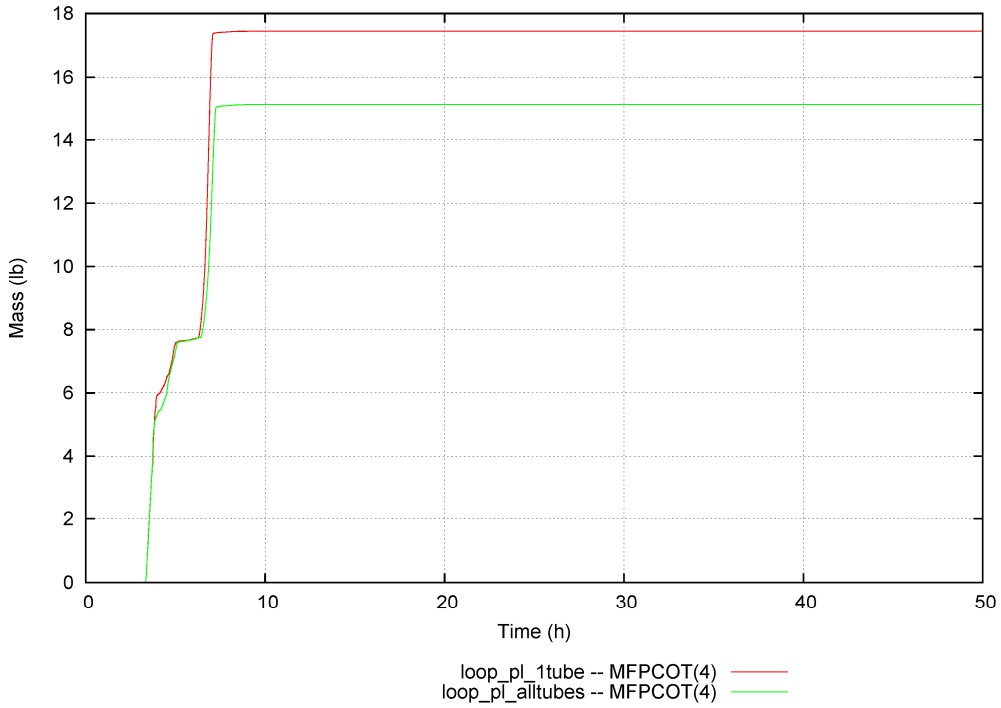
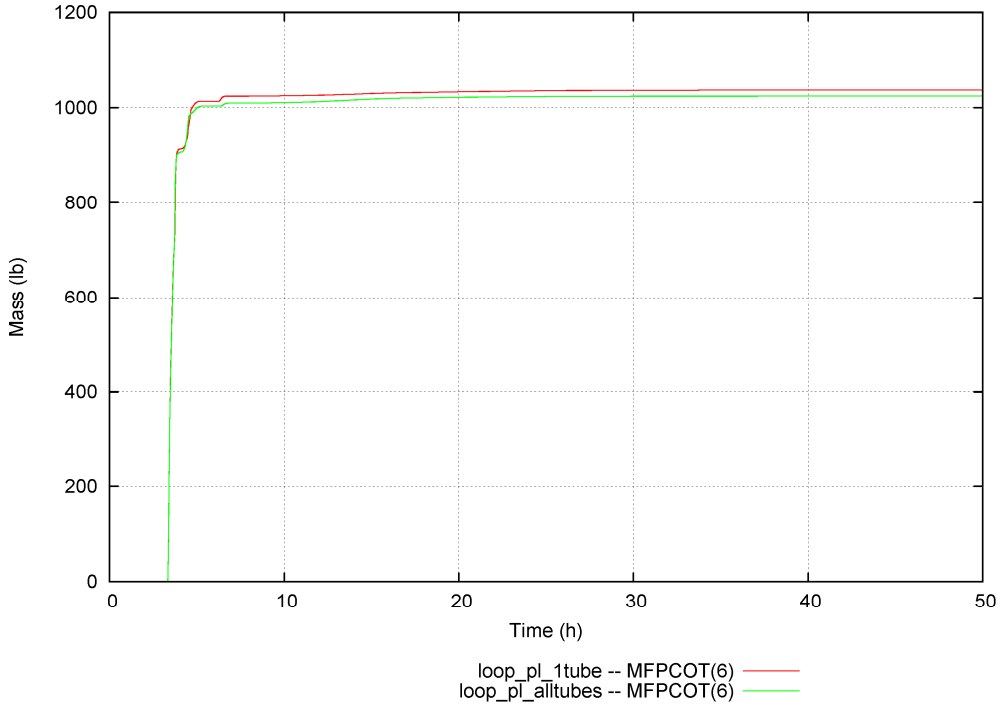


Figure 19-244-26 – CsOH + RbOH Mass in Containment (loop_pl)



19-244-27 – Containment and AICC Pressures (loop_pl_1tube)

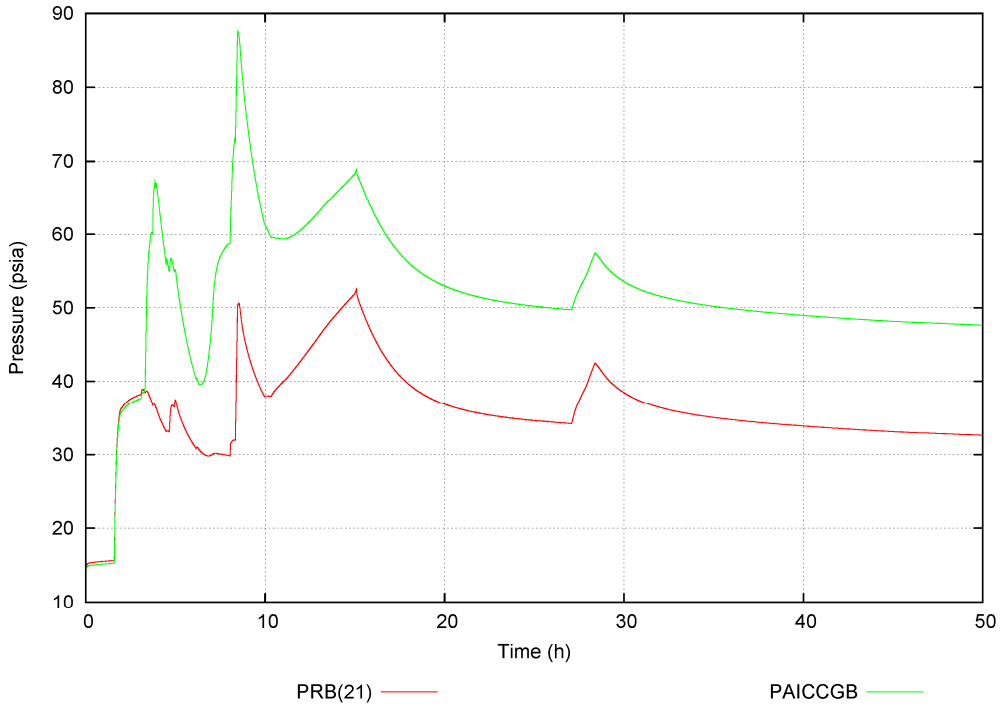


Figure 19-244-28 – Containment and AICC Pressures (loop_pl_alltubes)

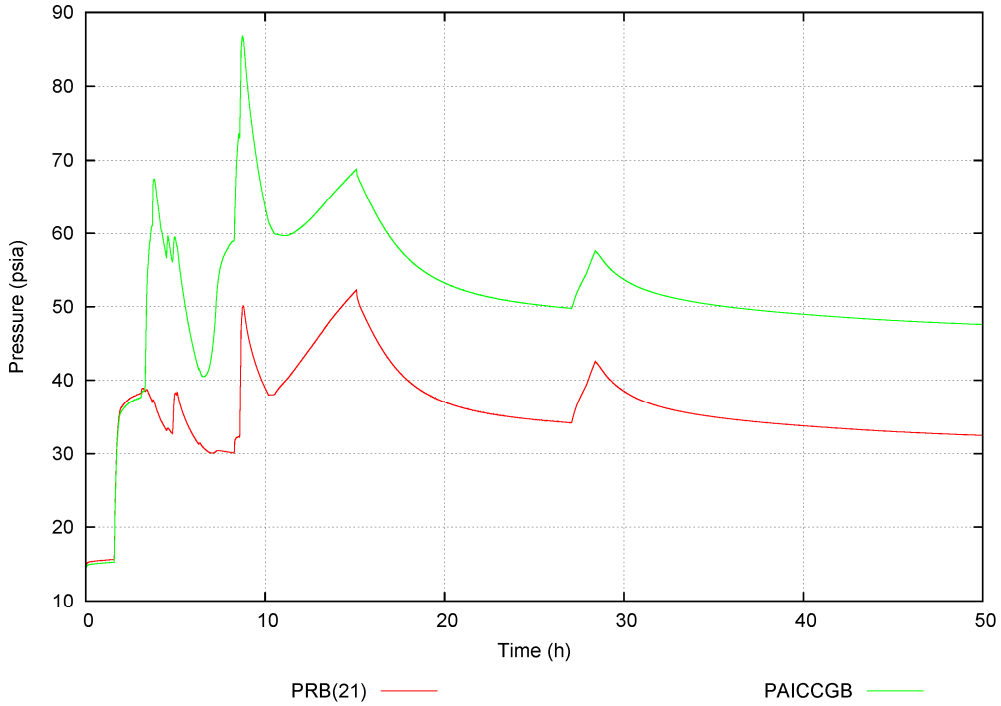


Figure 19-244-29 – Primary System Pressure (loop_pl)

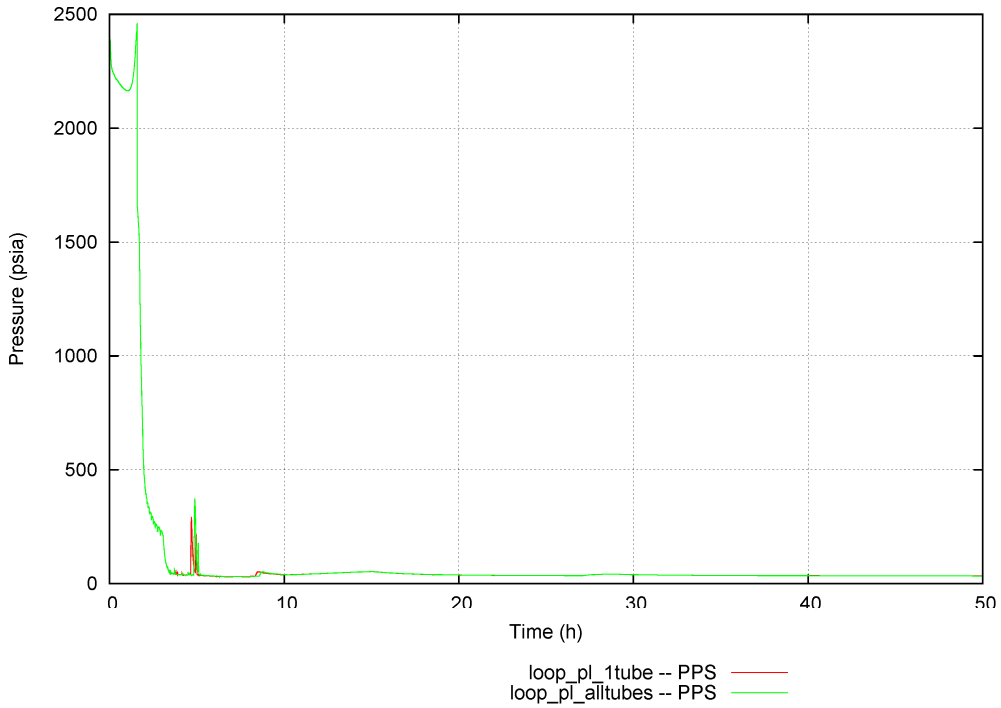


Figure 19-244-30 – Containment Temperature

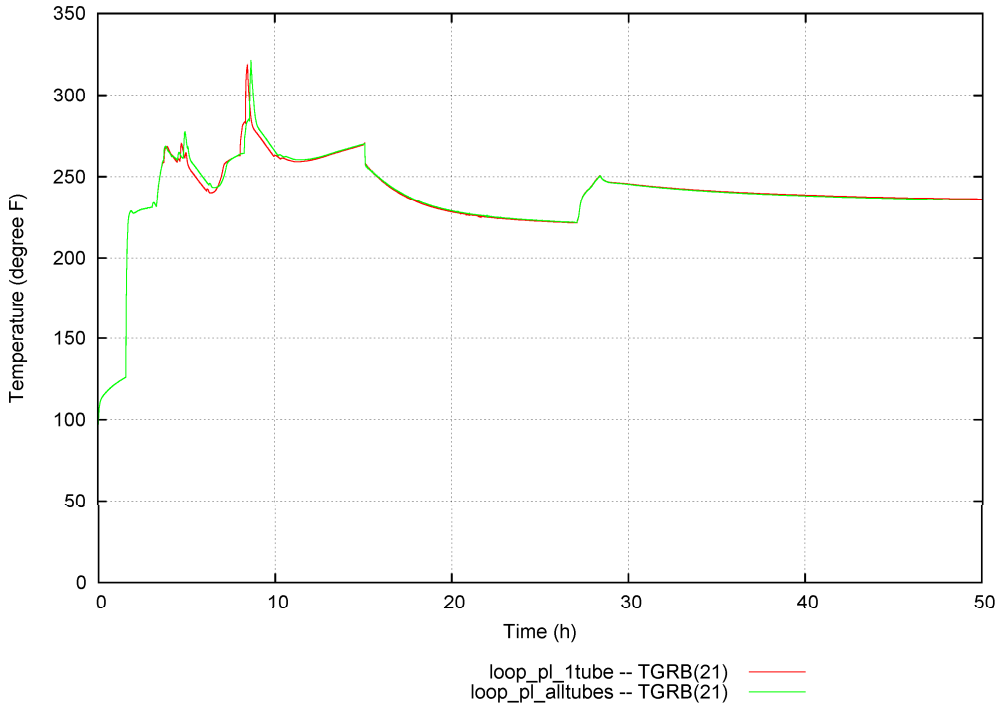
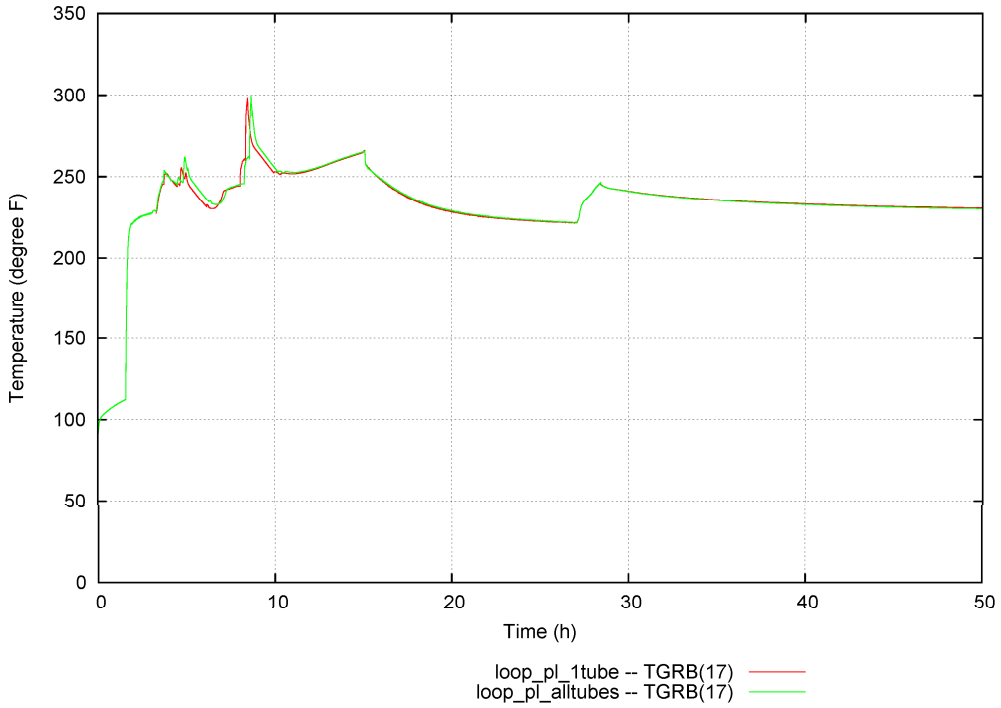


Figure 19-244-31 – Instrumentation Room Temperature



LOOP SS

Figures 19-244-32 and 19-244-33 plot the concentration of hydrogen in containment and concentration of hydrogen in the instrumentation room for the LOOP SS case simulating the failure of one AMS probe *(loop_ss_1tube)* and LBOP case simulating the failure of all AMS probes *(loop_ss_alltubes)*. Figures 19-244-34 and 19-244-35 plot the concentration of hydrogen in the adjacent compartments for the failure of one AMS probe *(loop_ss_1tube)* and failure of all AMS probes *(loop_ss_alltubes)*. The global hydrogen concentration is below the 10 CFR 50.44 limit of 10 percent as shown in Figure 19-244-32.

Figures 19-244-36 to 19-244-46 plot the concentration of steam, oxygen, nitrogen in containment, fractions of fission products in containment (CsI + RbI, SrO, CsOH + RbOH), containment and AICC pressures, primary system pressure, containment temperature, and instrumentation room temperature for the failure of one AMS probe *(loop_ss_1tube)* and failure of all AMS probes *(loop_ss_alltubes)*.

