TRACE Assessment against Semiscale NC-2 and NC-3 Tests and ROSA/LSTF SB-HL-02 Test

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ABSTRACT

The latest TRACE V5.0 Patch 8 advanced thermal-hydraulic computer code has been released in March 2023. The purpose of this study is to assess the TRACE V5.0 Patch 8 against the experimental data obtained on two integral test facilities and calculated results obtained by some earlier TRACE V5.0 code versions down to TRACE V5.0 Patch 1, as TRACE code is continuously updated. For example, the two-phase, two-component, choked-flow model currently in TRACE is different than in TRACE V5.0 Patch 4 and earlier versions where the choked-flow model is an extension of a model developed by Ransom and Trapp that incorporates an additional inert-gas component and nonequilibrium effects.

The first integral test facility considered in this study was the Semiscale Mod-2A, which is a small-scale model of the primary system of a four-loop pressurized water reactor (PWR). The selected experimental tests are Semiscale natural circulation S-NC-02 test, in which primary side mass inventory was varied and S-NC-03 test, in which steam generator secondary side mass inventory was varied. TRACE input deck from 2021 has been used, which was developed by conversion from RELAP5 input deck (obtained in the frame of RELAP5/MOD3.3 distribution in 2002, originating from RELAP5 standard model for the Semiscale Mod-2A from Idaho National Engineering Laboratory in 1981) using the Symbolic Nuclear Analysis Package (SNAP).

The second integral test facility considered in study was the Large Scale Test Facility (LSTF), which simulates a Westinghouse-type four-loop 3423 MW (thermal power) PWR by a full-height and 1/48 volumetrically scaled two-loop system. The experiment selected was SB-HL-02 hot leg break loss-of-coolant accident, performed on LSTF in the frame of Rig of Safety Assessment-IV (ROSA-IV) program with a break size equivalent to 10 % cold leg cross sectional area. TRACE input deck from 2017 has been used, which has been converted from the RELAP5/MOD2 input model obtained within the framework of International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP) on Evaluation of Uncertainties in Best Estimate Accident Analysis (2006-2010).

The simulated results obtained with various TRACE code versions and compared to experimental data for the selected S-NC-2, S-NC-3 and SB-HL-02 tests are presented and discussed. All considered TRACE versions are qualitatively comparable to experimental data, but some quantitative differences are identified.

Keywords: *TRACE, natural circulation, loss of coolant accident, Semiscale, LSTF*

1 INTRODUCTION

The latest TRACE V5.0 Patch 8 advanced thermal-hydraulic computer code has been released in March 2023 and has been independently assessed for Semiscale natural circulation tests and Large Scale Test Facility (LSTF) hot leg small break loss-of-coolant accident SB-HL-02 test in the frame of Rig of Safety Assessment-IV (ROSA-IV) program. TRACE assessment manual [1] includes the Semiscale natural circulation tests using TRACE Semiscale original inputs prepared by Information System Laboratories (ISL). The original TRACE input deck was obtained by conversion of RELAP5 input model described in [2] into TRACE input model and manual modifications as removing single junction components so the deck was more readable, the components representing the vessel combining into a VESSEL component, and creating signal variables, control blocks, and trips to control feedwater flow and to control the PUMP components which are used to reduce the mass inventory in both the primary and secondary sides. In the present study the TRACE input model used has been also converted from the RELAP5 input model described in [2], however no VESSEL component has been used. The conversion from RELAP5 to TRACE input model has been done in 2017 [3]. Besides Semiscale natural circulation test also ROSA-IV small break test in hot leg SB-HL-02 has been used for TRACE assessment, which is not included the TRACE code assessment manual [1]. Namely, by code developers TRACE was assessed against six ROSA-IV small breaks in cold leg (SB-CL-01, -05, -14, -15, -16 and -18).

The purpose of this study is to assess the latest TRACE V5.0 Patch 8 against the experimental data obtained on two integral test facilities and calculated results obtained by some earlier TRACE code versions, as TRACE code is continuously updated. The paper is organised as follows. First, Semiscale and LSTF facilities, the selected tests performed on the facilities, and TRACE input models of Semiscale and LSTF facilities are described. Then, the results of test simulations are compared to experimental data and major conclusions are drawn.

2 FACILITIES, TESTS, TRACE INPUT MODELS AND CODE VERSIONS USED DESCRIPTION

2.1 Semiscale Mod-2A Facility Description

The Semiscale program used a series of facilities called “Mods” to address water reactor safety concerns [4]. All these Mods were designed to simulate a four-loop pressurized water reactor (PWR), Westinghouse type. Regardless of Mod, the scaling approach to model a PWR was basically power-to-volume scaling and the scaling factor was on the order of 1/1705 of a commercial PWR. Semiscale Mods contained most of the components of large second generation PWR: active loops with pumps, steam generators, pressurizer, downcomer and a vessel with an electrically heated core.

The Mod-2A facility was the first Semiscale Mod designed specifically to run small break experiments. One loop (intact loop) is scaled to simulate the three intact loops in a PWR, while the other (broken loop) simulates the single loop in which a break is postulated to occur in a PWR [5]. For the bulk of the steady-state experiments single-loop configuration including the intact loop with steam generator and vessel /downcomer was used. The intact-loop pump was replaced with a spool piece containing an orifice that simulated the hydraulic resistance of a locked pump rotor. For the first time, external band heaters were used on the loop piping to offset heat loss, which is critical in a small-scale high pressure facility such as Semiscale. The heat loss is on the order of the core decay heat for much of the transient, therefore external heating is needed to reduce heat loss. A bypass line between the vessel upper head and downcomer inlet annulus contained an adjustable valve to set the core bypass flow rate. Also, the Mod-2A facility used quick opening valves and blowdown nozzles in place of rupture disks.

