CAMP Meetings in 2020

Two virtual CAMP meetings were held in 2020 amid the COVID-19 pandemic. The first was a pared-down "check-in" meeting that was held July 15-16, 2020. This meeting involved presentations only by the USNRC, which were followed by a question-and-answer period with open dialogue. Three of these "check-in" meetings were scheduled over the two-day period to accommodate the various time zones. Over the three sessions, 41 members participated in this first meeting, representing 15 countries. A key focus on this first meeting was on the new license key feature in TRACE, RELAP5 and PARCS. More information on this will be provided in a later article in this newsletter (see "License Keys for NRC Codes").

The second meeting was a fuller virtual meeting held November 4-6, 2020 and included member presentations. This meeting was held during a 4-hr block on each of the three days and was scheduled to optimize the time of day for all time zones. Over the three days, 89 members participated in this second meeting, representing 19 countries.

The second meeting was opened by Mr. Andrew Ireland, who then introduced Mr. Ray Furstenau from the USNRC. Mr. Furstenau welcomed everyone to the

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TRACE User Problems

The following is a report on TRACE user problems and resolutions. Open trouble reports identified in the previous newsletters with no new progress are not discussed, but can be found in the TRACE trouble report system (BugZilla) on the NRC Codes website (https://www.nrccodes.com).

For the time period January 1, 2020 through December 31, 2020, 13 new trouble reports were submitted to Bugzilla and 40 trouble reports were either resolved or closed. As of December 31, 2020, there were 939 trouble reports in the bug reporting system. Of those, 8 are for the PARCS code, 2 are bugs for the AVScript, 14 are bugs entered to test the system, 1 bug number (452) was skipped, 1 is associated with the python testing scripts used to test different versions of TRACE, and 1 is associated with SNAP and was passed on to the SNAP development team. There were 903 TRACE-specific bugs in the system at the end of the reporting period; 42 of those were open, with the remainder resolved or closed. This implies that ~95% of the TRACE trouble reports have been resolved or closed.

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CAMP Meetings in 2020 (Cont’d)
(continued from page 1)

meeting and noted that we have members from all over the world and that 19 member countries are represented at this meeting. He stated that this is the one good thing that comes out of having a virtual meeting; increased participation is possible. He thanked Andrew Ireland, Chris Hoxie and Antony Calvo for their work in preparing this meeting.

Mr. Furstenau stated that CAMP plays an essential role in the nuclear safety function of the NRC. At its core, CAMP is a regulator-to-regulator program. CAMP members have partnered with the NRC to produce one of the finest multi-physics codes in the world, the TRACE/PARCS/FAST code. Through CAMP, these advanced tools have allowed nuclear regulators around the world to check official licensee or vendor calculations of record for new vendor designs, license amendments and topical reports for methodologies. He noted that no one country or organization can do this all; it really takes national and international collaboration.

Mr. Furstenau noted that CAMP benefits all of us for what is a minimal investment. CAMP members can continue to have access to these world class computer tools, and CAMP membership helps us to prepare for the future of new advanced reactors and to discuss regulatory challenges. Furthermore, CAMP membership allows NRC access to confirmatory calculations on the world-wide operating fleet, which helps all of us. And CAMP members exercise code models and features that might otherwise go untested, and that feedback helps us all; we share that user experience which helps to identify deficiencies that can be corrected in the codes. As a result, the code applicability is expanded and the code robustness is improved.

Mr. Furstenau concluded by thanking everyone for getting up early in the morning or staying awake late at night to participate in this meeting.

Next, Mr. Ireland moved to have the minutes from the Fall 2019 and Spring 2020 (“Check-In”) meetings be accepted. Sean Roshan Ghas seconded. The minutes were accepted.