Figure 19-244-32 – Concentration of Hydrogen in Containment (loop_ss)

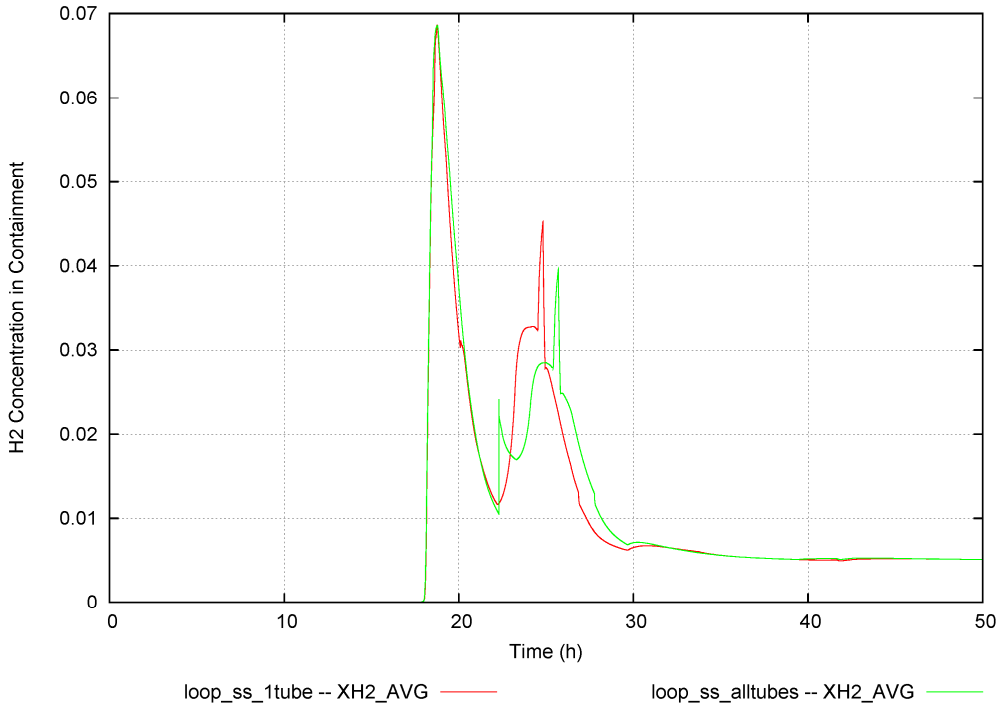


Figure 19-244-33 – Concentration of Hydrogen in Instrumentation Room (loop_ss)

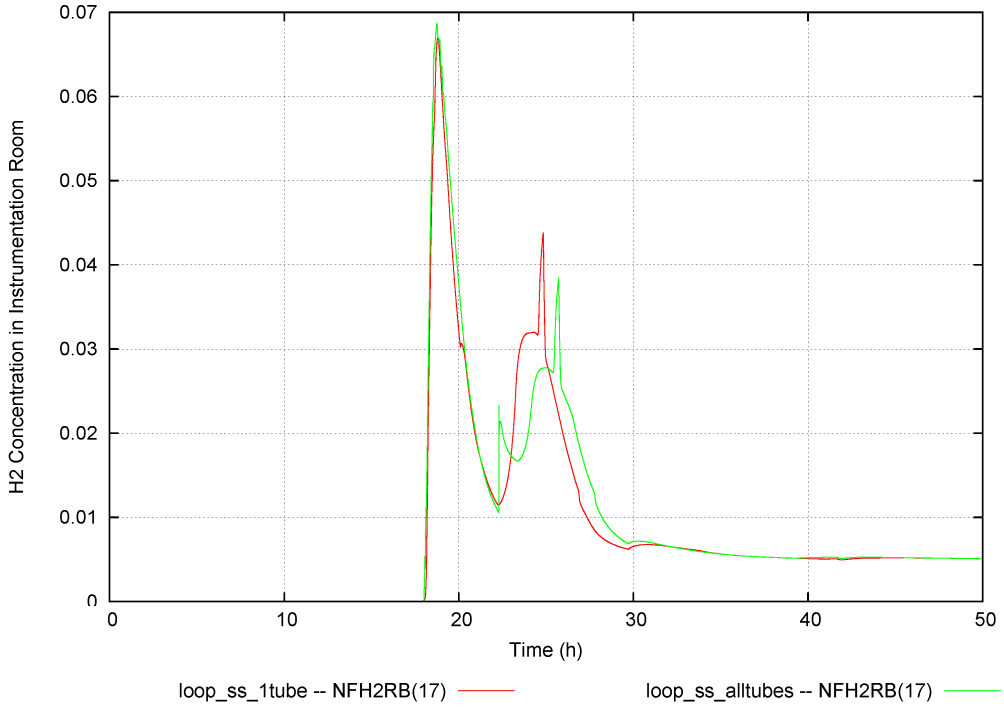


Figure 19-244-34 – Hydrogen Concentration in Adjacent Compartments (loop_ss_1tube)

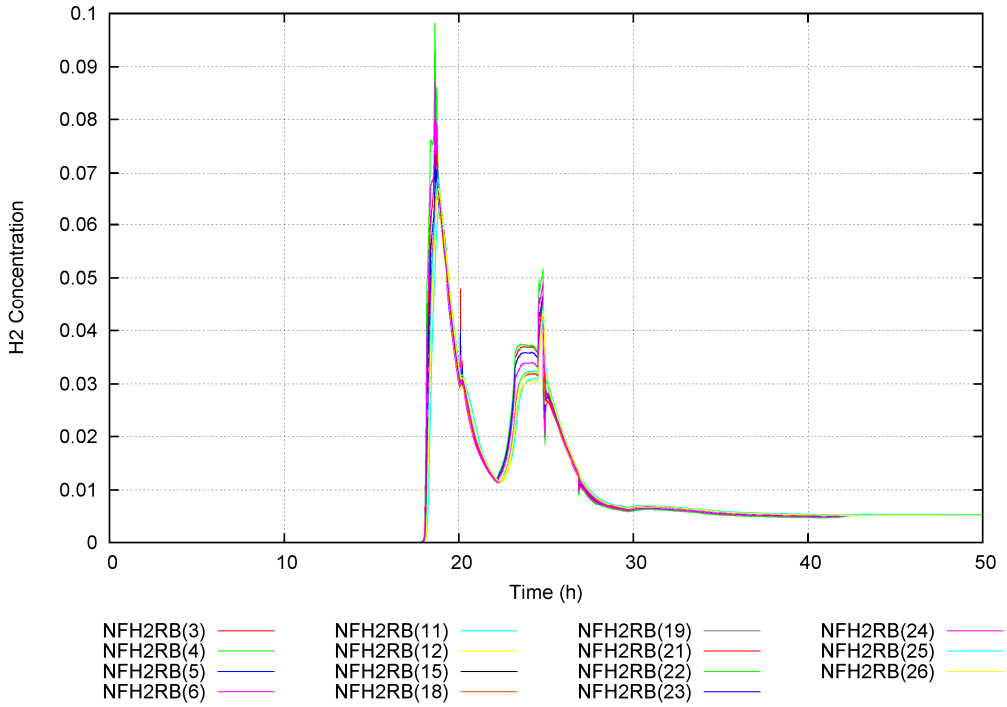


Figure 19-244-35 – Hydrogen Concentration in Adjacent Compartments (loop_ss_alltubes)

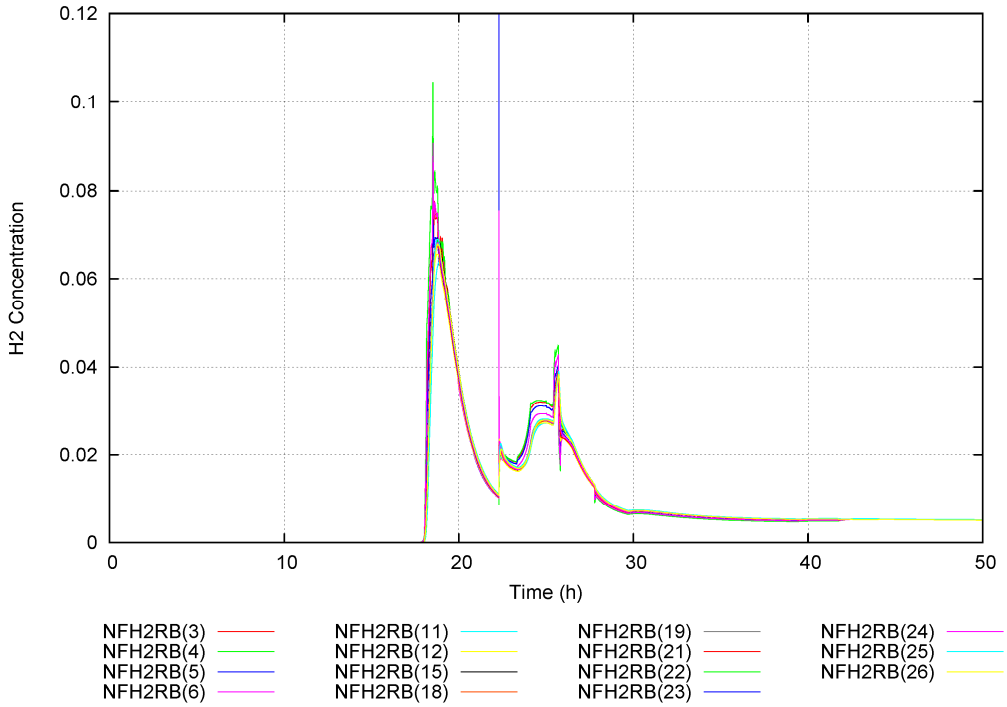


Figure 19-244-36 – Concentration of Steam in Containment (loop_ss)

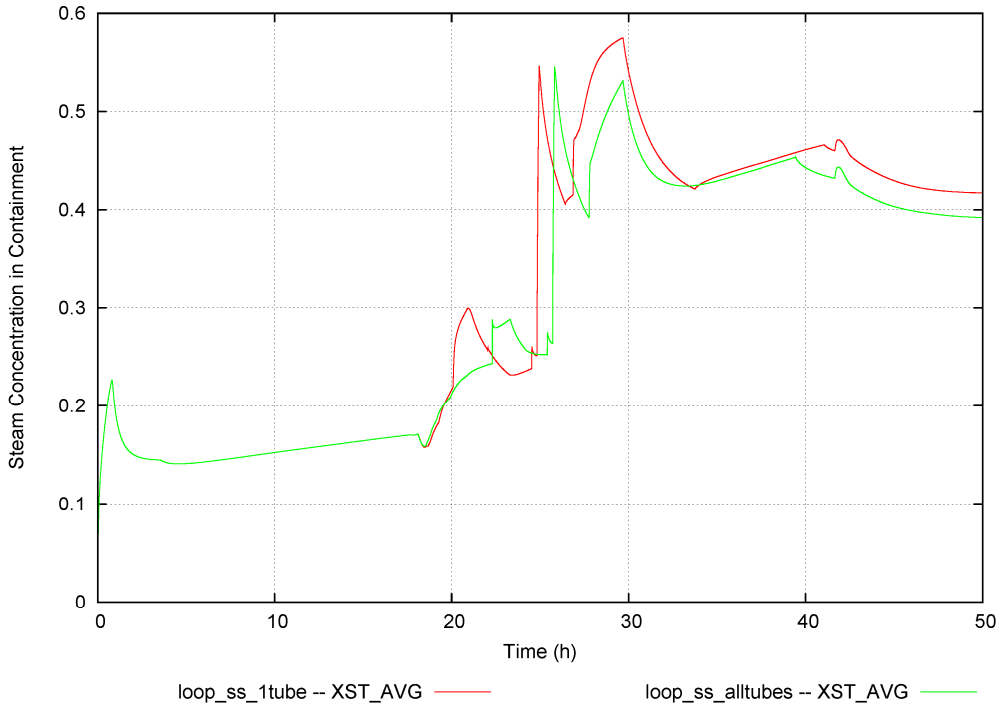


Figure 19-244-37 – Concentration of Oxygen in Containment (loop_ss)

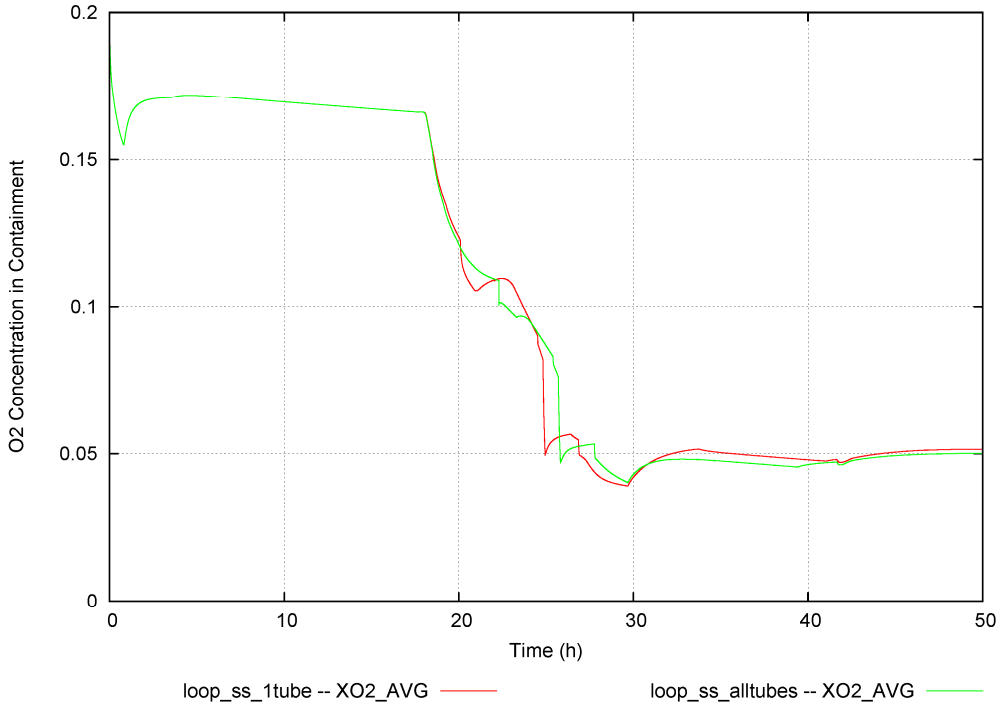


Figure 19-244-38 – Concentration of Nitrogen in Containment (loop_ss)

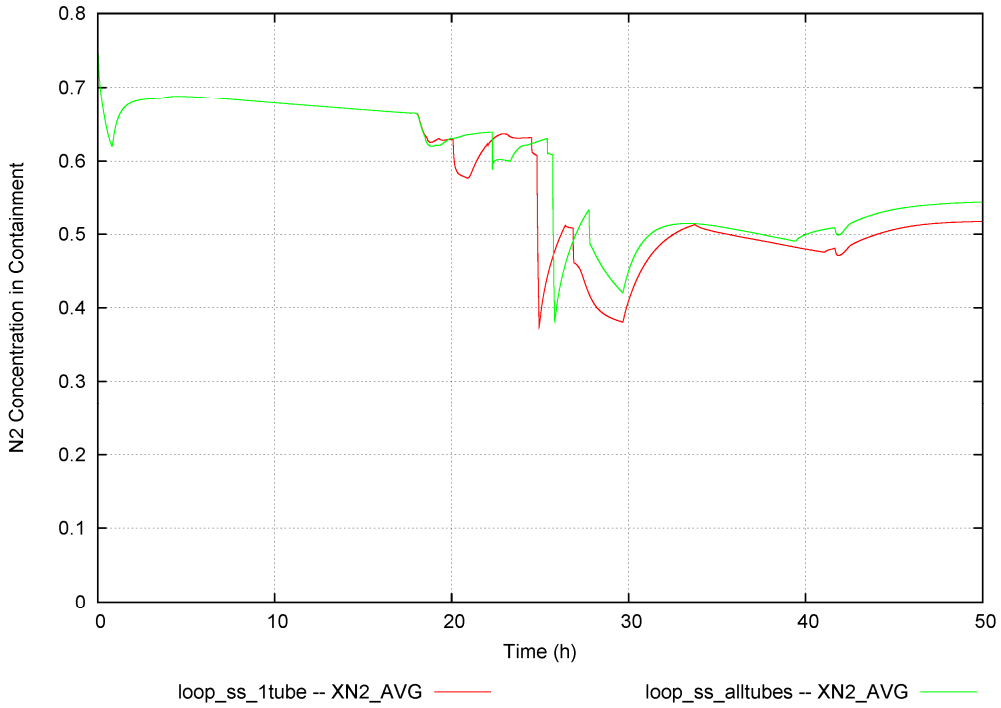


Figure 19-244-39 – CsI + RbI Mass in Containment (loop_ss)

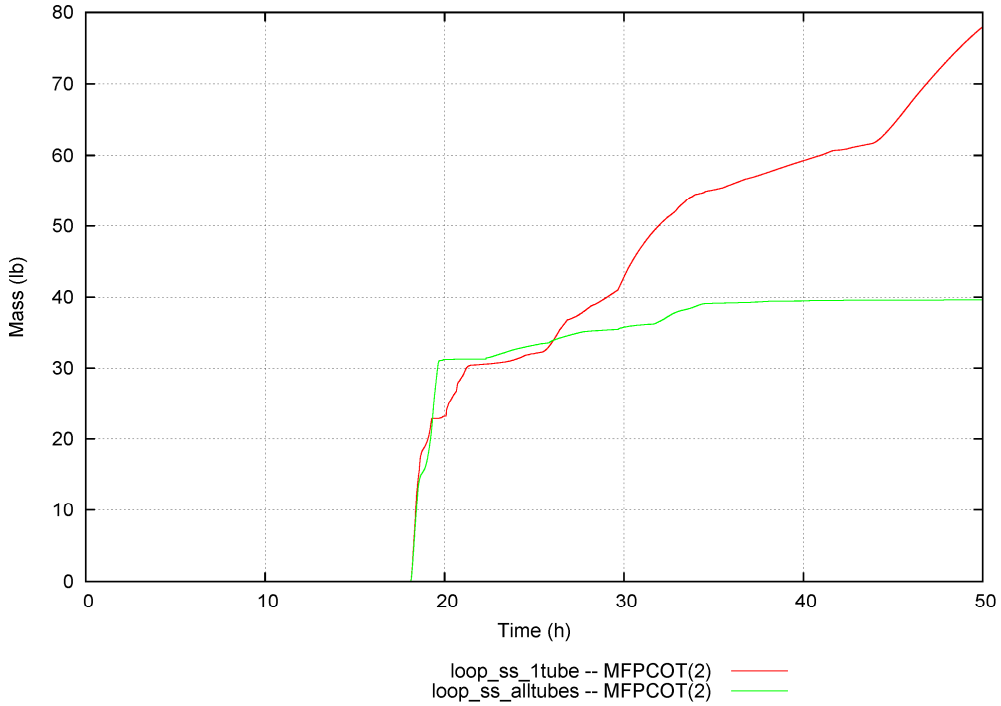


Figure 19-244-40 – SrO Mass in Containment (loop_ss)