2.2 ROSA-IV Large Scale Test Facility Description

The ROSA-IV program's LSTF [6] is designed for integral simulation of the thermal-hydraulic response of a PWR during a small break loss-of-coolant accident (SBLOCA) or an operational transient. Specifically, it aims to replicate thermal-hydraulic phenomena unique to

SBLOCAs and transients by incorporating prototypical component elevation differences, large loop-piping diameters, prototypical primary-pressure levels, and simulated system controls. The LSTF has volumes scaled at 1/48 of a typical 3423 MW thermal 4-loop PWR plant, Westinghouse type. The four primary loops in the reference PWR are represented by two symmetric loops in the LSTF, each one including an active steam generator and an active reactor coolant pump. The component elevations are preserved at full scale to simulate natural circulation phenomena peculiar to SBLOCAs and transients. Due to limitations in the power supply capacity of the test facility, the LSTF operates with an initial core power of 10 MW. This corresponds to 14 % of the volumetrically scaled (1/48) nominal core power of the PWR. To achieve prototypical initial fluid temperatures, the core flow rate in the LSTF is set to 14 % of the scaled nominal flow rate of the PWR. In addition to major components, the LSTF includes reactor protection systems, emergency core cooling systems (ECCSs), equipment controls, secondary systems (e.g. feedwater, condensate, and steam systems), and various auxiliary systems (e.g. cooling water, instrument air, and water purification). ECCSs consist of a high pressure injection system (HPIS), a low pressure injection system (LPIS), an accumulator (ACC) injection system, and a residual heat removal (RHR) system.

2.3 Semiscale S-NC-02 Natural Circulation Test Description

The S-NC-02 test cases were performed at 60 kW (6 % of full Semiscale core power). The objective of the steady-state S-NC-02 natural circulation test was to study thermal hydraulic response during the three modes of natural circulation: single-phase, two-phase, and reflux. First the steady state, single phase, 100 % primary mass inventory condition was established. The secondary side conditions were also constant. The pressurizer was then isolated from the system and a drain of 1 % to 5 % of the total primary coolant system (PCS) mass was performed. After the step drain, sufficient time was allowed for the pressure, temperature, and natural circulation flow to stabilize. The drain was repeated in step increments, until a reflux was visually observed and until the core temperatures started increasing due to core dryout. Continuous feed-and-bleed was used to maintain secondary conditions. At 60 kW power level, 16 different steady-state conditions were obtained as shown in Table 1.

Table 1: Mass flow rate as a function PCS inventory (see Table B-3 of [7])

Case	PCS Inventory (%)	Mass flow rate (kg/s)	Case	PCS Inventory (%)	Mass flow rate (kg/s)
C1	100	0.36	C9	79.8	0.6
C2	97.6	0.38	C10	78.6	0.58
C3	91.4	0.58	C11	75.6	0.5
C4	90.3	0.68	C12	72.6	0.2
C5	89.2	0.74	C13	69.4	0.08
C6	88.1	0.77	C14	66.4	0.06
C7	85.9	0.74	C15	61.3	0
C8	82.8	0.63	C16	56.2	0

Here it should be noted that in [7] the mass inventory variation range is between 100 % and 56.2 %, while in [8], [9] and [11] the mass inventory varies from 100 % to 61.2 %. TRACE assessment manual [1] use PCS inventory data from [5] and these values were followed in this study (see also [12], where this mismatch in data was studied in detail). On the other hand, RELAP5 manual [13] suggests that the mass inventory variation range is from 100 % to 61.2 %, like reported in [8] (in the report it is stated that "results are presented from a preliminary analysis of Semiscale Mod-2A Test S-NC-2"), [9] (referencing [8]) and [11] (referencing [9]). It can be easily concluded that the source data came from Table 3 of [8]). However, RELAP5 study in [12] demonstrated the RELAP5 results are in much better agreement with experimental data when using data from [5] comparing to data used in RELAP5 manual [13]. In this study the TRACE calculations will be compared to experimental data as used in TRACE assessment manual [1].

2.4 Semiscale S-NC-03 Natural Circulation Test Description

In the case of S-NC-3 test cases the two-phase mode of natural circulation was established by draining a discrete amount of fluid out of the lower plenum. The amount was previously determined from the results of S-NC-2. The S-NC-3 test cases were thus performed with core power of 62 kW and at constant primary system mass inventory of 91.8 %. After the two-phase natural circulation flow was established, the secondary pressure and collapsed liquid level were varied to examine the effect of steam generator conditions on the natural circulation flow rate. By varying the steam generator (SG) secondary side collapsed liquid level as measured from the top of the tube sheet, the effective heat transfer area from the primary to secondary side was changed. The objective of the test is to study the effect of different steam generator secondary conditions on the two-phase natural circulation. There are a series of 10 steady state conditions (cases C10 to C19) obtained at 6.0 MPa secondary pressure and primary system mass inventory of 91.8 % and lowering the steam generator secondary level in approximately 1 m increments (see Table 2).