The following presentations from the USNRC were then presented:

- Status of NRC Code Development (Chris Hoxie)
- TRACE Code Development Status (Christopher Murray)
- RELAP5 Status & User Problem Report (Doug Barber, ISL)
- PARCS Updates and Status (Nate Hudson)
- SNAP Development Overview (Chester Gingrich)

The current CAMP-related contacts at the NRC are as follows:

- CAMP Program: Andrew.Ireland@nrc.gov
- NUREG/IA: Kirk.Tien@nrc.gov
- TRACE: Christopher.Murray@nrc.gov
- SNAP: Chester.Gingrich@nrc.gov
- PARCS: Nathanael.Hudson@nrc.gov
- RELAP5: Joseph.Staudenmeier@nrc.gov

This was followed by member status and technical reports. These presentations included the following:

- Konstantin Nikitin (PSI, Switzerland), “Status of CAMP-related Activities at PSI”
- Tomasz Kozłowski (University of Illinois, USA), “Heuristic vs Mathematically Complete Sources of Uncertainty”
- Andrej Prošek (Jožef Stefan Institute, Slovenia), “Status of CAMP Activities in Slovenia”
- Nadia Cipriani & Fulvio Mascari (ENEA, Italy), “ENEA TRACE Application in Fission and Fusion Field”
- Kanglong Zhang (KIT, Germany), “The ICoCo based Coupling of TRACE and SCF in SALOME, and a new function of TRACE: an automatic connection between Cylinder and Cartesian VESSELS instead of using the VESSEL JUNCTION component in SNAP”
- Geoff Waddington (CNL, Canada), “TRACE Modelling of RD-14M Station Blackout Experiments”
- Richard Trewin (Framatome GmbH, Germany), “Simulation with RELAP5/MOD3.3 of an Integral-Effect Test on Loop- Seal Clearing in the Upper Plenum Test Facility During Test A5”
- Surik Bznuni (Nuclear and Radiation Safety Center, Armenia), “Assessment of PARCS 3D Macroscopic Depletion Model for VVER-440 Reactor Core”
- Luigi Mercatali (KIT, Germany), “Exploring Cross Section Generation for PARCS Nodal Diffusion and SP3 Pin-wise Simulation of Cores with HEX and Square FAs”

All presentations from the Summer and Fall 2020 CAMP meetings are available on the web site:

https://www.nrccodes.com/CAMP/
The Technical Program Committee (TPC) meeting was held on November 6, 2020, following the conclusion of the general meeting. Andrew Ireland asked if there were any corrections or changes needed to the Fall 2019 TPC Meeting minutes. There were none. He moved that the minutes stand approved. Sean Roshan Ghias seconded the motion. The motion passed, and the minutes were accepted.

The TPC meeting then focused on the NUREG/IA status (see article on Page 12 of this newsletter). Dr. Staudenmeier asked if there were any new In-Kind proposals to discuss. The following contributions were proposed.

- Dr. Andrej Prošek, Slovenia, proposed “RELAP5 and TRACE Simulation of Bethsy 9.1b Test with Accuracy Quantification.” This proposal was accepted.
- Dr. Francesco Cadinu, Sweden, proposed “Wilks vs. Deterministic Sampling Methods of Uncertainty Analysis.” This proposal was accepted.
- Dr. József Bánáti, Hungary, proposed “Simulation of the IAEA SPE-4 Small Break LOCA Experiment with RELAP5 and TRACE.” This proposal was accepted.

The CAMP action items, both “In Progress” and “Not Started,” were then reviewed and status updates were provided for each. This was followed by a general discussion on several items. Dr. Chris Hoxie then presented concluding remarks. He thanked everyone for their time and contributions, and he noted that they had great participation throughout the meeting. The entire discussion was great, and he noted that he liked the idea of having special virtual topical meetings in the future as well.

In conclusion, he wished everyone to stay healthy and be safe. He noted his disappointment and mentioned that it is hard to believe that we’re still meeting like this, and may very well still be meeting like this six months from now. But he also noted that there have been some silver linings. In short, he encouraged everyone to take it one day at a time, and to let him know if there is anything he can do for them.

TRACE User Problems (Cont’d) (continued from page 1)

A resolved trouble report indicates that it has been addressed with an update or documentation change that is pending. A closed trouble report indicates that it has either been addressed by successfully re-running the test problem(s) of interest with a current version of TRACE, it has been closed by incorporating a pending update into the NRC developmental version of TRACE, is a duplicate of another trouble report, or has been declared “won’t fix.” A closed “won’t fix” trouble report is typically a trouble report where the resources required to fix far outweigh the potential benefit of fixing the trouble report. A pending update implies that it has been tested, documented, reviewed, and submitted to the NRC, but has not been included in the developmental version of TRACE. Inclusion of a pending update into TRACE typically requires additional review and testing by the NRC staff.