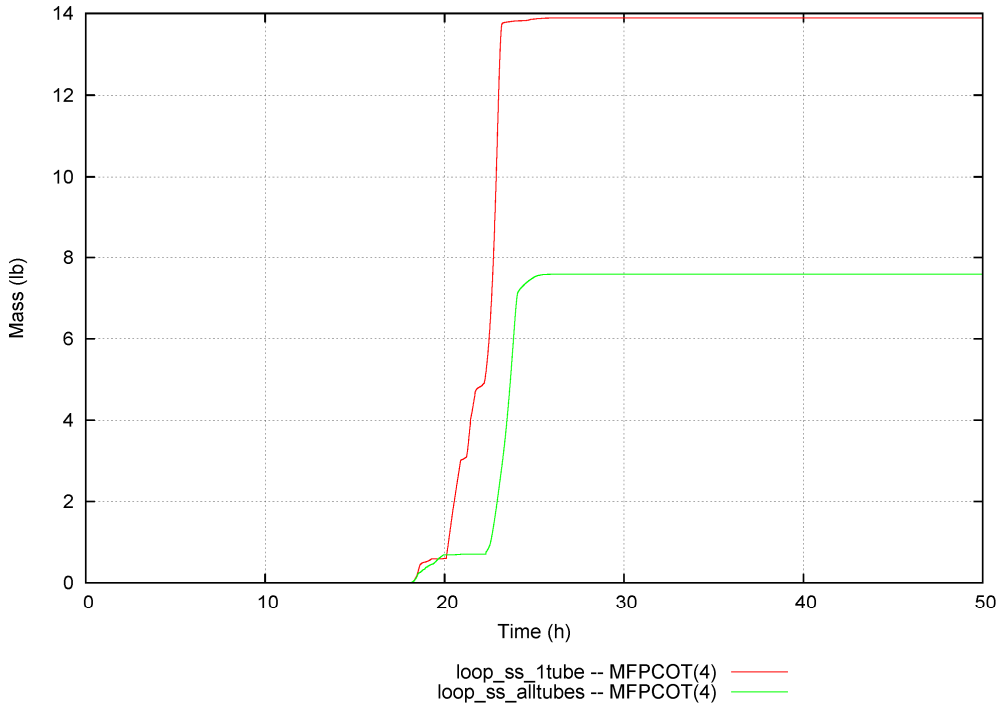


Figure 19-244-41 – CsOH + RbOH Mass in Containment (loop_ss)

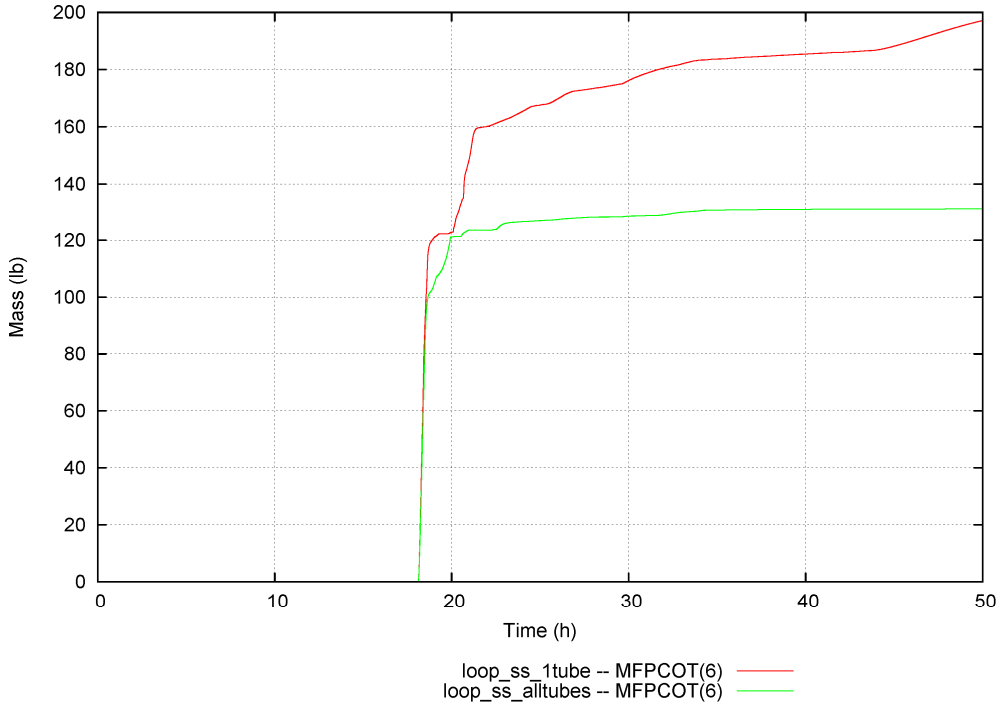


Figure 19-244-42 – Containment Pressure (loop_ss_1tube)

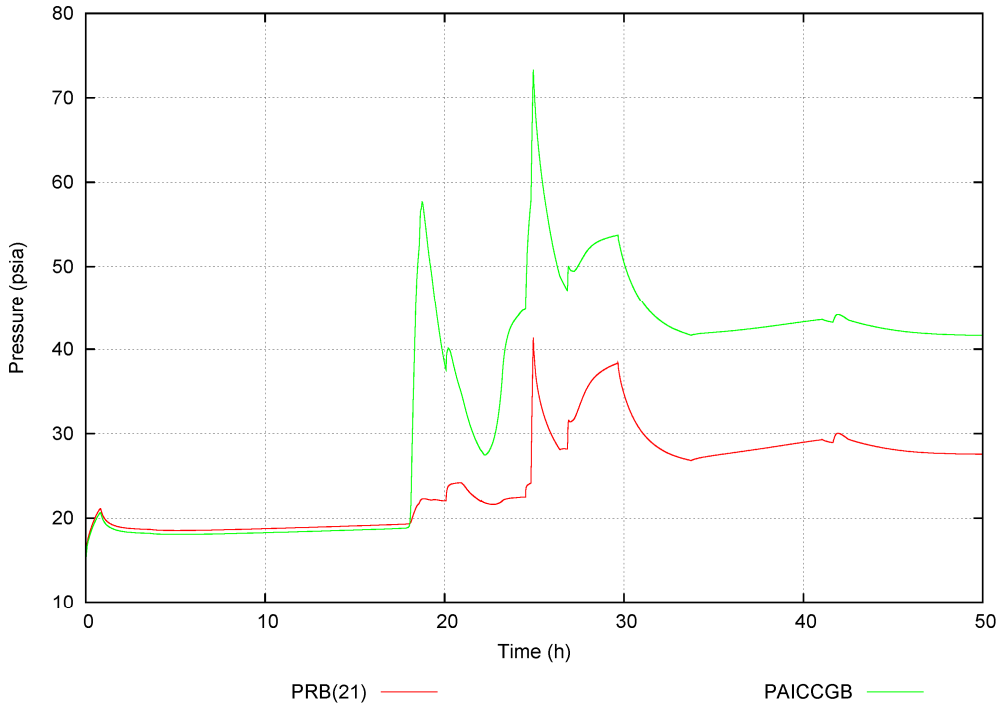


Figure 19-244-43 – Containment Pressure (loop_ss_alltubes)

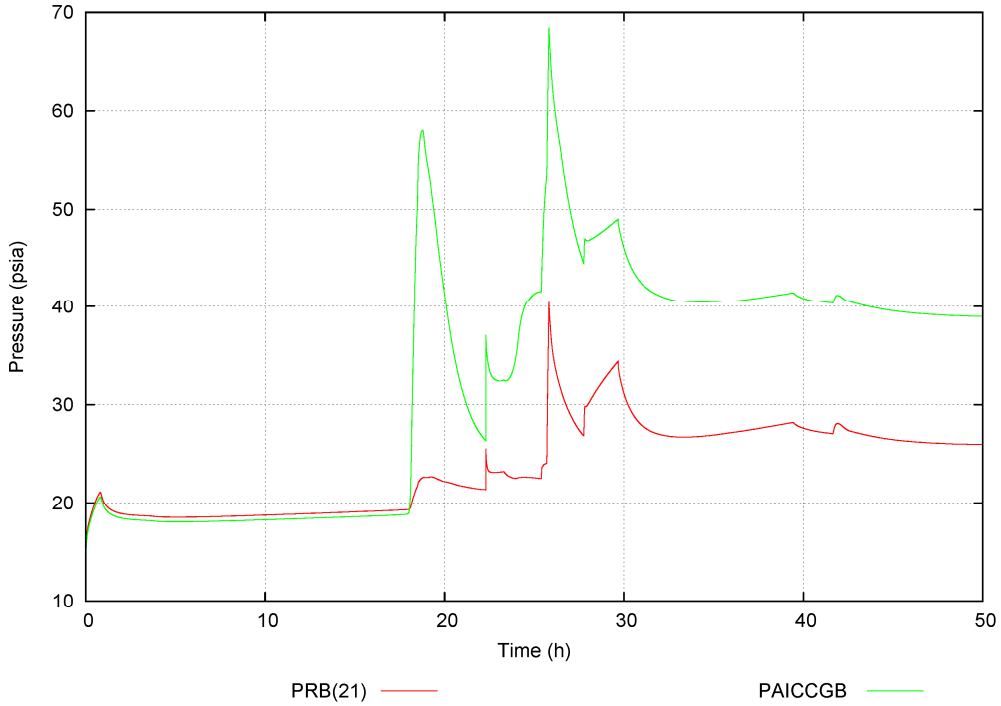


Figure 19-244-44 – Primary System Pressure (loop_ss)

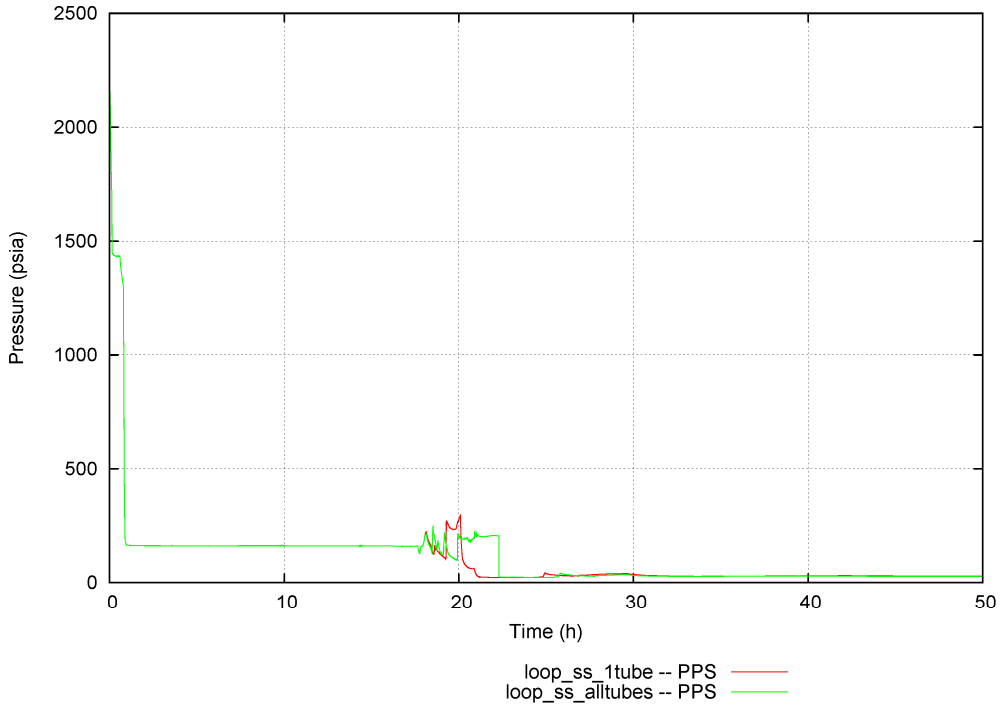


Figure 19-244-45 – Containment Temperature

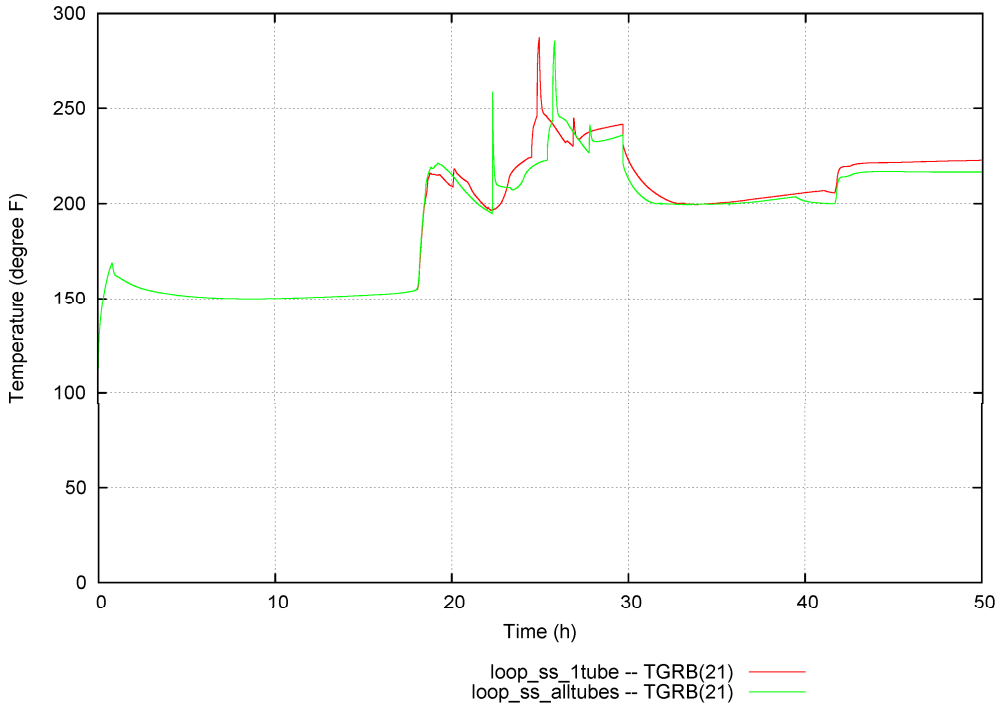
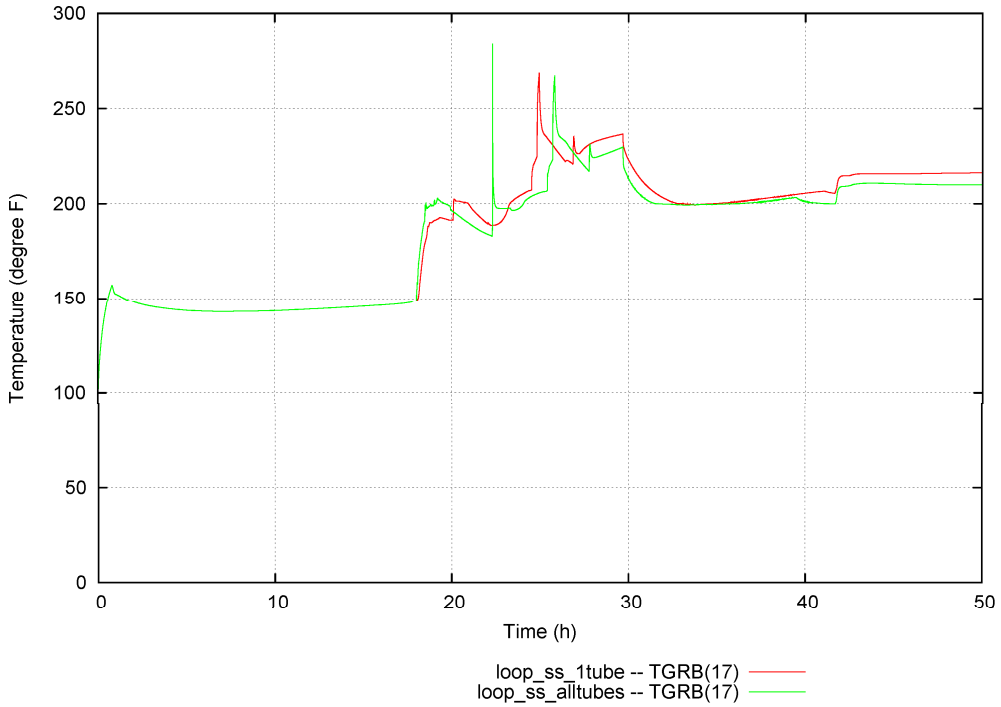


Figure 19-244-46 – Instrumentation Room Temperature



LOOP TR

Figures 19-244-47 and 19-244-48 plot the concentration of hydrogen in containment and concentration of hydrogen in the instrumentation room for the LOOP TR case simulating the failure of one AMS probe *(loop_tr_1tube)* and LBOP case simulating the failure of all AMS probes *(loop_tr_alltubes)*. Figures 19-244-49 and 19-244-50 plot the concentration of hydrogen in the adjacent compartments for the failure of one AMS probe *(loop_tr_1tube)* and failure of all AMS probes *(loop_tr_alltubes)*. The global hydrogen concentration is below the 10 CFR 50.44 limit of 10 percent as shown in Figure 19-244-47.

Figures 19-244-51 to 19-244-61 plot the concentration of steam, oxygen, nitrogen in containment, fractions of fission products in containment (CsI + RbI, SrO, CsOH + RbOH), primary system pressure, and containment and AICC pressures for the failure of one AMS probe *(loop_tr_1tube)* and failure of all AMS probes *(loop_tr_alltubes)*.