Table 2: Mass flow rate as a function of heat transfer area (see Table 2 of [15])

Case	SG liquid level (m)	SG heat transfer area (%)	Mass flow rate (kg/s)	Case	SG liquid level (m)	SG heat transfer area (%)	Mass flow rate (kg/s)
C10	10.67	100.0	0.75	C15	5.14	55.5	0.68
C11	9.70	99.1	0.69	C16	4.04	43.6	0.59 ± 0.06
C12	8.04	86.9	0.76	C17	3.07	33.2	0.45 ± 0.11
C13	6.94	75.5	0.75	C18	2.10	22.7	0.30 ± 0.17
C14	6.24	67.4	0.77	C19	1.41	15.2	0.20 ± 0.13

2.5 ROSA-IV LSTF SB-HL-02 Small Break Test Description

The SB-HL-02 test was conducted on June 30, 1987, using the LSTF facility in ROSA-IV program. The break size was equivalent to 10 % cold leg break using 31.9 mm ID sharp-edge orifice at downstream of horizontal pipe connected to hot leg break nozzle (see Figure 1) in loop without pressurizer. The break size of 10 % is the largest among integral experiments on PWR break loss of coolant accidents (LOCAs) that are being performed at the ROSA-IV LSTF. Total failure of high pressure injection system and auxiliary feedwater as well as loss of off-site power concurrent with the scram were assumed as the experimental conditions.

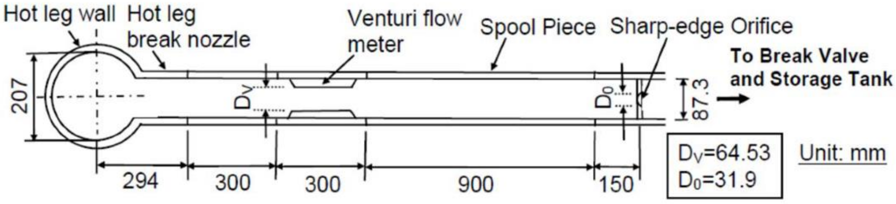

Figure 1: Configuration of Break Unit [14]

Detailed thermal-hydraulic data on a PWR hot leg break LOCA were obtained through the ROSA-IV LSTF experiment. The hot leg break LOCA transient was characterized by vapor condensation on accumulator coolant in cold legs inducing loop seal clearing and effectively enhancing core cooling thereafter. The experimental data were open to the public through publishing the data report [14].

The main sequence of events is shown in Table 3. The transient started with break valve opening at 0 s. At pressurizer pressure 12.97 MPa and 12.27 MPa the scram and safety injection signal are simulated, respectively. At 42 s core power decay is started. At 160 s cold leg fluid started flashing and primary pressure is lower than steam generator secondary-side pressure. Then primary coolant pumps were stopped at 261 s. At 300 s to 350 s the core uncovered and superheating occurred, with loop seal clearing at 340 s. At 900 s low pressure injection (LPI) system in loop with pressurizer (PRZ) is initiated at pressurizer pressure 1.29 MPa. The measured data have been provided for 1000 s.

Table 3: Major Events during SB-HL-02 Test

Time (s)	Event
0	Break valve open
6	Scram signal (primary pressure = 12.97 MPa)
9	Safety injection signal (primary pressure = 12.27 MPa)
10	Break flow from single-phase liquid to two-phase flow
42	Core power decay started
160	Cold leg fluid started flashing, primary pressure lower than steam generator (SG) secondary-side pressure
261	Primary coolant pumps stopped
280	Break flow to single-phase vapor
300 to 350	Core uncovery, superheating
330	Initiation of accumulator system (primary pressure = 4.51 MPa)
340	Loop seal clearing
900	Initiation of low pressure injection (LPI) system in loop with PZR (pressure vessel lower plenum pressure =1.29 MPa)

2.6 Semiscale Mod-2A TRACE Input Model Description

The initial conversion of input model from RELAP5 to TRACE has been done in 2020 and is presented in [12]. The TRACE input model used for Semiscale natural circulation simulations is shown in Figure 2. The reactor vessel is modelled with external downcomer, lower plenum, lower head, active core, upper plenum, upper head bypass line, simulated guide tubes and support column. The intact loop is modelled with a hot leg, an intermediate leg, a pump spool piece, and a cold leg. The intact loop hot leg is connected to the reactor vessel upper plenum volume and cold leg is connected to the volume at a reactor downcomer. The pressurizer surge line is connected to the hot leg. The secondary side is modelled with feedwater downcomer, boiling space, a separator, steam dome, a normal steam discharge and an auxiliary feedwater source.