The developmental version of TRACE is Version 5.1360 as of December 31, 2020. Updates up to Version 5.1360 are listed on the TRACE build page of the NRC Codes website:

https://www.nrccodes.com/TRACE/Build/default.aspx

New Trouble Reports Still Open

Trouble Report 921 – TRACE level tracking model is not consistent with higher order special derivatives.

The current TRACE level tracking logic assumes donor cell spatial derivatives. At a minimum, input checking should be added to TRACE to test for higher order methods with level tracking turned on. A longer-term fix is to modify level tracking logic to be consistent with higher order methods. This trouble report is still open.

Trouble Report 922 – Regression test problems FullModel_Rev8 and FullModel_Rev9 have step changes in the non-condensable gas mass error.

Test problems FullModel_Rev8 and FullModel_Rev9 are steady-state models with non-condensable gas (NCG) over liquid sodium with level tracking turned on. Step
Changes in NCG mass error typically indicate that the explicit level position prediction at the beginning of the time step was inconsistent with the end of time step level position. A more implicit level tracking model should be considered or improved logic concerning when to backup and repeat the time step when explicit level position is incorrect. This trouble report is still open.

**Trouble Report 934** – ECI client is not allowed to trigger restart dump, short or long hardcopy edits, plot dump, or significant data dump.

ECI allows clients to listen for restart dump, short edit, long edit, and plot point events via a variable that is associated with each of these. The ECI client can try and set these values. However, this has no effect. TRACE does receive the value from the ECI client and set it. However, at a later point when it checks to see whether one of these events is triggered, it resets variable that triggers one of these events if it has not been triggered. If the reset point were moved to before ECI is called, or to after the event (for example writing a restart point) has taken place, then ECI clients would have the ability to control these events, which can be quite useful for analysis of results. This trouble report is still open.

**Trouble Report 935** – Changes in the total number of fine mesh nodes appeared to result in a change in the HTSTR stored energy.

The WStoreE update was developed to add HTSTR stored energy as a plot variable. During testing of this logic plots indicated that as the number of fine mesh axial levels changed for a given HTSTR component, the HTSTR stored energy appeared to change. The WStoreE update is adding new plot variables, which have no direct or indirect impact on the TRACE steady-state and transient results. It was determined at later date that the HTSTR stored energy calculation in the WStoreE update was in error and when this logic was corrected the HTSTR stored energy was not a strong function of the number of fine mesh axial levels. The FxHStoreE update is under development to ensure that the HTSTR stored energy is not a function of the fine mesh logic. This trouble report is still open.

**Trouble Report 938** – Parameters required for the TRACE critical quality correlations are currently only available for HTSTRs spawned by a CHAN component.

Critical quality correlation parameters such as the RFI parameter, the ration of heated perimeter to wetted perimeter, and number of rows of fuel rods in the fuel rod assembly are currently input for CHAN components. Therefore, these parameters can only be inherited by HTSTR components spawned by a CHAN component. At a later date input processing will be added to the HTSTR component so that these parameters can be input to TRACE and critical quality correlations evaluated. Note currently, if critical quality correlation is turned on for a HTSTR component, then this parameter will be defaulted to 1.0.

**Trouble Report 939** – Fraction of power lost between PARCS and TRACE for test problem VVER-1000-Kalinin.

A coupled TRACE/PARCS steady-state calculation for test problem VVER-1000-Kalinin does not have consistent steady-state total power between PARCS and TRACE. This trouble report is still open.

**Trouble Reports Resolved with Updates Pending or Closed**

During the time period January 1, 2020 through December 31, 2020, the following trouble reports were resolved or closed. A trouble report is resolved with updates or documentation modifications pending NRC review. These Trouble Reports are awaiting NRC review and a decision to implement or not to implement the associated code updates or document modifications into TRACE. A trouble report is closed by: (1) rerunning the test problem of interest successfully with the latest version of TRACE, (2) updating documentation to address the trouble report, (3) incorporating an update into the NRC development version of TRACE, or (4) it was decided that the resources required to fix the trouble report far outweigh the benefits. In some cases, a combination of these four fixes may be used.