Figure 19-244-47 – Concentration of Hydrogen in Containment (loop_tr)

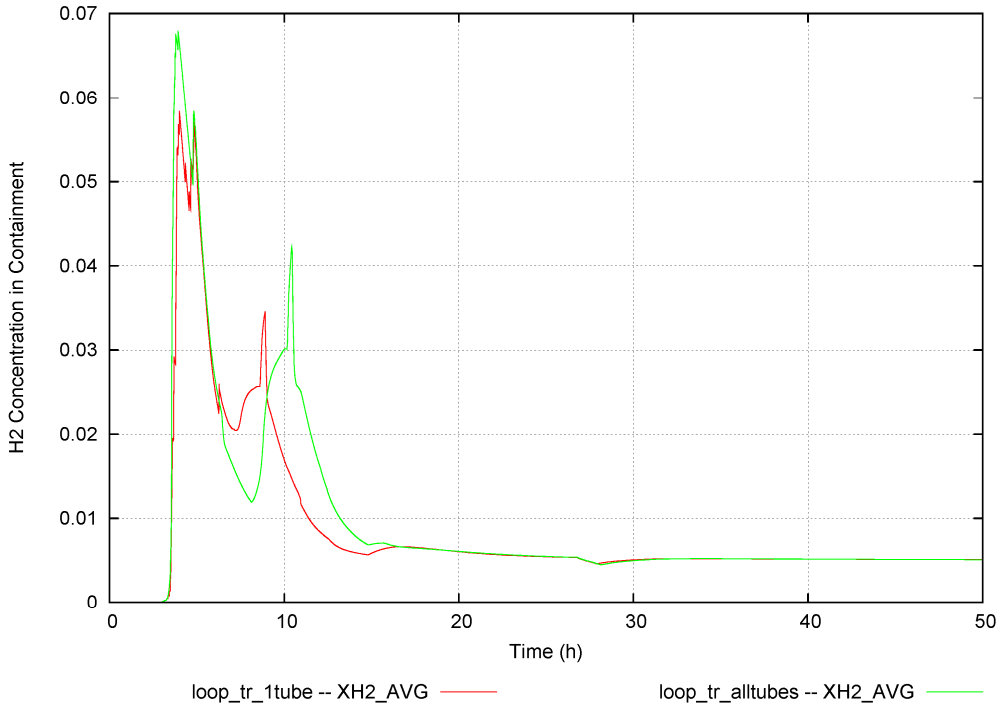


Figure 19-244-48 – Concentration of Hydrogen in Instrumentation Room (loop_tr)

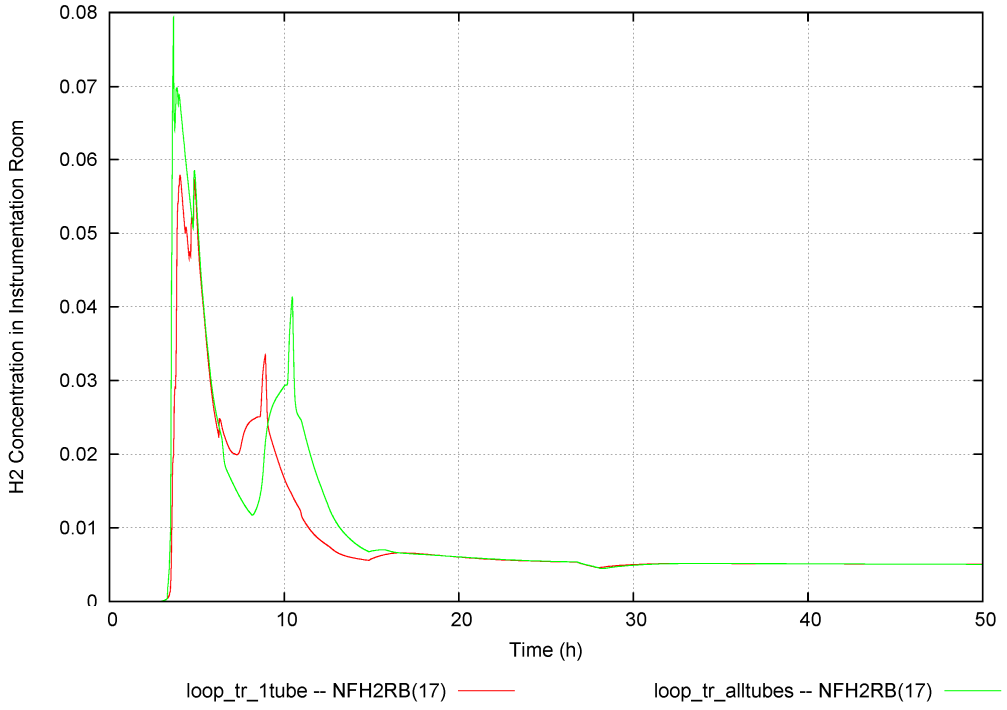


Figure 19-244-49 – Hydrogen Concentration in Adjacent Compartments (loop_tr_1tube)

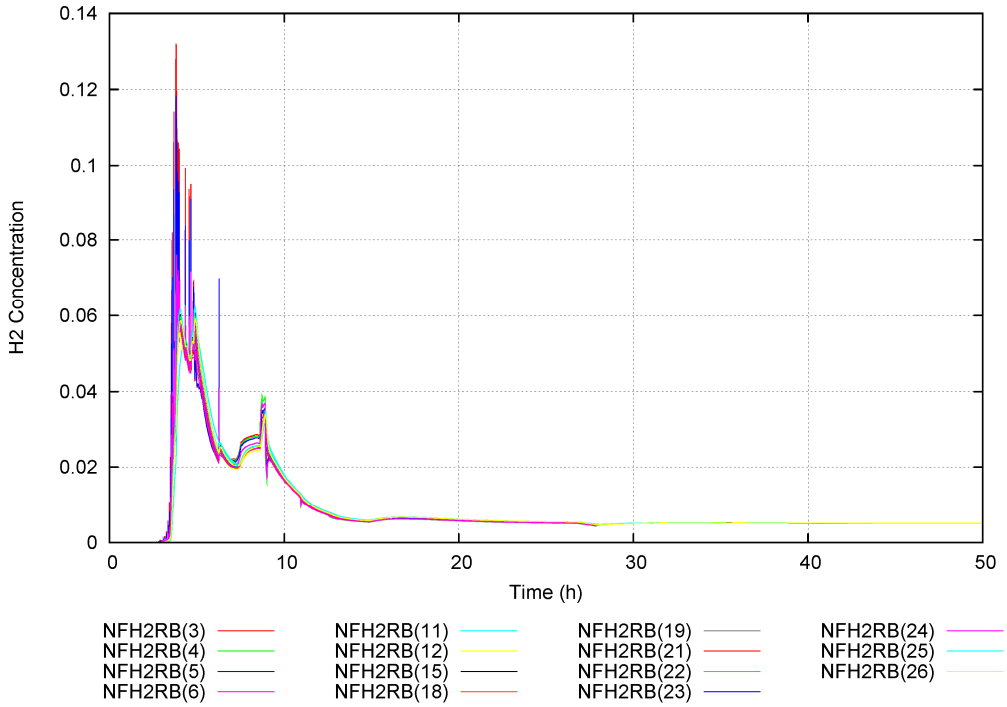


Figure 19-244-50 – Hydrogen Concentration in Adjacent Compartments (loop_tr_alltubes)

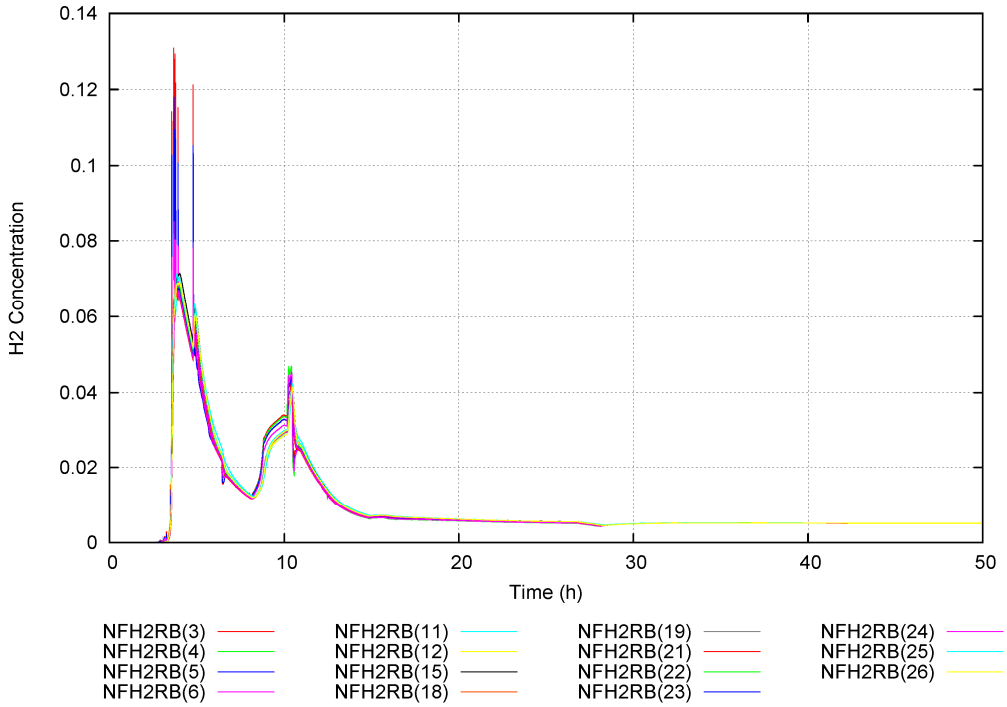


Figure 19-244-51 – Concentration of Steam in Containment (loop_tr)

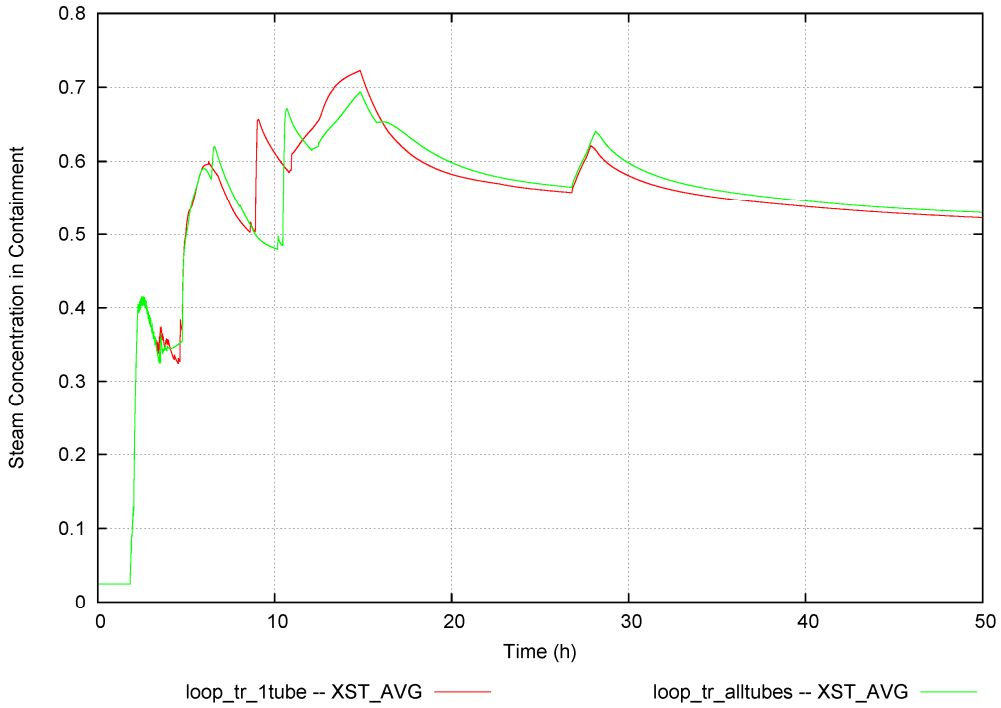


Figure 19-244-52 – Concentration of Oxygen in Containment (loop_tr)

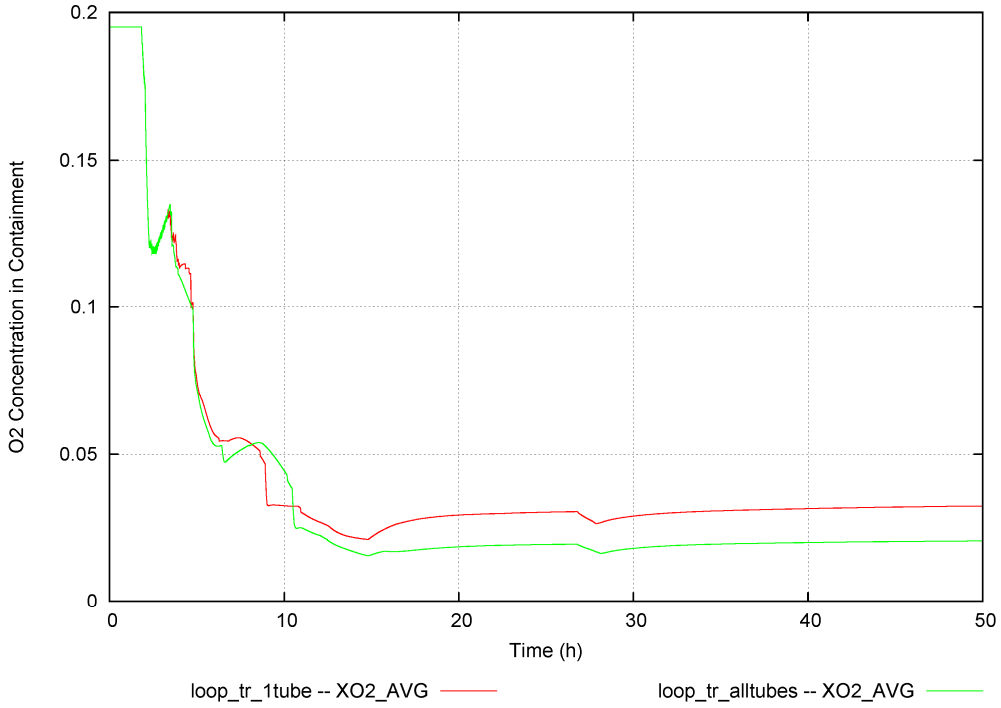


Figure 19-244-53 – Concentration of Nitrogen in Containment (loop_tr)

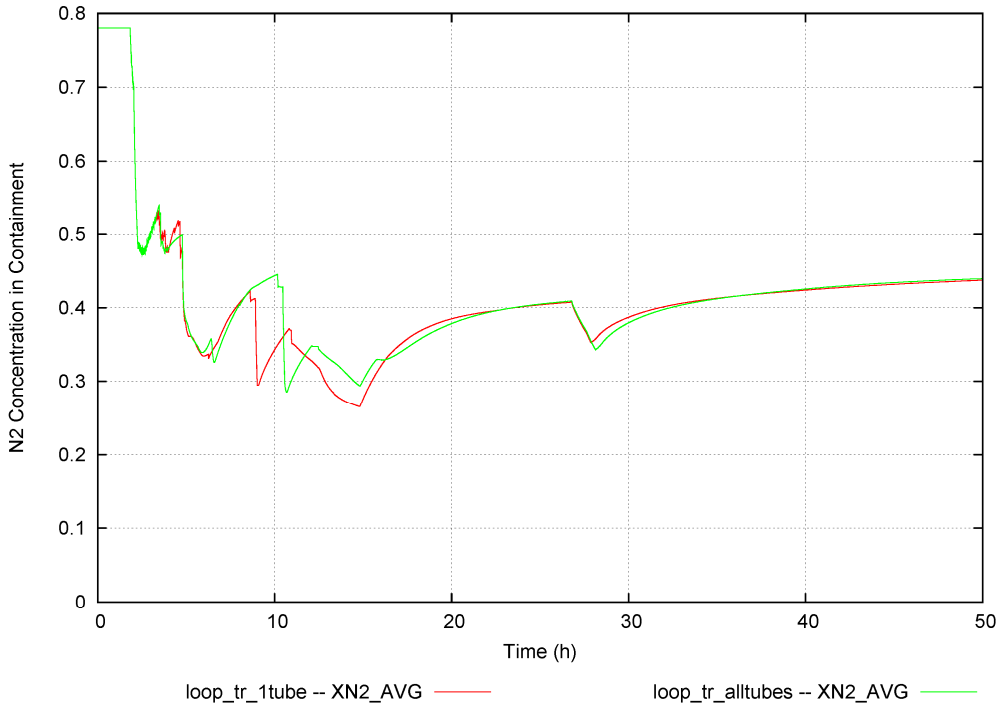


Figure 19-244-54 – CsI + RbI Mass in Containment (loop_tr)

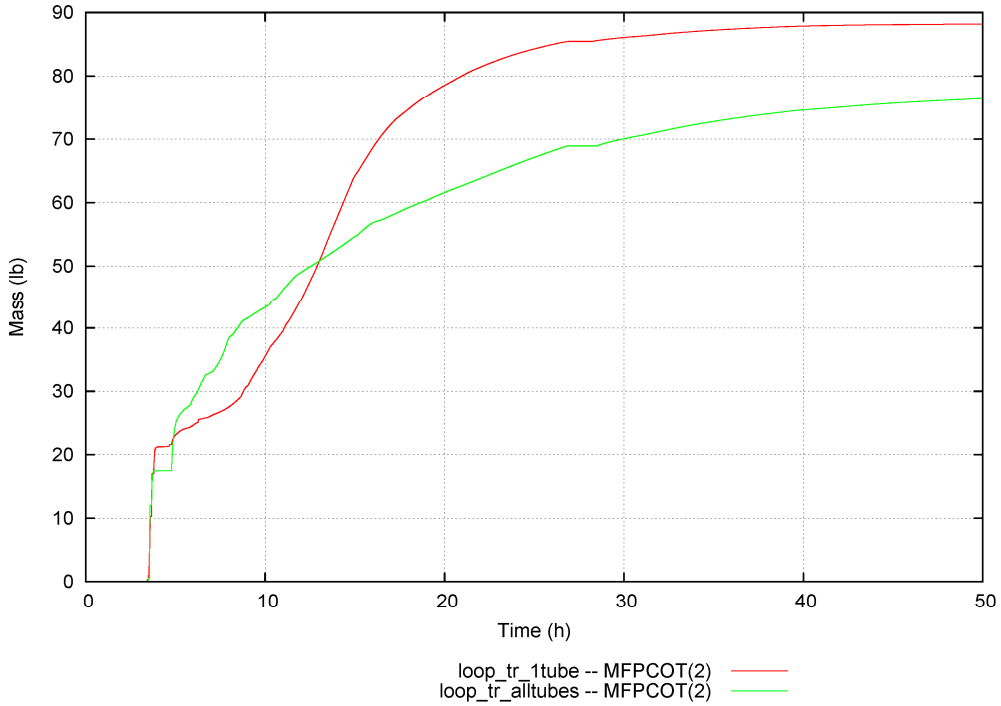


Figure 19-244-55 – SrO Mass in Containment (loop_tr)

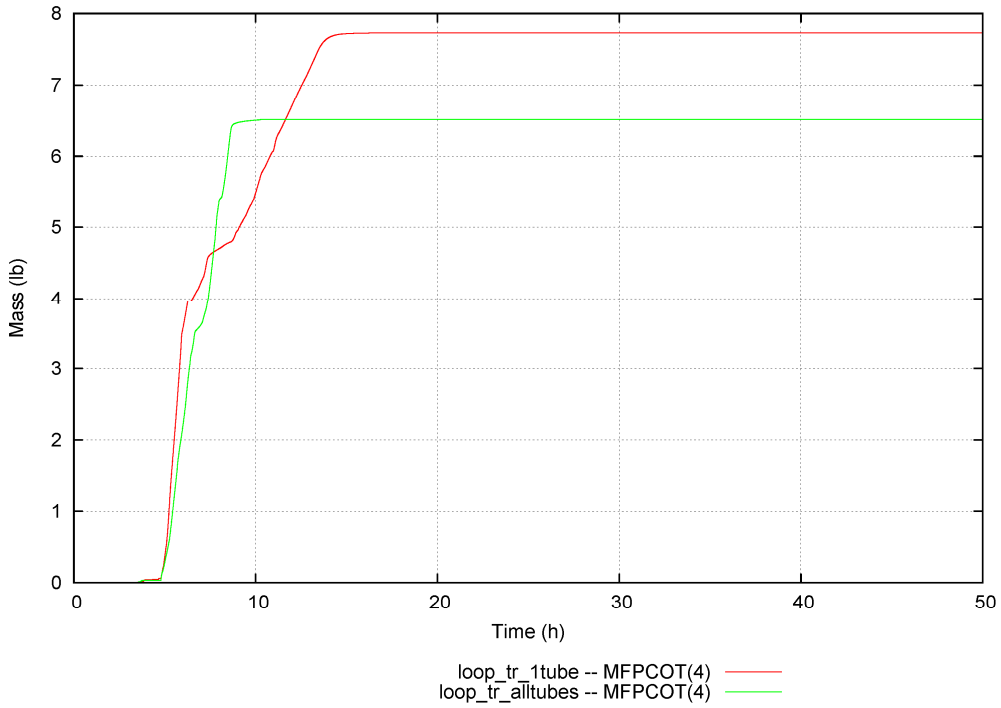


Figure 19-244-56 – CsOH + RbOH Mass in Containment (loop_tr)