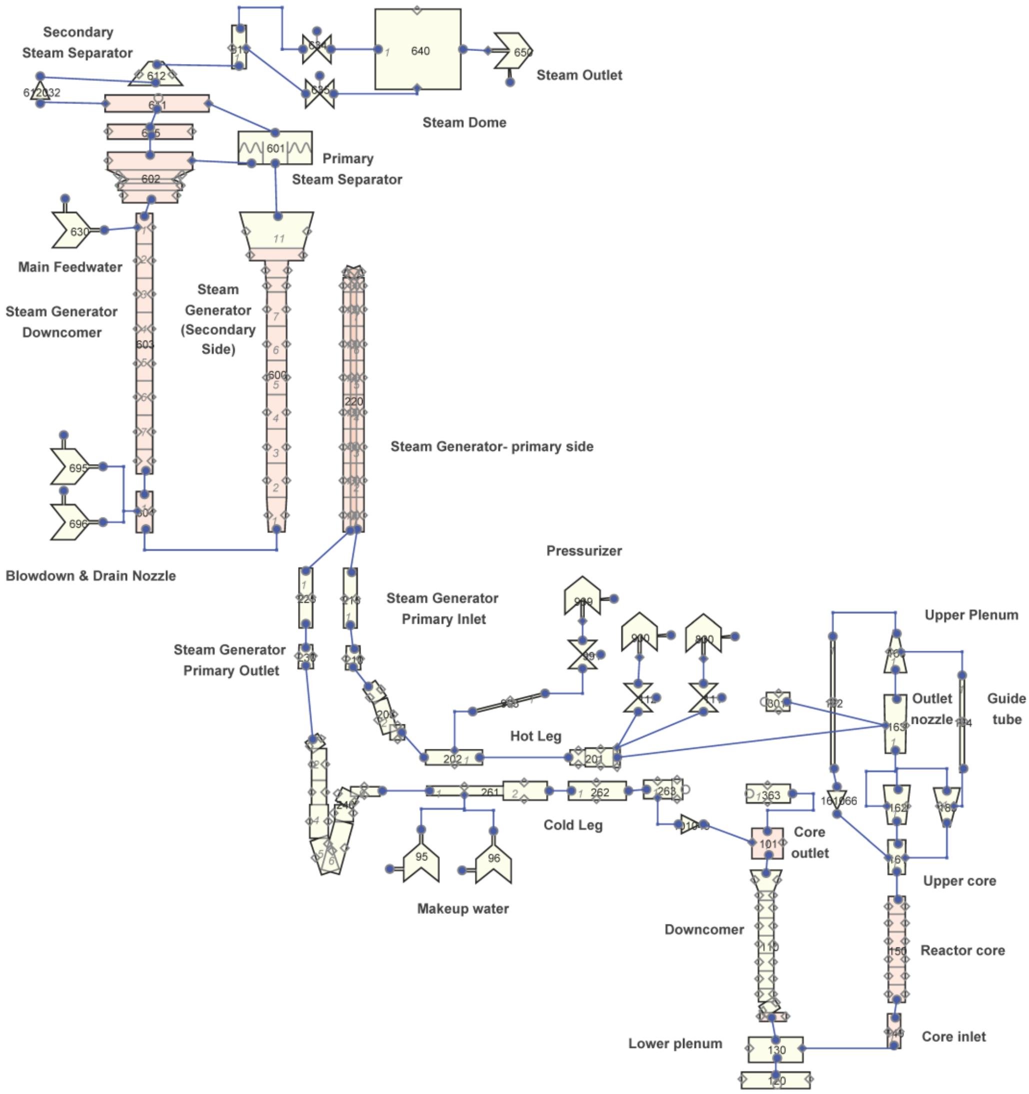

Figure 2: TRACE input model of Semiscale Mod-2A single loop represented by SNAP

2.7 ROSA-IV LSTF TRACE Input Model Description

The TRACE input model was obtained from RELAP5 through conversion by SNAP [17]. Manual corrections like break model, tees for accumulator connection, and corrections for steady-state calculation have been performed. The TRACE input model, shown in Figure 3, consists of 171 hydraulic components and 44 heat structures. It includes all important systems and components of ROSA-IV LSTF facility like reactor vessel, pressurizer, two symmetric loops, each one including steam generator, reactor coolant pump and ECCSs, which consist of a HPIS, LPIS and accumulator injection system. High pressure injection (HPI) pump is modelled only in loop 2 with the break. By assumption both HPI pumps were unavailable in the selected SB-HL-02 scenario.