**Trouble Report 338** – Add “PARCS” to CASETYPE.

Developer requested that “PARCS” be added as a valid CaseType for the AVScript. This would allow *.bpf files generated by PARCS to be processed. Currently, effort and resources required to address this request are not consistent with the benefit. This trouble report is marked as resolved/wontfix.

**Trouble Report 745** – Heat structure documentation is duplicated in Users Guide ComponentModels chapter in HTSTR and CHAN chapters.

With update FxDupVars, the duplicate documentation for the HTSTR component in the CHAN component description was moved to the HTSTR component and the CHAN component referenced that HTSTR component documentation. This update is pending NRC review.

**Trouble Report 748** – cpu time showing up in eciTest_2pipe_b.msg.

User reported that when running Regression test problem set ECI and –nouniqueout, CPU time appeared in message file eciTest_2pipe_b.msg. Update FxEcICpu
resolves this issue by modifying the runTests.py python script to insure that the ECI client jobs use consistent output options. This update is pending NRC review.

**Trouble Report 823** – Run time error with NAG compiled exe related to NumericalJacobian.

For test problems w4VesselFI.inp & pipeRupture1FI.inp, the code is throwing a run time when using a NAG compiled executable on Linux and with –checkJacobian in the command line. Reran these test problems with Version 5.1330 and no run time failures. This trouble report is closed.

**Trouble Report 824** – Run time error with NAG exe on Linux related to IATE.

Test problem BoilingIATE.inp is failing with a run time error using a NAG-compiled optimized exe on Linux. Reran this test problem with Version 5.1330 and no run time errors with NAG compiled optimized exe on LINUX. This trouble report is closed.

**Trouble Report 826** – Run time error with NAG-compiled executable related to PARCS.

Several test problems (mslb_cart_suprod_ss.inp, mslb_trace_hidr_ss.inp, mslb_trace_ss.inp, mslb_trace_tr.inp) are failing with a run time error on Linux using a NAG-compiled executable. Reran these test problems with Version 5.1330 and no run time errors with NAG compiled optimized exe on LINUX. This trouble report is closed.

**Trouble Report 827** – Run time errors in Choking routines using NAG-compiled exe on Linux.

Test problems Type7Valve.Mod4.inp and ocone3.31mbk.inp are both failing with different run time errors in the Choking module using a NAG-compiled exe on Linux. Reran these test problems with Version 5.1330 and no run time errors with NAG compiled optimized exe on LINUX. This trouble report is closed.

**Trouble Report 829** – Regression test problem epr_mod_0.50 results in gas density > liquid density for specific platform compiler.

User reported that for test problem epr_mod_0.50, the gas density is predicted to be larger than the liquid density for at least one time step at ~31 seconds for the VESSEL component at axial level 14 for Version 5.1150 compiled on Windows 7 OS 64 bit with MSVS Profession 2017 Version 15.2 with Intel Parallel Studio XE 2017 Update 4 Composer Edition for Fortran Windows. Building Version 5.1150 on other platforms with other compilers did not result in an executable that exhibits this specific problem. Reran this test problem with Version 5.1330 and no run time errors found. This trouble report is resolved.

**Trouble Report 863** – No code failure for out-of-bounds pressures.

If a user defines a flow path that has a fixed flow rate BC, but no pressure boundary condition (no outlet flow BC), then for positive flow boundary condition into the flow path the pressure will continue to increase until the maximum allowed EOS pressure is reached. For negative flow BC, the pressure will decrease until the minimum allowed pressure is calculated. If the time step size is small enough, the change in pressure at the EOS boundaries may be small enough such that TRACE accepts the solution as converged. The FxDPC update added logic to terminate the TRACE calculation if the minimum or maximum pressure limit was exceeded in the same fluid cell for 50 consecutive time steps. This update went into Version 5.1353 and closed this trouble report.

**Trouble Report 866** – Regression test problems with significant solute mass error for the PLENUM component.

During the development of the FxDTMINLogic update and the inclusion of assertion testing in a number of Regression test problems it was determined that if the PLENUM component was present, then significant solute mass error may be calculated. Update FxDTMINLogic was modified to resolve this PLENUM component solute mass balance issue. Update FxDTMINLogic went into Version 5.1253. However, test problem Mixed1b still had a significant solute mass error. Reran this test problem with Version 5.1330 and results were acceptable and this trouble report was marked as resolved.