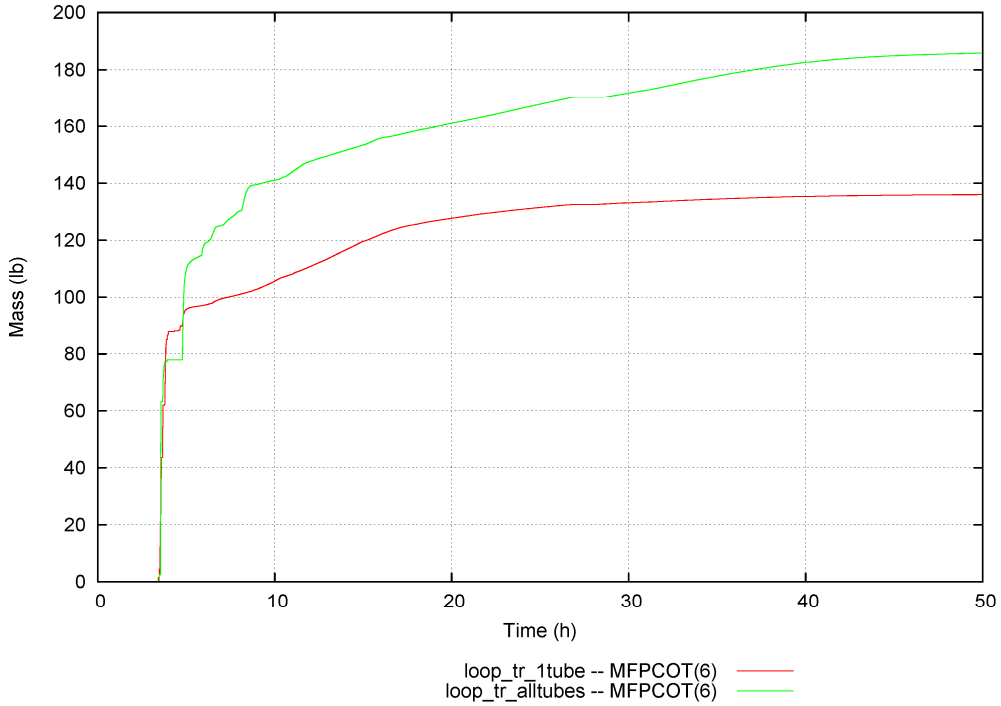


Figure 19-244-57 – Containment Pressure (loop_tr_1tube)

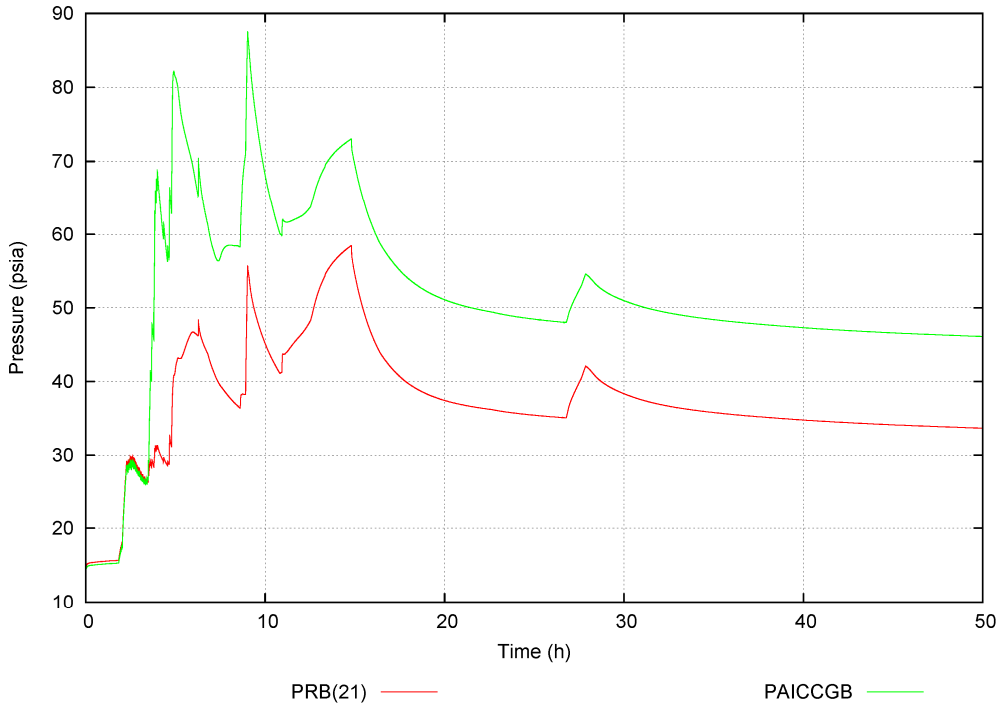


Figure 19-244-58 – Containment Pressure (loop_tr_alltubes)

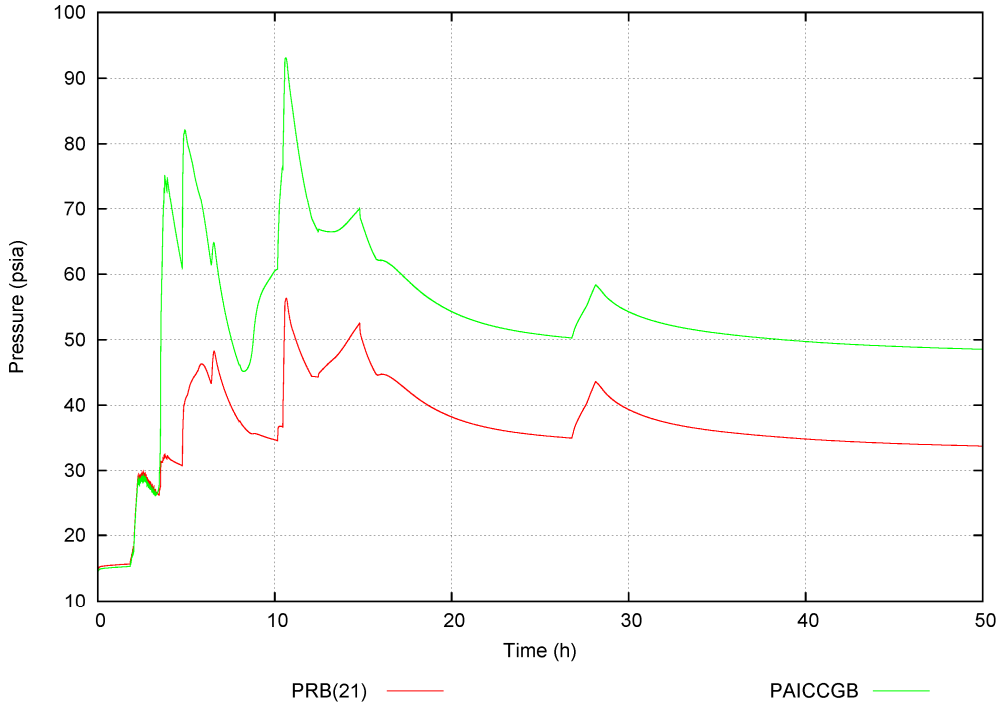


Figure 19-244-59 – Primary System Pressure (loop_tr)

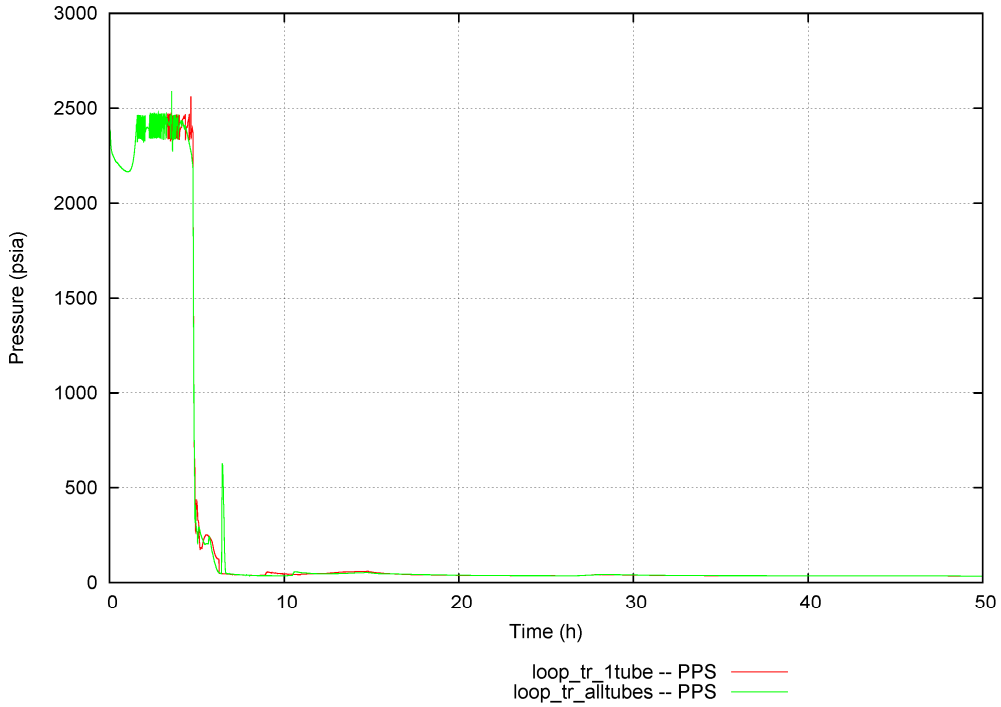


Figure 19-244-60 – Containment Temperature

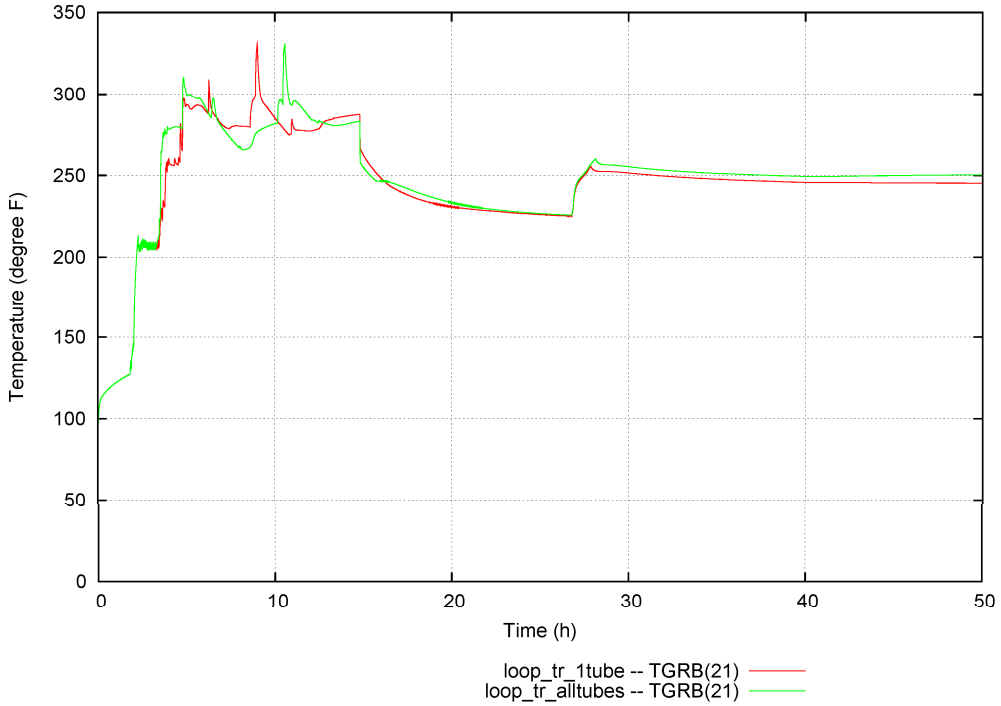
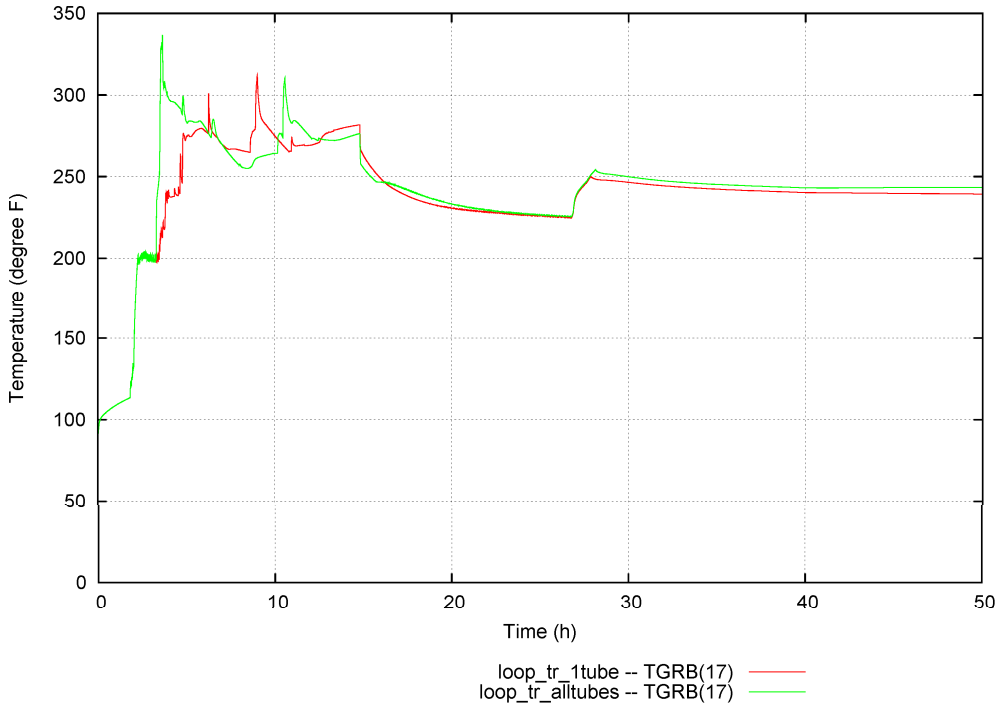


Figure 19-244-61 – Instrumentation Room Temperature



Response to Question 19-244 (2):

Figures 19-244-62 through 19-244-73 plot the core-to-upper plenum natural circulation (WGUPCR), countercurrent natural circulation flowrates in the hot leg (WHLUL and WHLBL) and steam generator tubes (WSGUL and WSGBL), and damage fractions in the hot leg (FCRPUH and FCRPBH) and steam generator tubes (FCRUHT and FCRBHT) for the requested relevant scenarios simulating the failure of one AMS probe. For several of the relevant scenarios the hot leg and steam generator tube damage fractions are negligible. Therefore, for these relevant scenarios the damage fraction figures do not show damage fractions for the hot leg and steam generator tubes.

In MAAP, the core-to-upper plenum natural circulation parameter is considered valid from core uncovery to reactor pressure vessel (RPV) failure. Table 19-244-1 contains the timing of core uncovery and reactor pressure vessel failure for each relevant scenario case simulating the failure of one AMS probe.

Table 19-244-1 – Timing of Events for Failure of One AMS Probe for Each Relevant Scenario

Case	Event	Time
lbop_1tube	Core Uncovery	1.24 hr
	RPV Failure	8.85 hr
loop_pl_1tube	Core Uncovery	1.83 hr
	RPV Failure	6.15 hr
loop_ss_1tube	Core Uncovery	15.29 hr
	RPV Failure	22.04 hr
loop_tr_1tube	Core Uncovery	2.41 hr
	RPV Failure	6.26 hr

Figure 19-244-62 – Core-to-Upper Plenum Natural Circulation (lbop_1tube)

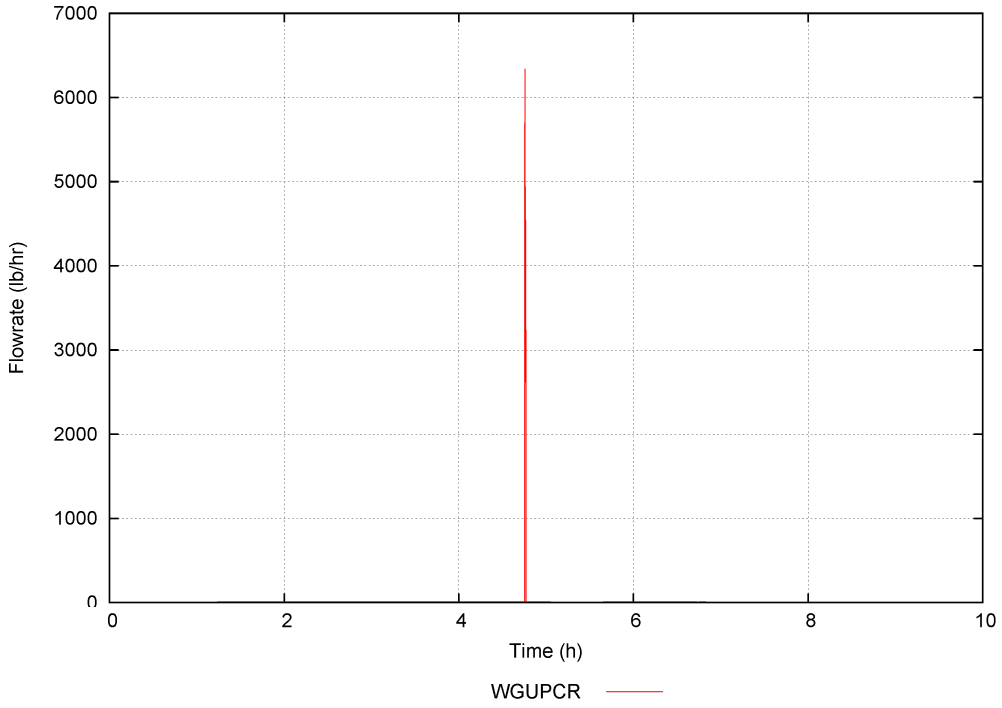


Figure 19-244-63 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (lbop_1tube)