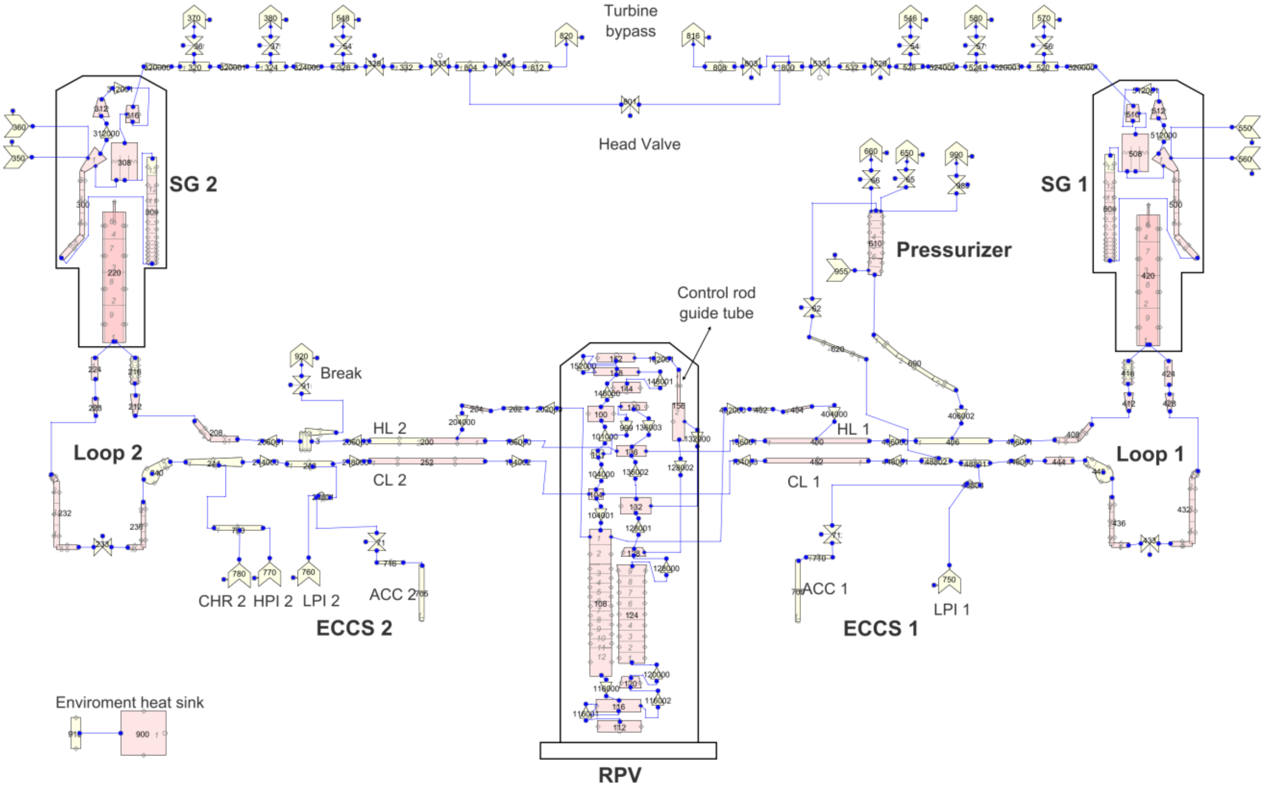

Figure 3: TRACE input model of ROSA-IV LSTF represented by SNAP

2.8 TRACE Code Versions Used

Table 4 shows five different TRACE V5.0 code versions (released as patches), which were used for calculations of the tests described above. Information on the version, date of release, calculation label and choke flow model implemented is given. The complete document revision history of TRACE Theory Manual and User's Guide provide tables with changes (date, code version and notes).

Table 4: TRACE V5.0 computer code (released on 31. 7.2007) patches description

TRACE V5.0 Patch number (code version)	**Date of release**	**Calculation label**	**Choke flow model**
V5.0 Patch 1 (V5.141)	17. 10. 2008	TraceP1	The subcooled choked-flow model is a modified form of the Burnell model and is essentially the same as that used in RELAP5. The two-phase, two-component, choked-flow model is an extension of a model developed by Ransom and Trapp that incorporates an additional inert-gas component and nonequilibrium effects. Same as in TRACE V5.0.
V5.0 Patch 4 (V5.840)	11. 4. 2014	TraceP4	Same as in TRACE V5.0.
V5.0 Patch 5 (V5.1145)	7. 7. 2017	TraceP5	The subcooled choked-flow model is same as in TRACE V5.0. The two-phase, two-component, choked-flow model replaces the characteristic analysis approach developed by Ransom and Trapp with maximization of mass flux assuming thermal equilibrium and a calculated slip between the phases.
V5.0 Patch 6 (V5.1360)	3. 8. 2020	TraceP6	Same as in TRACE V5.0 Patch 5.
V5.0 Patch 8 (V5.1671)	10. 3. 2023	TraceP8	Same as in TRACE V5.0 Patch 5.

3 RESULTS OF TRACE SIMULATIONS

3.1 Semiscale S-NC-02 Test Results

The results for S-NC-2 are shown in Figure 4. TRACE calculated results by different versions are compared to experimental data for the mass flow rate, hot leg fluid temperature, primary side steam generator outlet fluid temperature, and primary system pressure. The difference in density is the only driving force for natural circulation. The fluid density variation occurs as a result of fluid heating in the core region and fluid cooling in the steam generators. Natural circulation will occur in PWRs primary loop (in the absence of pumped flow) whenever the buoyant forces caused by difference in the fluid densities in the loop balance the flow resistance of the loop components (steam generators, primary coolant pumps, etc.). Transition from the single-phase mode through the two-phase and reflux condensation modes occurs as primary system liquid mass inventory decreases.

The test data for S-NC-2 show that for mass inventories between 97 % and 100 % the primary system behavior was similar to single-phase natural circulation. TRACE calculations show that between 69 % and 92 % of PCS inventory, there is a two-phase region, while transition from two-phase to reflux mode appears between 66 % and 69 % of the PCS inventory. In the original report [8] it is stated that selecting 91.8 % PCS inventory at which peak mass flow is reached, was based on report [7]. If we look Figure 4(a), which shows the mass flow rate as a function of PCS inventory variation for selected 16 cases, the maximum mass flow rate occurs around 88 %. From the results in Figure 4(a) it can be concluded that TRACE Patch 5 and later predicts the mass flow rate very well below 90 % (better than reported in TRACE V5.0 assessment manual).

When comparing different TRACE versions, it can be seen that TRACE V5.0 Patch 5 and later agree very well with the measured mass flow rate data. Hot leg fluid temperature shown in Figure 4(b) and primary pressure shown in Figure 4(d) are in good agreement below 88 % for all calculations. The largest discrepancy is for primary side steam generator outlet fluid temperature for calculations labelled 'TraceP1' and 'TraceP4', as shown in Figure 4(c).