**Trouble Report 870** – Conduction equations based on fixed dimension, with time dependent HTSTR density.

A user pointed out that mass of fuel may not be conserved with the current TRACE conduction equation solutions. The TRACE HTSTR material density is a function of temperature and will change with time. Given that the TRACE conduction equation solution uses fixed dimensions (does not change with time), then TRACE HTSTR material mass for each conduction node is not constant. The MovingMesh update is pending NRC review. This update resolves this trouble report.

**Trouble Report 874** – Regression case PbBi_H2O_withSJC.inp case incorrect.

Regression test problem PbBi_H2O_withSJC did not include an SJC. Update FxAlpChk modified this test problem to include an SJC. This update resolves this trouble report and is currently pending NRC review.
Trouble Report 892 – User requested that old non-ideal He gas properties included back into TRACE.

Because of conflicts with the multi-non-condensable gas mixture option in TRACE, the non-ideal He gas properties were removed from Version 5.801. The nonIdealHe update resolves this trouble report and is currently pending NRC review.

Trouble Report 893 – Sign of Mass Fluxes passed to CHF routines does not take into account fluid cells pointing down.

The TRACE CHF table uses the sign of the mass flux to determine the range for the low mass flux CHF formula. For mass flux in the range \(-400 < G < 100\) (G is total two-phase mass flux) the CHF is a linear interpolation between the CHF value at the mass flux boundary and the CHF at zero mass flux. However, the mass flux passed to the CHF routines has the mass flow sign associated with the fluid component cell. So, if the fluid component cell is pointing up, then G positive is upflow and G negative is downflow. If the fluid component cell is pointing down, then G positive is downflow and G negative is upflow. Update FsSgnMFlux resolves this trouble and is currently pending NRC review.

Trouble Report 894 – Time step control in terms of Courant limit is not fully documented.

The Courant limit time step control logic was not fully documented. Update AddLevGlobal resolves this trouble report and is currently pending NRC review.

Trouble Report 900 – Programming error that should have been an input error.

User provided an input with CHAN component leakage path input that resulted in a programming error, which should have been an input error. Update FxLeakPthErr resolves this trouble report and was included into version 5.1328 and closed this trouble report.

Trouble Report 903 – BWR steady-state with version 5.630 had no significant liquid in the steam line while 5.0P5 did.

User reported that version 5.630 had no significant liquid in the steam line for a BWR steady-state, while version 5.0P5 had significant liquid flow in the steam line. Between versions 5.0P5 and 5.0P6 additional capability was added to the TRACE PUMP component and without input model changes the BWR recirculation pumps where not pumping during the steady-state calculation. This resulted in core dry out during the steady-state and flow quality into the separators was large enough such that steam separators were no longer separating steam. With the input corrected the 5.0P6 version of TRACE calculation a consistent and reasonable steady-state. This closes this trouble report.

Trouble Report 905 – Remove multiple maintenance blocks of coding for allocation of pointer arrays.

Currently the pointer allocation routines in the TRACAllo interface first check to see if the pointer array has already been associated. If so, then the appropriate re-allocation routine is called. With this logic included into the AllocM.f90 file, the reallocation routines such as ReAllocGen1D are no longer required. These routines could be removed and all calls to ReAllocGen1D would be replaced with calls to AllocGen1D. This would remove significant blocks of coding from TRACE and remove multiple maintenance points in TRACE associated with adding or deleting a new pointer array. Update FxAllo resolved this trouble report and was included in Version 5.1357 and closed this trouble report.

Trouble Report 907 – Adiabatic expansion of nitrogen gas.

User reported that adiabatic expansion of nitrogen gas calculated by TRACE did not match expectations. User reported oscillating exit flow that was not expected and significant non-condensable gas mass error. The test problems provided by the user did not run with Version 5.1340 of TRACE. With the input files corrected the predicted adiabatic expansion is consistent with analytical solution. In addition, no significant non-condensable gas mass error was calculated, and no flow oscillations were calculated.


While reviewing coding in routine cella3, a developer noticed a block of coding that was computing the interfacial area for the droplets flowing from a 1D fluid cell to a 3D fluid cell if there was a level in the 3D fluid cell. This block of coding would typically compute the interfacial area associated with spray of ECCS water into the upper plenum of a BWR if there is a level in the upper plenum. The logic error in this block of coding was that it included all 1D to 3D connections in this computation, rather than just the 1D to 3D connections for a specific fluid cell. Update FxFaJet resolves this logic error and is pending NRC review.