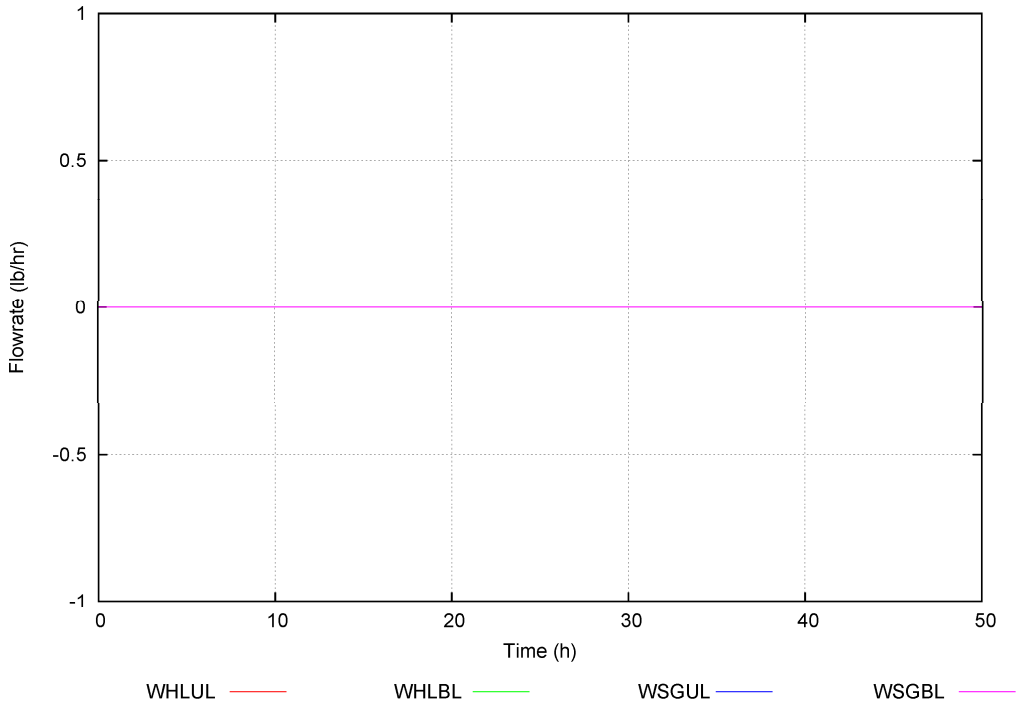


Figure 19-244-64 – Damage Fractions (lbop_1tube)

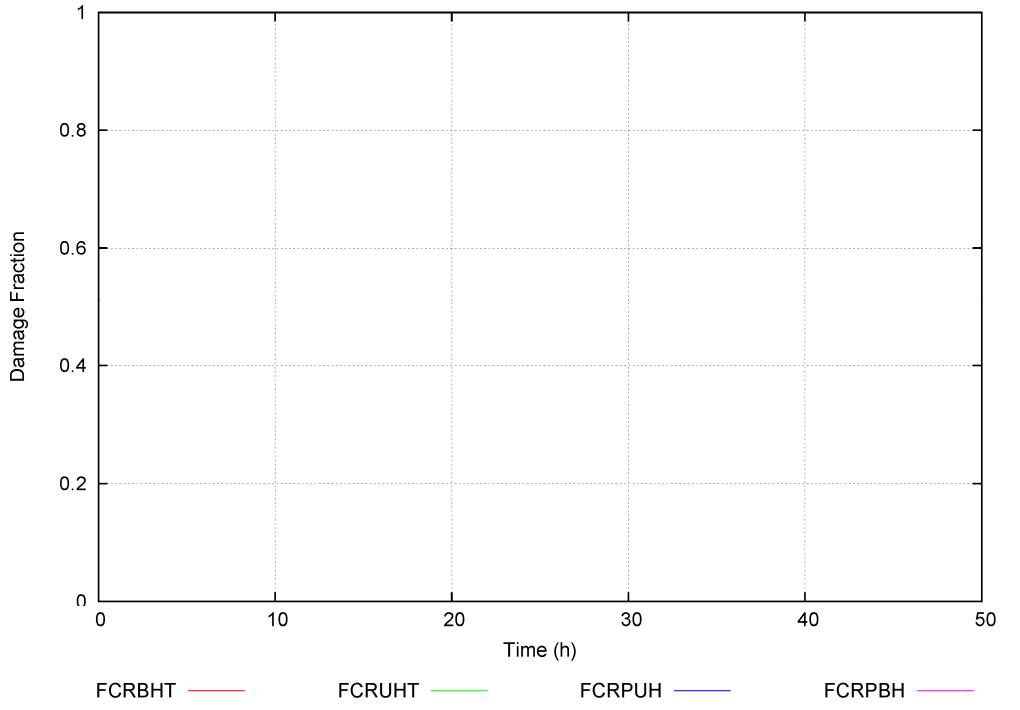


Figure 19-244-65 – Core-to-Upper Plenum Natural Circulation (loop_pl_1tube)

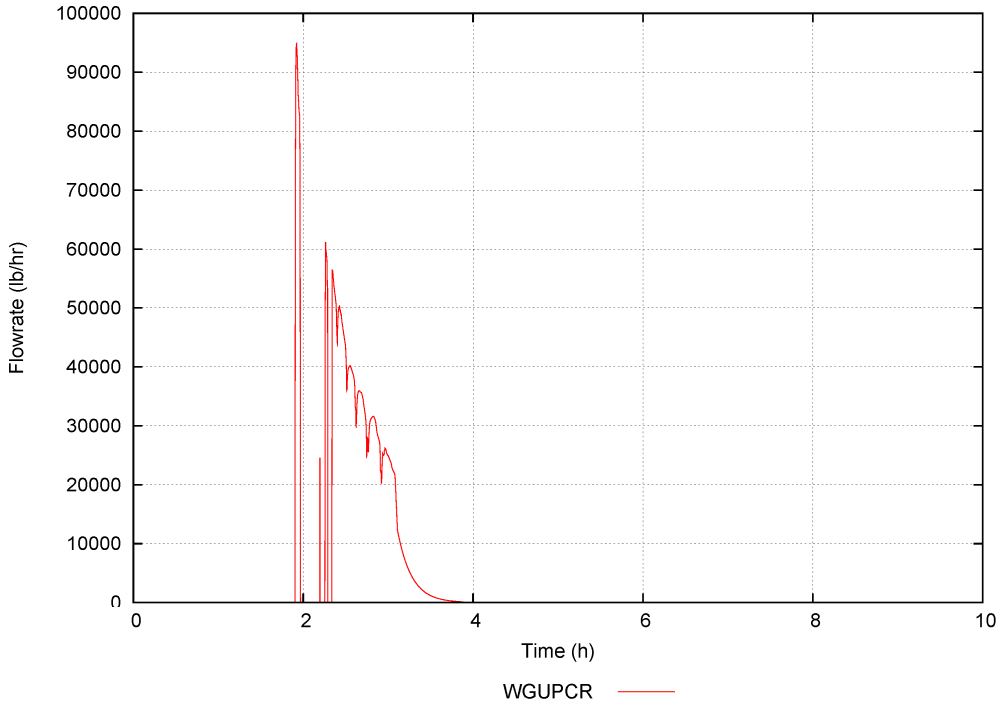


Figure 19-244-66 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_pl_1tube)

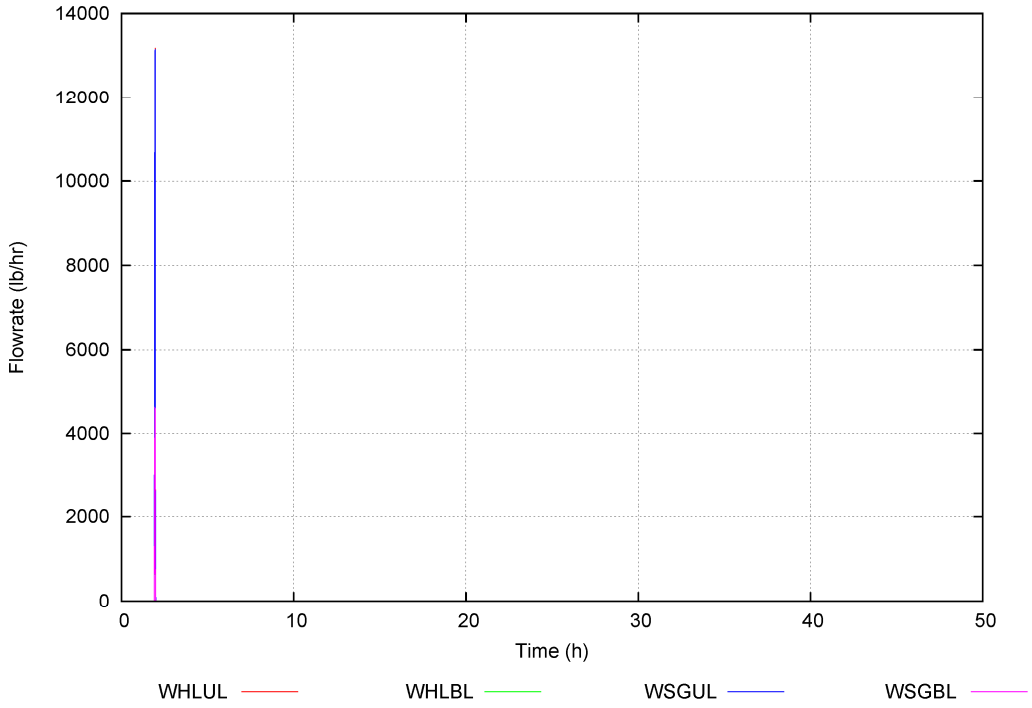


Figure 19-244-67 – Damage Fractions (loop_pl_1tube)

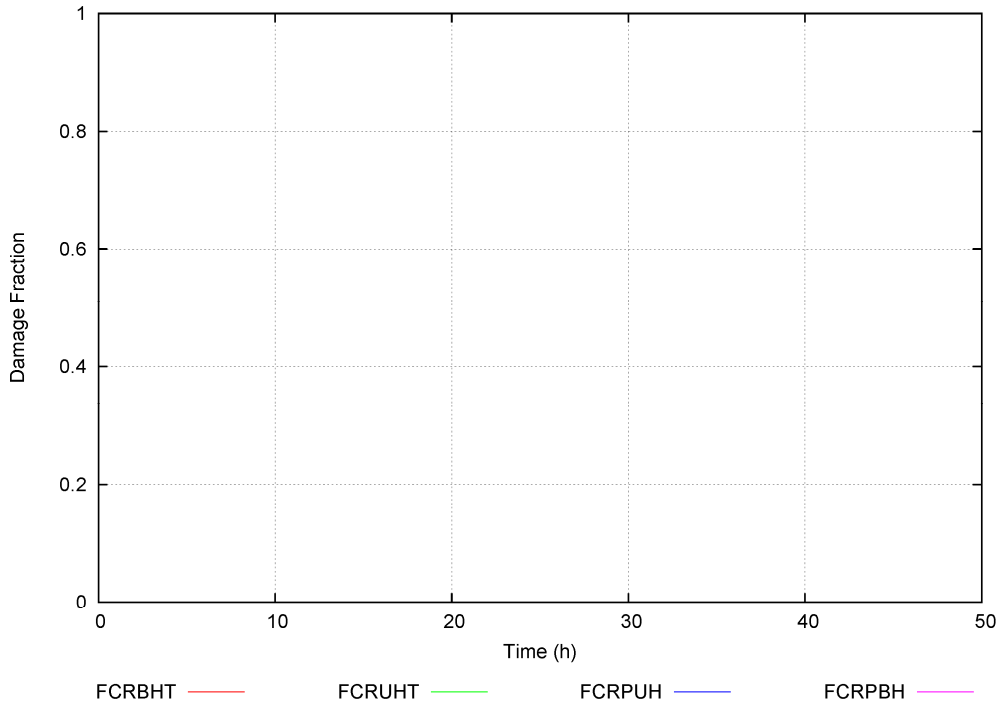


Figure 19-244-68 – Core-to-Upper Plenum Natural Circulation (loop_ss_1tube)

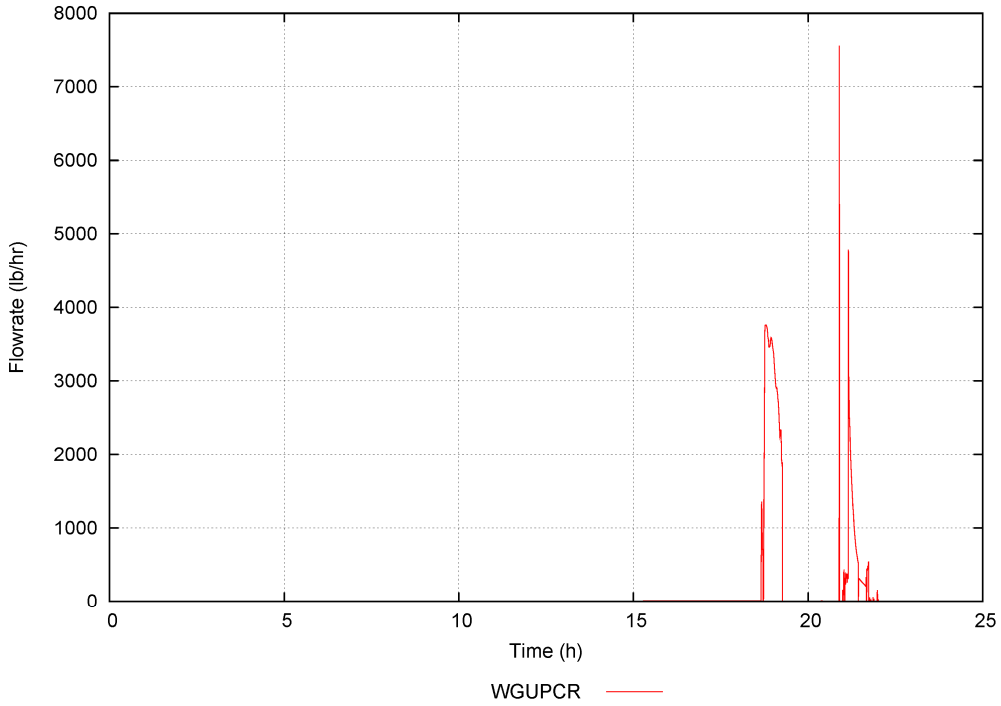


Figure 19-244-69 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_ss_1tube)

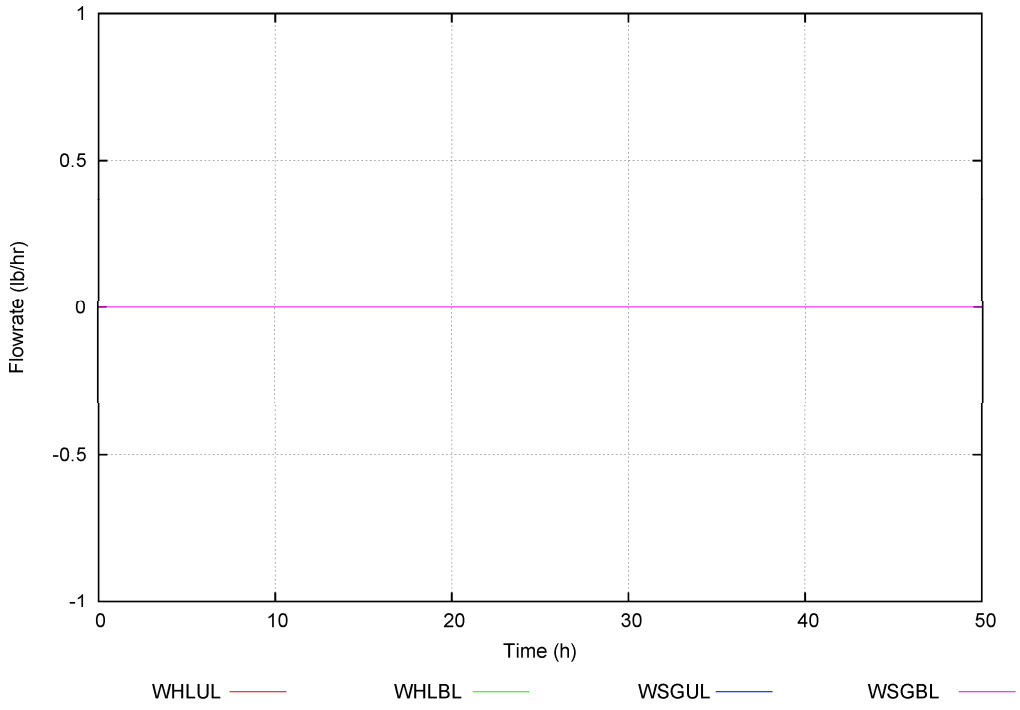


Figure 19-244-70 – Damage Fractions (loop_ss_1tube)

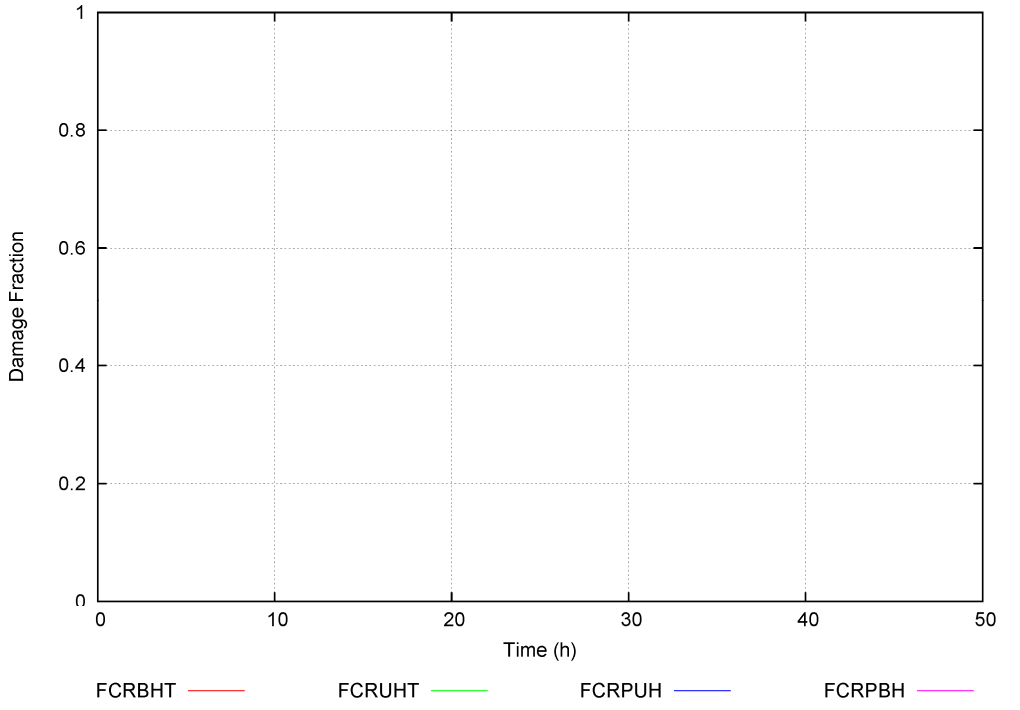


Figure 19-244-71 – Core-to-Upper Plenum Natural Circulation (loop_tr_1tube)