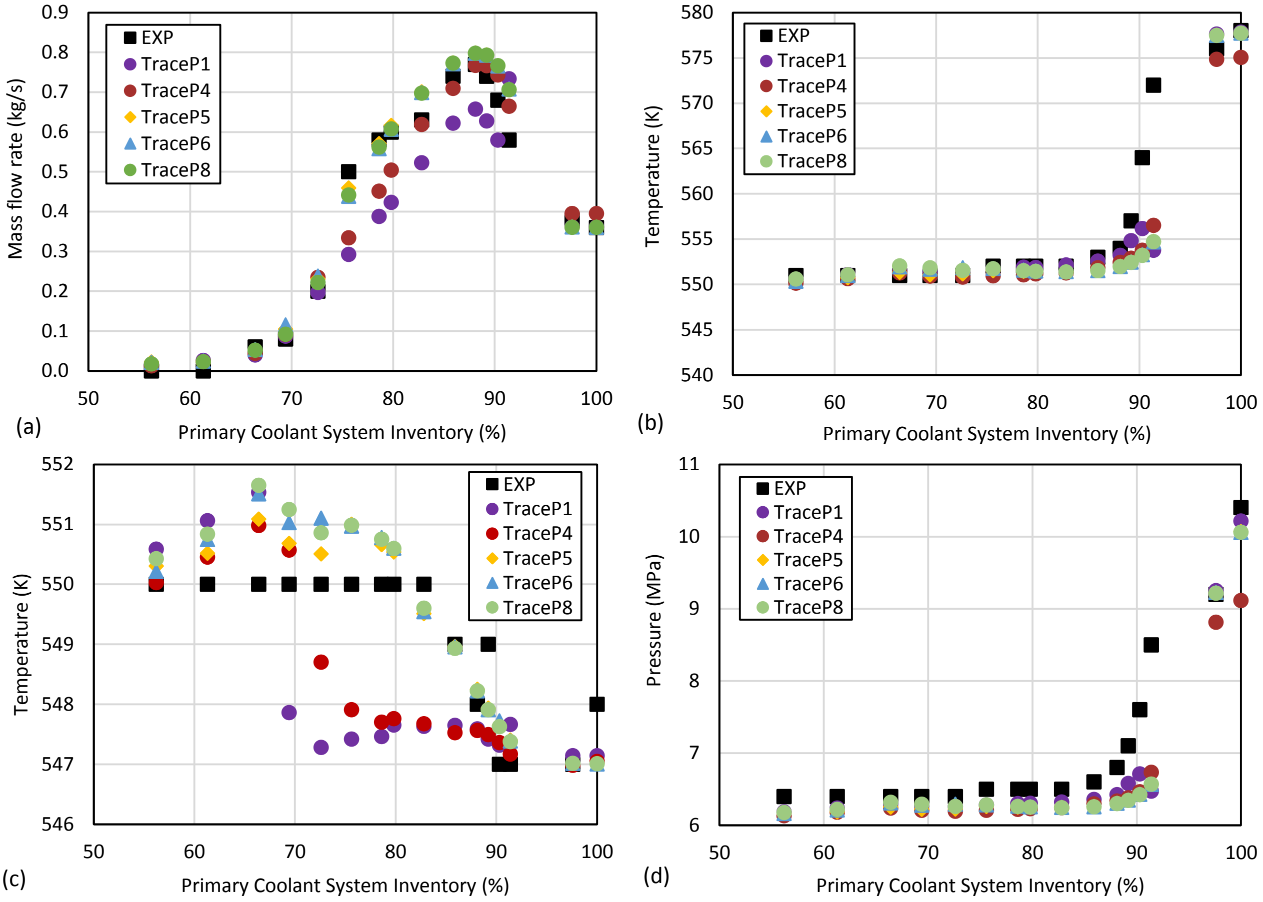

Figure 4: Comparison between TRACE Versions and S-NC-2 Test Data: (a) Primary System Mass Flowrate; (b) Hot Leg Fluid Temperature, (c) SG Outlet Temperature, (d) Primary Pressure

3.2 Semiscale S-NC-03 Test Results

The calculated results obtained by five different TRACE computer code versions are compared to Semiscale S-NC-3 experimental data for mass flow rate, hot leg fluid temperature, primary side steam generator outlet fluid temperature, and primary system pressure. Following the TRACE assessment manual [1] the simulations of S-NC-3 were done with an 89.2 % primary system mass inventory even though the test data indicate a level of 91.8 % (Table B-5 of [7]). The reason for this is that the inventory level (91.8 %) quoted for case number 10 in Table B-5 of [7] is inconsistent with the stated flow rate of 0.75 kg/s. Table B-3 of [7] shows that a primary system mass inventory of 91.8 % would correspond to a flow rate of about 0.55 kg/s, while a flow rate of 89.2 % would correspond to a flow rate of 0.74 kg/s. This inconsistency in the data report was resolved in [1] by using a mass inventory of 89.2 % in the TRACE simulations. Therefore, in this study primary mass inventory of 89.2 % was used.

In the S-NC-3 experiment [7] the mass flow rate remained nearly the same when the available heat transfer area was more than 55.5 %, but the mass flow rate decreased considerably when the heat transfer area was further reduced. As shown in Figure 5, above 55.5 % steam generator heat transfer area the agreement of TRACE calculations in mass flow rate is relatively good (especially for 'TraceP1' calculation, performed by TRACE Patch 1). Similar good agreement was obtained for hot leg fluid temperature and primary side steam generator outlet fluid temperature. The primary system pressure is in good agreement with experimental data for all TRACE calculations except 'TraceP1'.

Below 55.5 % steam generator heat transfer area the mass flow rate is overpredicted and subsequently hot leg fluid temperature and primary side steam generator outlet fluid temperature are underpredicted. The study [12] using TRACE V5.0 Patch 6 showed that further reduction of primary mass down to 82.6 % a bit improves the TRACE mass flow rate prediction, but still with significant overprediction. On the other hand, the RELAP5/MOD3.3 Patch 5 results in [12] are in good agreement with reduction of primary mass down to 82.6 %. Also, in S-NC-3 experiment an oscillatory flow occurred when the heat transfer area was 43.6 % or less, and uncertainties are quite large (see Table 2). In the report [9] it is stated that the oscillation is believed to be caused by an alternating liquid build-up in the steam generator tubes and a sweepout of the liquid from the steam generator into the pump suction.

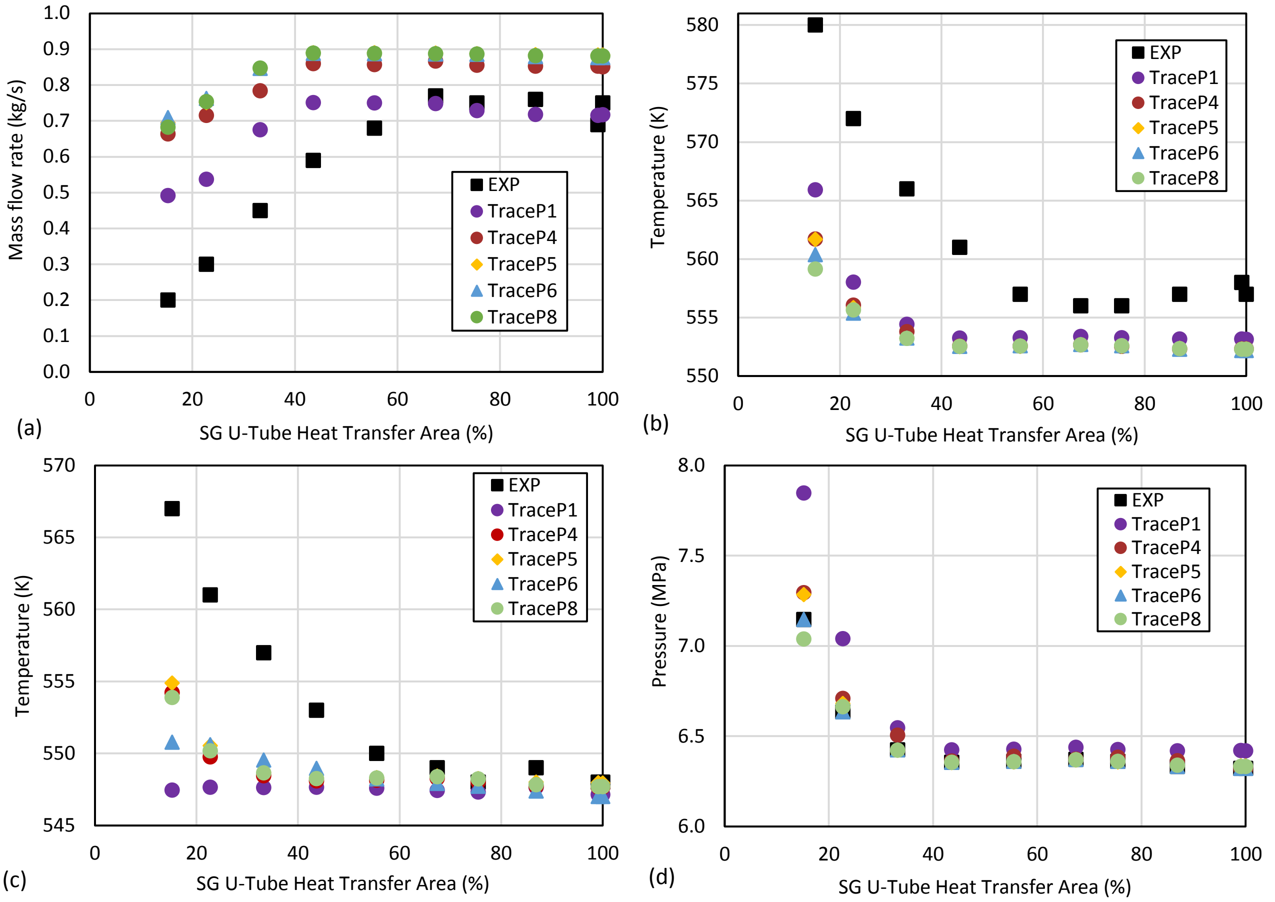

Figure 5: Comparison between TRACE Versions and S-NC-3 Test Data: (a) Primary System Mass Flowrate; (b) Hot Leg Fluid Temperature, (c) SG Outlet Temperature, (d) Primary Pressure

3.3 ROSA-IV LSTF SB-HL-02 Small Break Test Results

Figure 6 shows comparison of different TRACE versions with experimental data. The selected value of subcooled and two-phase multiplier for selected TRACE versions were 1.0 and 0.7, respectively. The value of multipliers for choke flow was selected following the study [17] performed by TRACE Patch 4, which showed that sequence of events strongly depended on the primary (pressurizer) pressure. Therefore, the choke flow coefficients were selected by user, which gave the best agreement for pressurizer pressure between TRACE Patch 4 calculation and experiment.

The TRACE Patch 4 (and earlier TRACE Patch 1) choke flow model is an extension of a choke flow model developed by Ransom and Trapp that incorporates an additional inert-gas component and non-equilibrium effects. The two-phase, two-component, choked-flow model in TRACE Patch 5 (and later versions up to the latest TRACE Patch 8) replaces the characteristic analysis approach developed by Ransom and Trapp with maximization of mass flux assuming thermal equilibrium and a calculated slip between the phases. As can be seen from Figure 6(a), TRACE Patch 6 and TRACE Patch 8 the pressurizer pressure drop is slightly slower comparing to earlier TRACE versions, but in all calculated cases the pressure drop is slower than in the experiment. Therefore, also core uncovery is a bit delayed, as shown in Figure 6(h). The TRACE calculations confirm that better pressure agreement with experimental data also mean better time agreement of minimum core collapsed liquid level (see Figure 6(g)) and peak cladding temperature occurrence with experimental data (see Figure 6(h)), which are the main safety parameters. On the other hand, Figure 6(c) and Figure 6(d) clearly show that the calculated break flow is initially in good agreement to experimental data and after 230 s it is underpredicted regardless the TRACE choke flow model. Finally, when looking the results, the choke flow model modification in TRACE Patch 5 seems not be the most significant when comparing to results obtained by TRACE Patch 4. The difference between TRACE Patch 5 and TRACE Patch 6 (and Patch 8) calculated results is larger. This may be due to significant drag model changes as part of implicit numerics robustness efforts. This change was introduced into TRACE version V5.1180 on 19. 9. 2018. This change could be compensated by tuning the calculated primary pressure to experimental trend by setting the two-phase choke flow coefficient to 0.76 (instead of 0.7) as shown by 'TraceP8-t' curve.