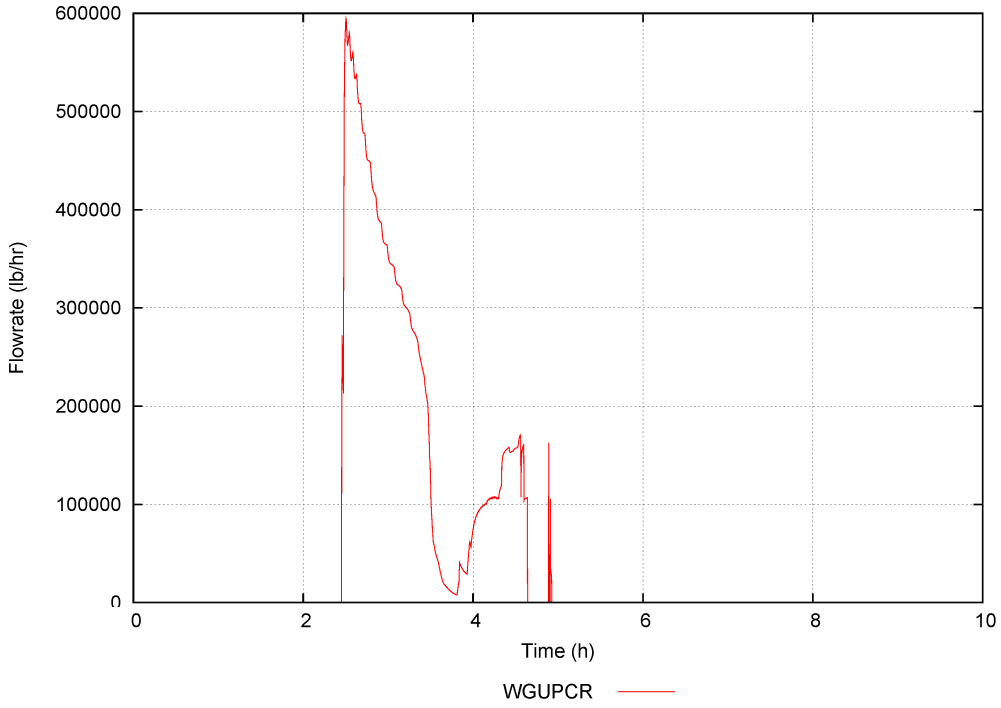


Figure 19-244-72 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_tr_1tube)

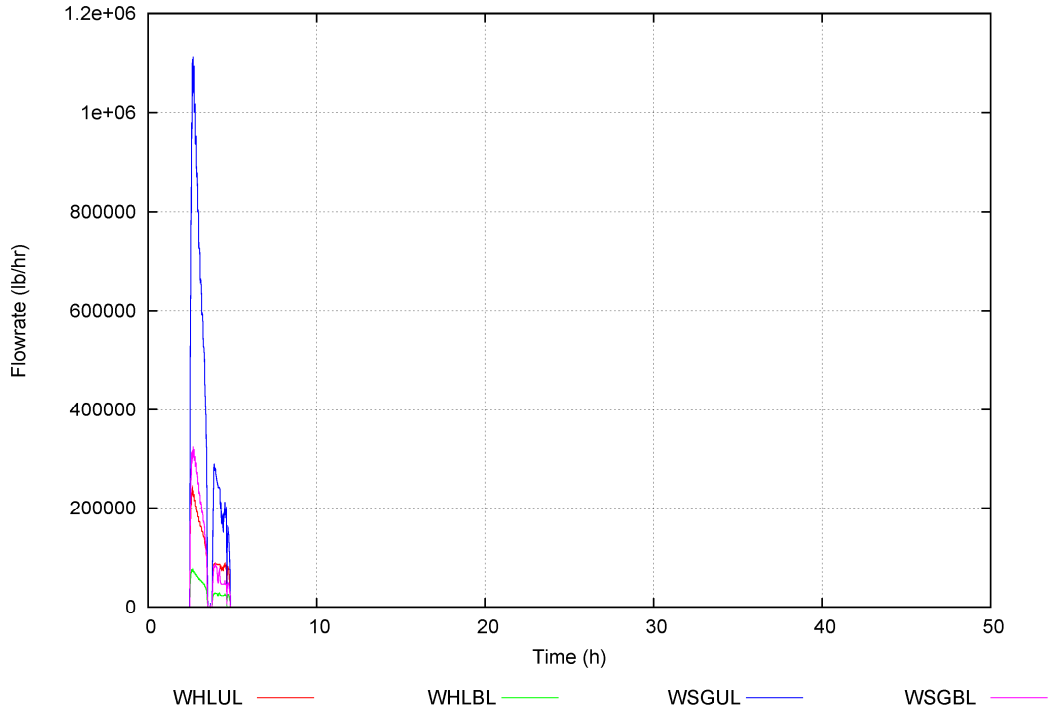
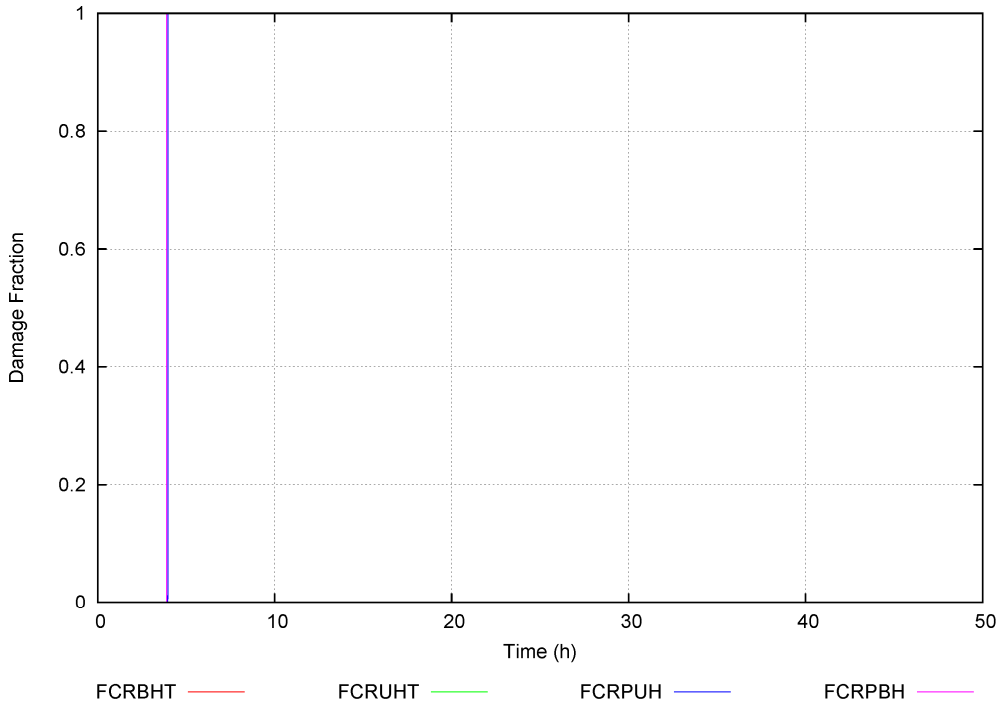


Figure 19-244-73 – Damage Fractions (loop_tr_1tube)



Figures 19-244-74 through 19-244-85 plot the core-to-upper plenum natural circulation (WGUPCR), countercurrent natural circulation flowrates in the hot leg (WHLUL and WHLBL) and steam generator tubes (WSGUL and WSGBL), and damage fractions in the hot leg (FCRPUH and FCRPBH) and steam generator tubes (FCRUHT and FCRBHT) for the requested relevant scenarios simulating the failure of all AMS probes.

In MAAP, the core-to-upper plenum natural circulation parameter is considered valid from core uncovery to reactor pressure vessel failure. Table 19-244-2 contains the timing of core uncovery and reactor pressure vessel failure for each relevant scenario case simulating the failure of all AMS probes.

Table 19-244-2 – Timing of Events for Failure of All AMS Probes for Each Relevant Scenario

Case	Event	Time
lbop_alltubes	Core Uncovery	1.24 hr
	RPV Failure	8.55 hr
loop_pl_ alltubes	Core Uncovery	1.83 hr
	RPV Failure	6.29 hr
loop_ss_ alltubes	Core Uncovery	15.29 hr
	RPV Failure	22.30 hr
loop_tr_ alltubes	Core Uncovery	2.41 hr
	RPV Failure	8.00 hr

Figure 19-244-74 – Core-to-Upper Plenum Natural Circulation (lbop_alltubes)

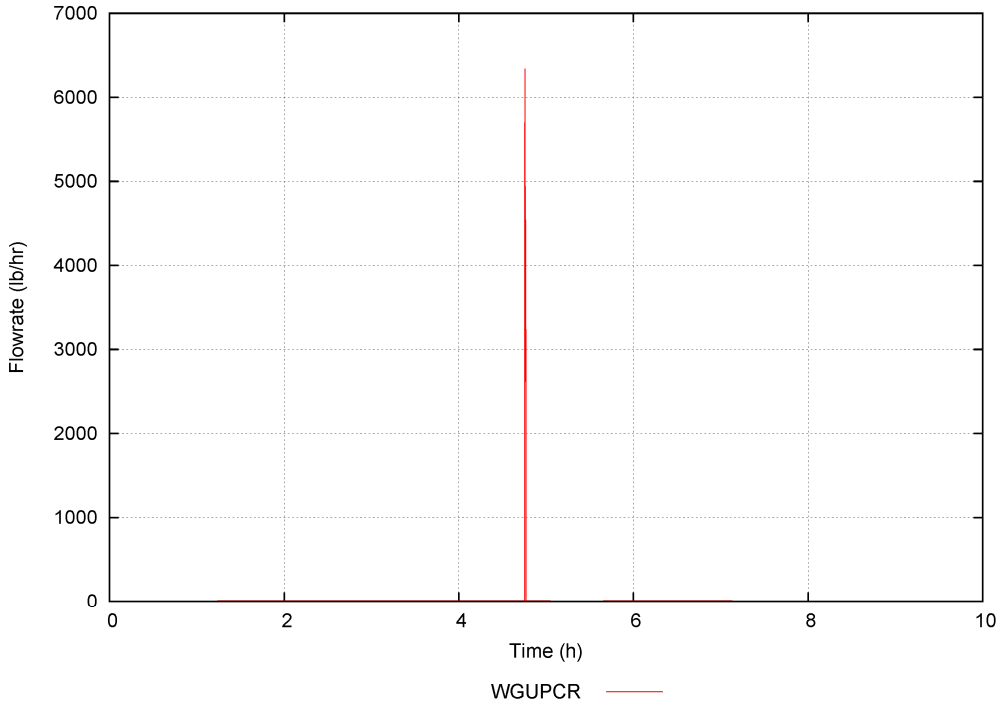


Figure 19-244-75 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (lbop_alltubes)

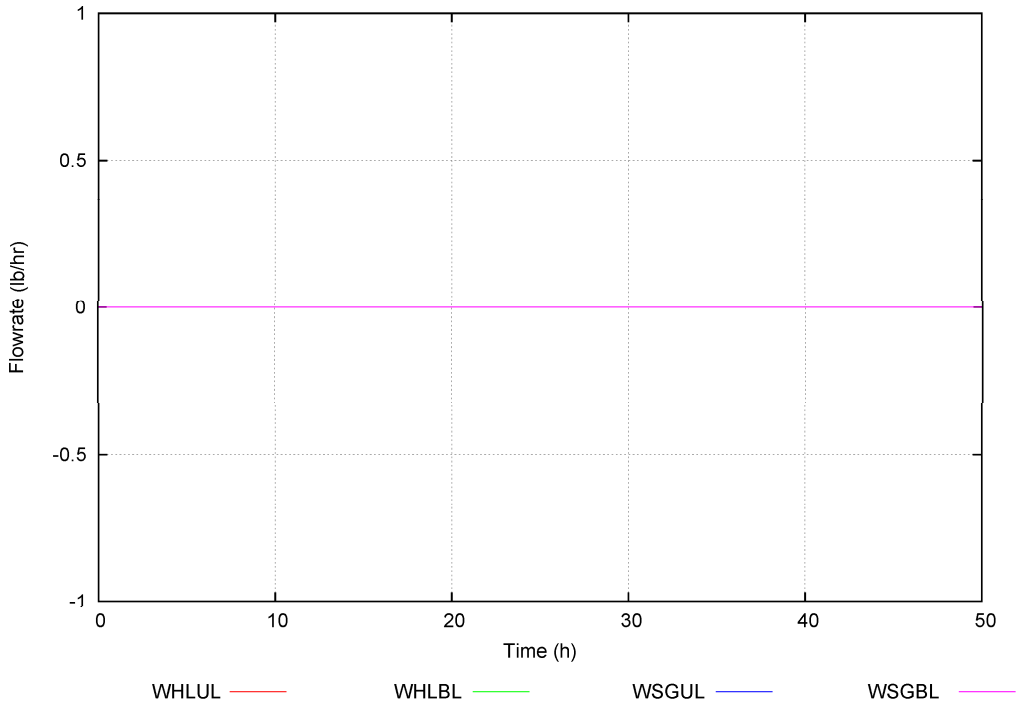


Figure 19-244-76 – Damage Fractions (lbop_alltubes)

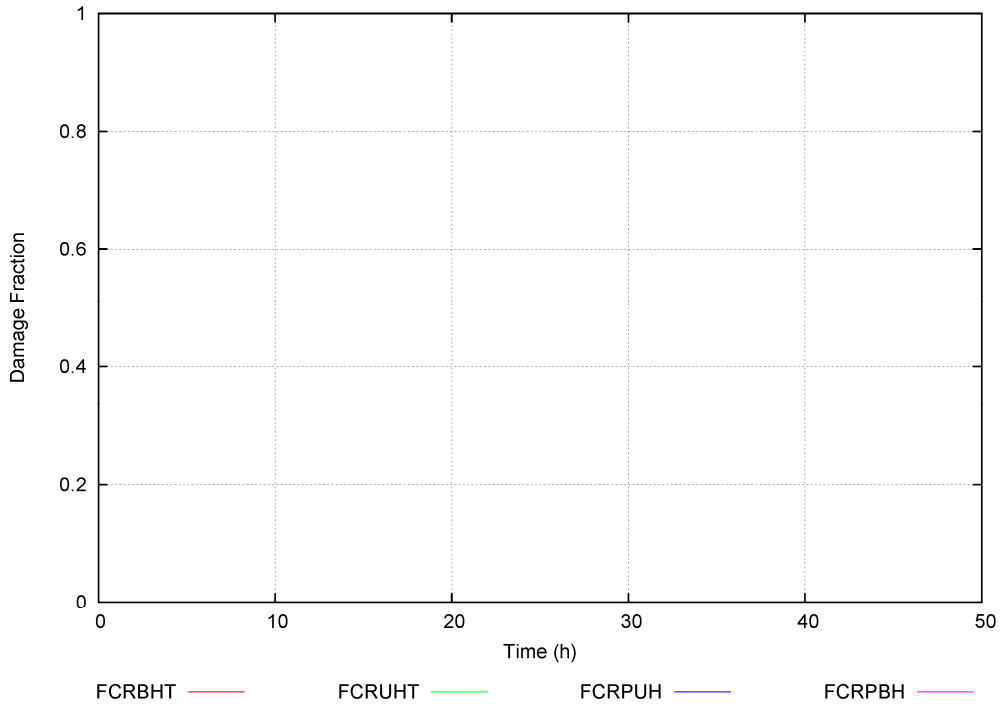


Figure 19-244-77 – Core-to-Upper Plenum Natural Circulation (loop_pl_alltubes)

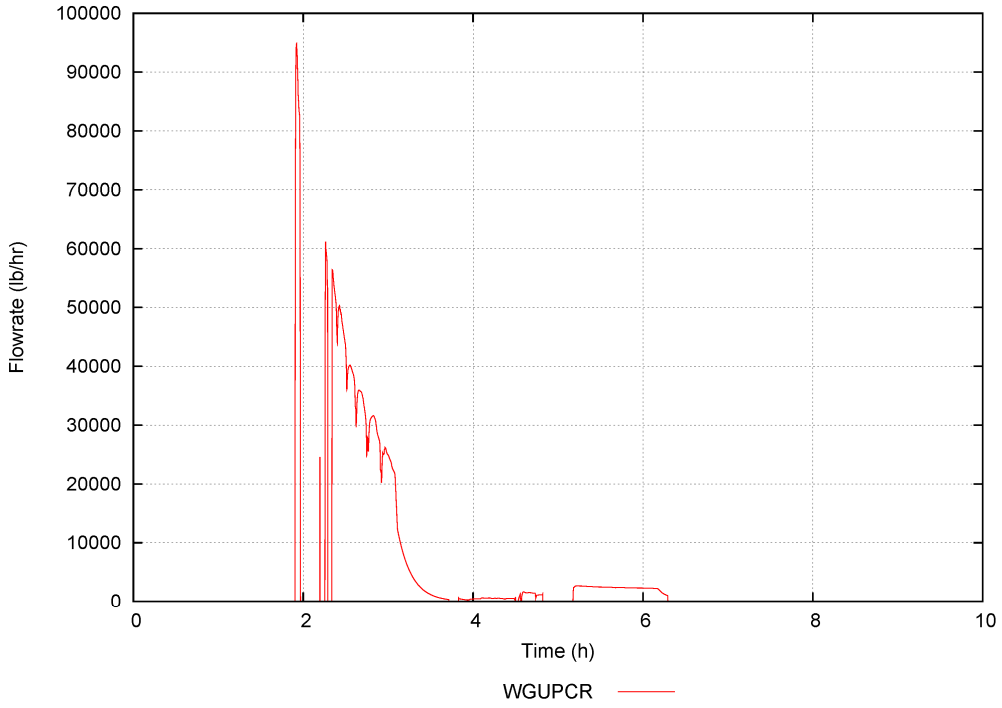


Figure 19-244-78 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_pl_alltubes)