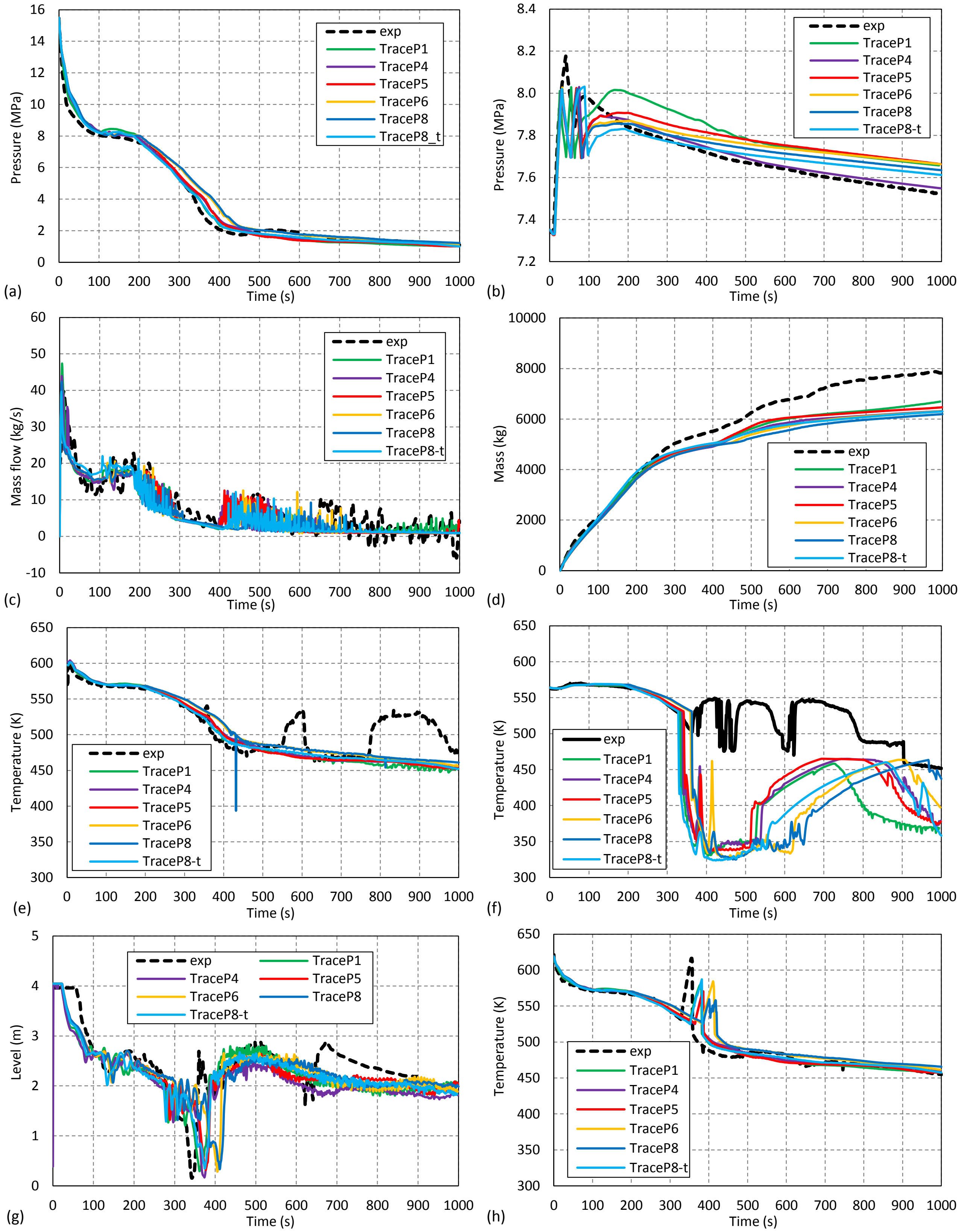

Figure 6: Comparison between TRACE Calculations and Experiment: (a) PRZ Pressure, (b) SG no. 1 Pressure, (c) Break Mass Flow Rate, (d) Integrated Break Mass, (e) Hot Leg no. 1 Temperature, (f) Cold Leg no. 1 Temperature, (g) Core Collapsed Liquid Level, (h) Rod Surface no. 7 Temperature

4 CONCLUSIONS

Five versions of TRACE V5.0 computer codes have been used for code assessment against Semiscale natural circulation tests and small break loss-of-coolant accident (LOCA) in hot leg, performed on Large Scale Test Facility (LSTF) in the Rig of Safety Assessment-IV (ROSA-IV) program.

Semiscale natural circulation tests S-NC-2 and S-NC-3 were performed at a different primary mass inventory and under the degraded heat transfer conditions, respectively. The TRACE results obtained for S-NC-2 test showed that primary system mass flow rate is in a good agreement with the experimental values. For S-NC-3 test the mass flow rate is constantly overpredicted with all TRACE versions, where the results obtained by TRACE V5.0 Patch 1 are in the closest agreement.

TRACE assessment for hot leg small break LOCA experiment SB-HL-02 performed on the ROSA IV LSTF facility suggests that all TRACE calculations are comparable and that results obtained with selected five TRACE code versions agree well with the experimental data.

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