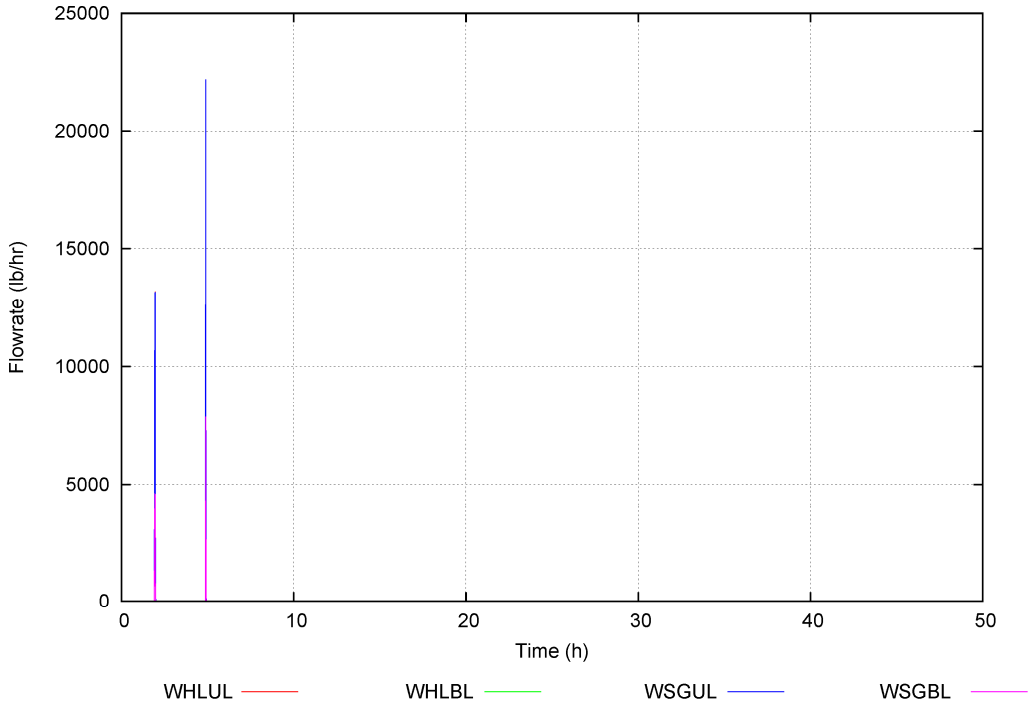


Figure 19-244-79 – Damage Fractions (loop_pl_alltubes)

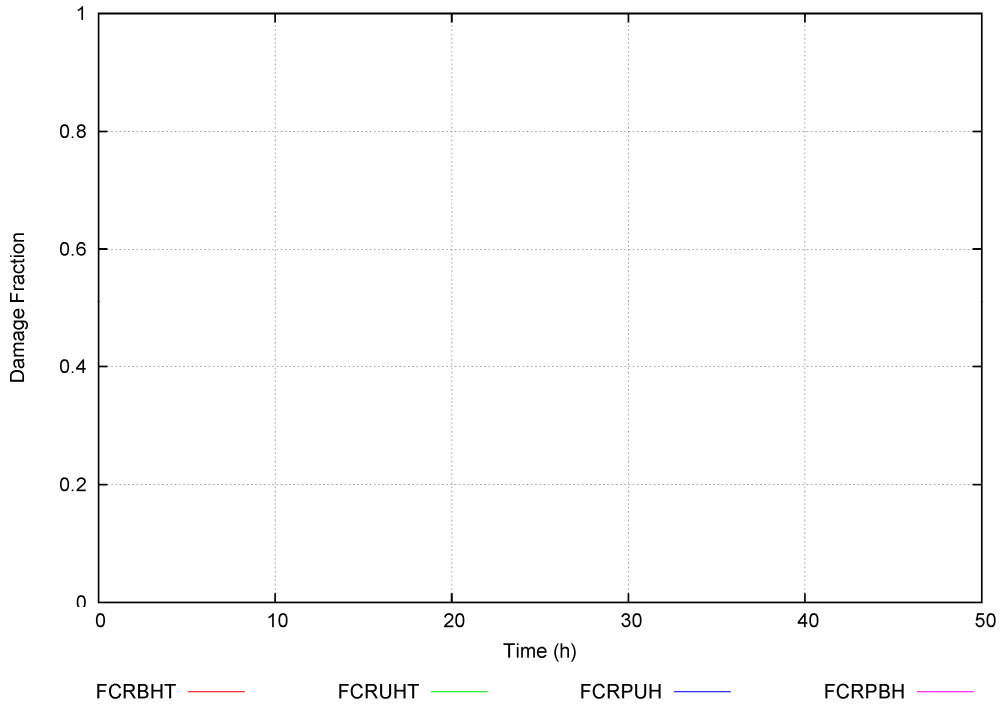


Figure 19-244-80 – Core-to-Upper Plenum Natural Circulation (loop_ss_alltubes)

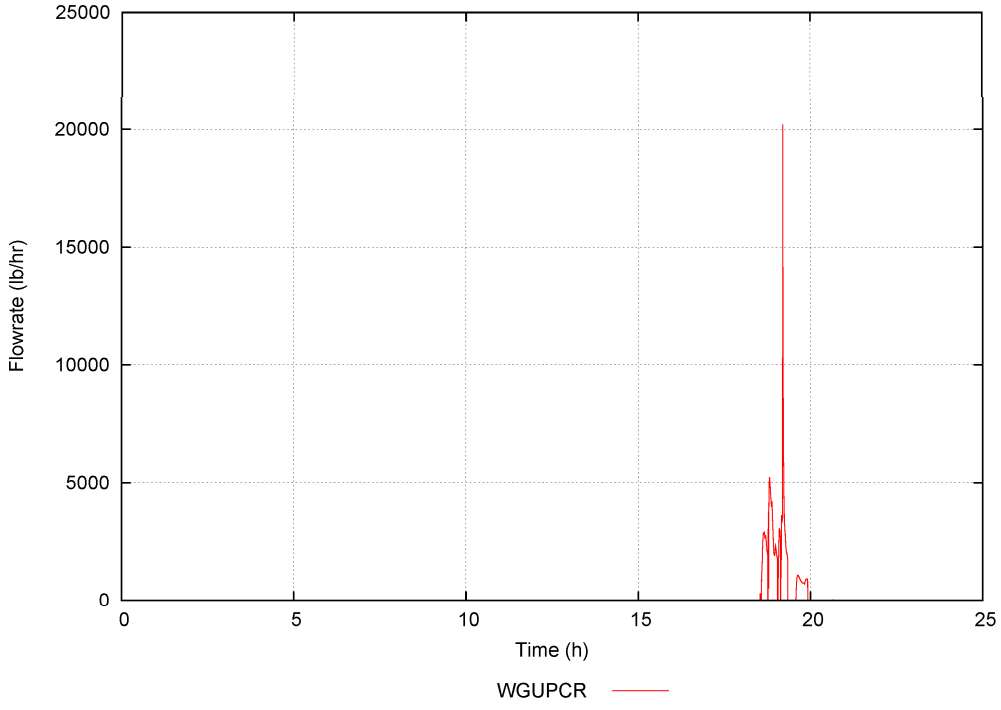


Figure 19-244-81 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_ss_alltubes)

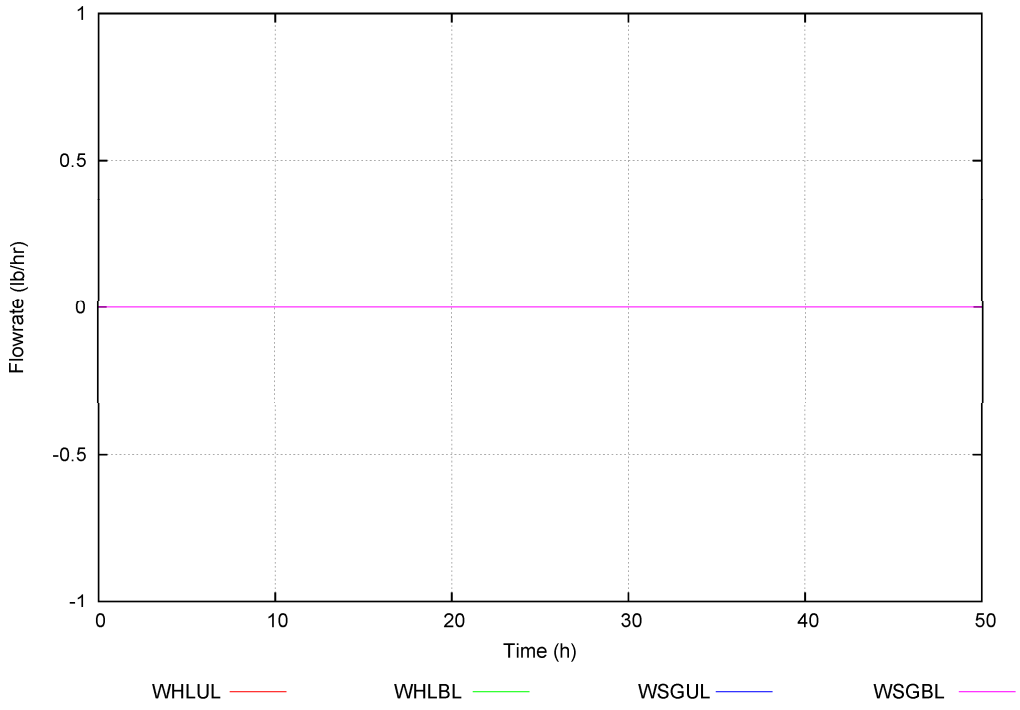


Figure 19-244-82 – Damage Fractions (loop_ss_alltubes)

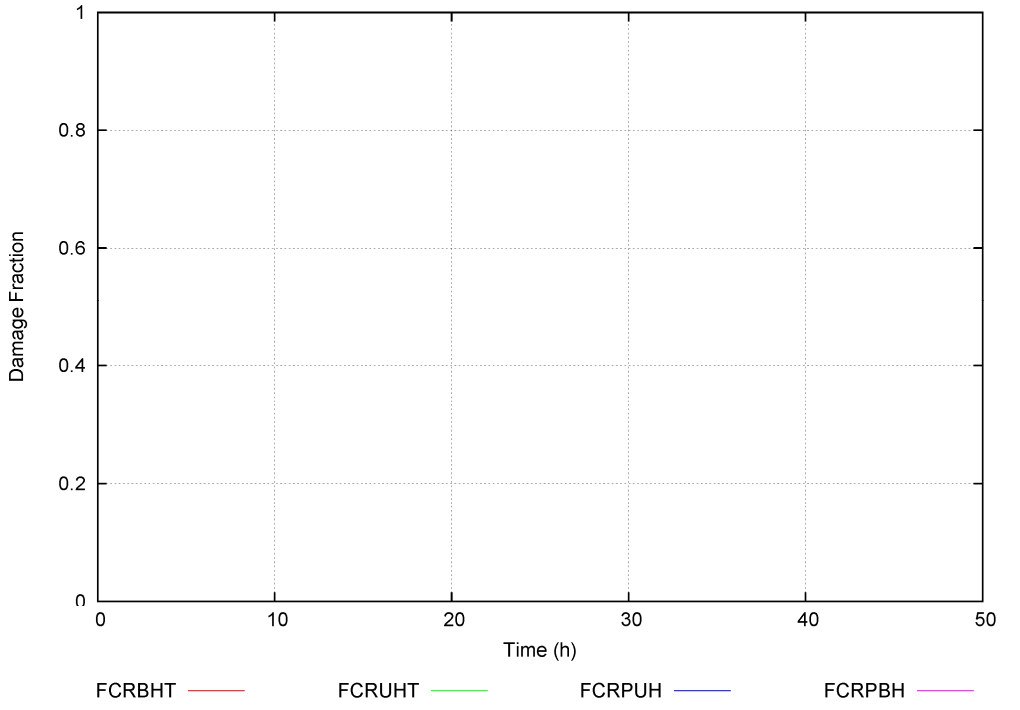


Figure 19-244-83 – Core-to-Upper Plenum Natural Circulation (loop_tr_alltubes)

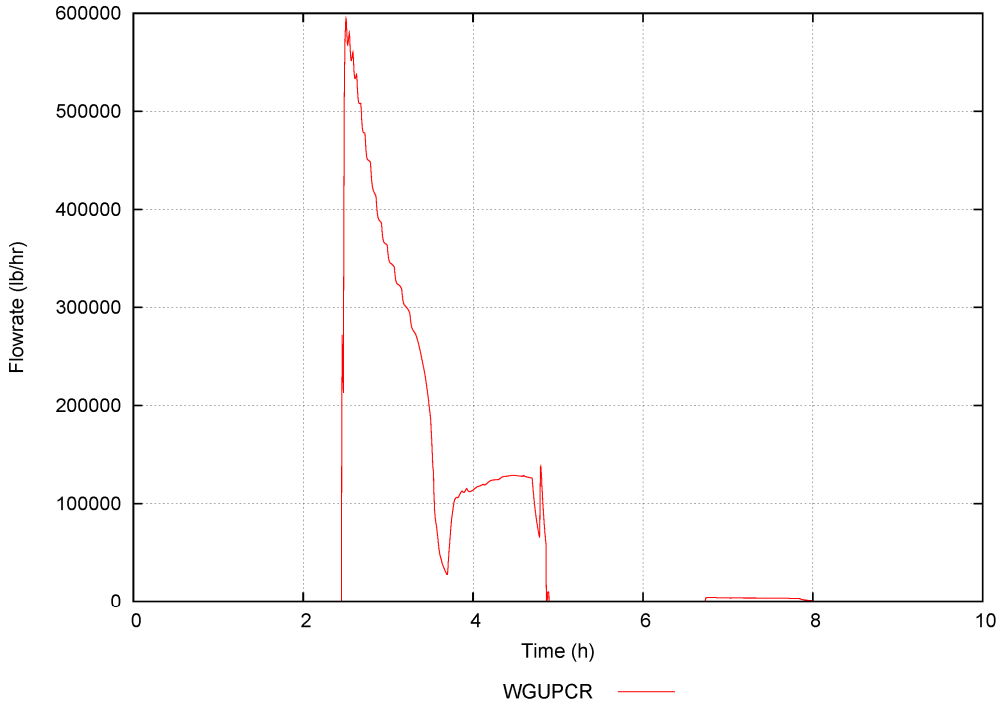


Figure 19-244-84 – Countercurrent Natural Circulation for Hot Leg and Steam Generator Tubes (loop_tr_alltubes)

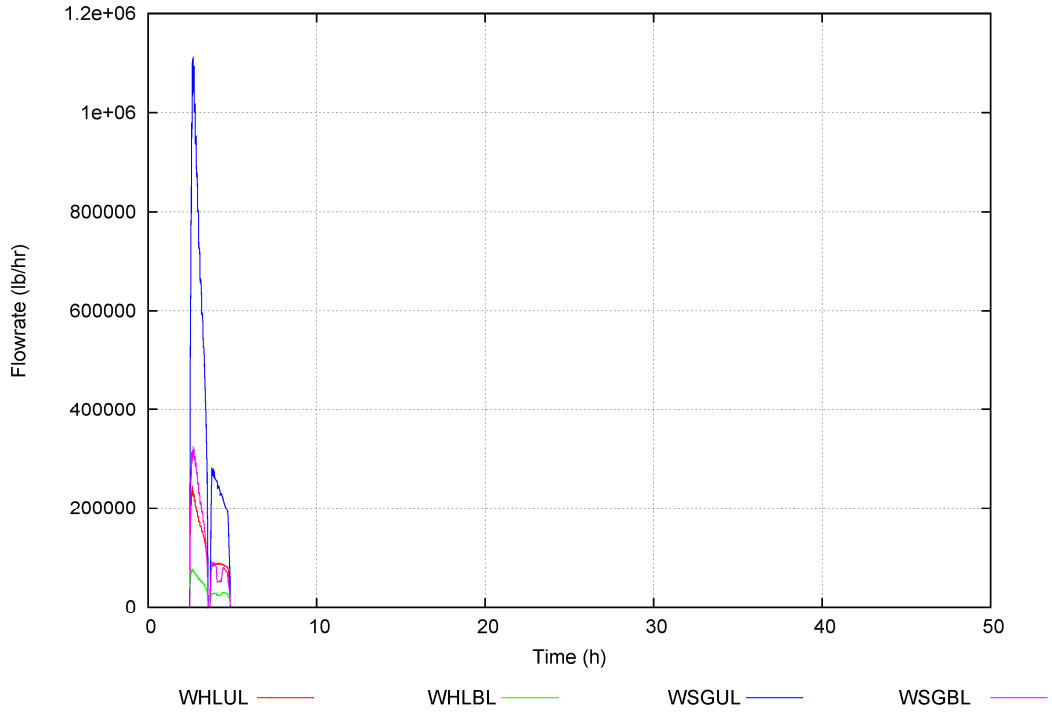
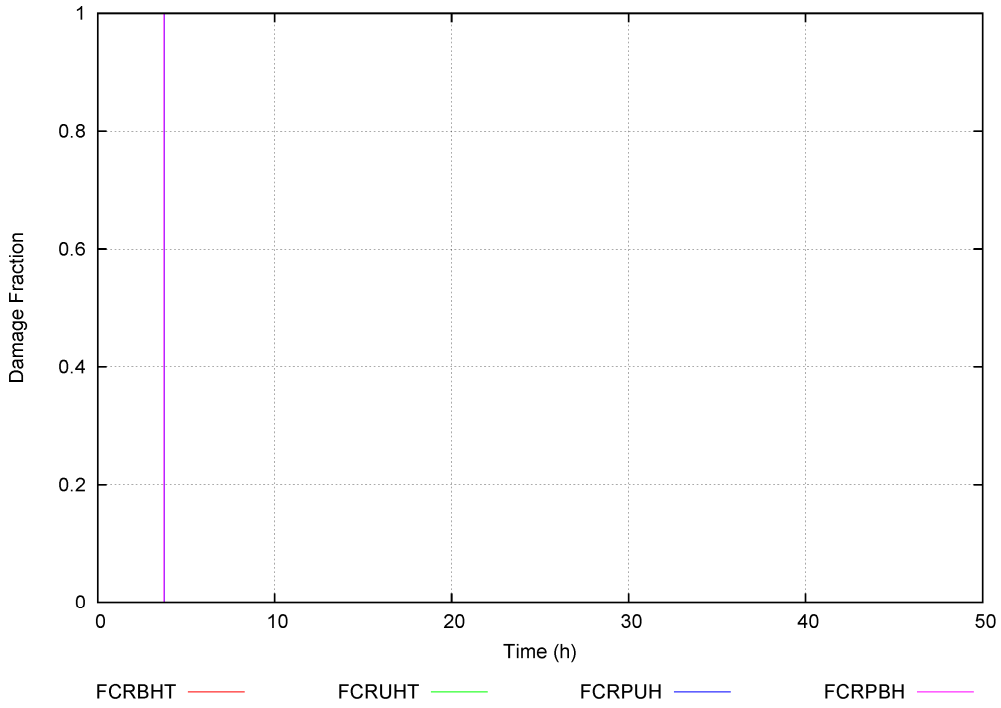


Figure 19-244-85 – Damage Fractions (loop_tr_alltubes)



Conclusions: Question 19-244

In general, both the trending and magnitudes calculated in the single and multiple AMS probe failure simulations are similar in each of the relevant scenarios. The consequences of these failure conditions are minor relative to the hydrogen transport phenomena driven by the pressurizer relief/safety, and primary depressurization (PDS) valves.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.