Trouble Report 911 – Potential restart issue for Regression test problem mano1dbd.

Regression test problem mano1dbd is a simple 1D manometer oscillation test problem that tests the level tracking model, when more than one 1D fluid component is used to represent the U-tube geometry. The mano1dbd test problem runs to 50 seconds. During the development
of the FxMANO1D update, a restart for this test problem was developed that restarted from 25 seconds and then ran to 50 seconds. The restart was not exact. The restart input deck had the wrong value for DTSTRT (0.001) for null restart testing. When DTSTRT was changed to -1.0, then restart results were consistent with expectations. User input of DTSTRT of -1.0, implies that the time step size from the restart dump is used for the first time step. This trouble report is closed.

Trouble Report 915 – User reported problems with PUMP type = 0.

User indicated when a FILL was replaced with a BREAK and PUMP (pump type = 0) the results were not consistent. For the user provided test problems the inlet flow rate boundary condition (BC) was not consistent. For the FILL test problem, the flow rate BC was 2 m/s. However, for the PUMP type = 0 test problem, the flow rate BC was 2 m/s. When the flow rate BC are consistent the results will not be exactly the same. The PUMP component applies the flow rate BC at cell edge 2 of the PUMP component. Therefore, the fluid conditions flow across cell edge 2 are the calculated fluid conditions in fluid cell 1, which will not be exactly the same as the fluid conditions in the BREAK component connected to cell edge 1 of the PUMP component. The FILL component applies the flow rate BC at cell edge 1 and the upstream fluid conditions are defined by the user input for the FILL component. Therefore, even though the BREAK component used to define the inlet flow fluid conditions for PUMP type = 0 model are the same as the fluid conditions in the FILL component for the FILL test problem, the upstream fluid conditions (pressure, temperature, density, etc.), will not be exactly the same for both test problems. This trouble report is closed.


During testing for the FxMANO1D update, it was observed that the peak for the manometer oscillations for this test problem increased with time rather than decreased with time. Test problems manopipe2, mano1dSimple, and mano1dbd test the level tracking model for manometer oscillation behavior. Based on an analytical model for these oscillations, a period for the oscillations can be computed. The oscillations calculated by TRACE for these test problems are consistent with the analytical model. The peak level position predicted by TRACE for test problems mano1dSimple and mano1dbd decreases with time due to wall drag. For test problem manopipe2 the peak position increases with time. It was determined that this behavior for test problem manopipe2 was associated with inconsistencies with the initial conditions. Update Fxlofftk includes the input changes to make this test problem have consistent initial conditions. This update resolves this trouble report and is pending NRC review.

Trouble Report 917 – Potential input inconsistency for test problem twovsltkM.

This test problem is for level tracking for two VESSEL components connected with 1D fluid components. These fluid components are all vertical and the input inconsistency is at the 1D to 3D connections. For the level tracking logic to work correctly as the level crosses from the 1D fluid component into the 3D fluid component the 1D to 3D connection must be on an axial 3D fluid cell face. Note that TRACE calculates the correct elevation change for these 1D to 3D connections. When namelist IELV variable is input as 0 or 1, then the input requirement is that bounds or changes in the gravity vector occur at cell centers and not cell edges. For this test problem at the 1D to 3D connections the change in the gravity vector is at the cell edge. Additional input checking to ensure that 1D to 3D connections were consistent with the level tracking model in the FxSideTubeVssGrav update resolves this trouble report and is pending NRC review.

Trouble Report 918 – Liquid metal Na with NCG present does not run.

The original implementation of the liquid sodium properties into the TRAC-M code was for specific applications that only involved single phase liquid sodium flow and heat transfer. The TRAC-M code was the base code version for the TRACE code, which then incorporated additional models and capabilities from TRAC-B and RELAP5. The sodium equation of state in TRACE does not currently support a sodium vapor phase, but was expected to be able to support non-condensible gas (NCG) over liquid sodium. This option was never tested and a user indicated to be able to simulate liquid sodium and NCG. Code version 5.1355 + LowVapPress + AddLevGlobal + FxLT resolved this trouble report. Update LowVapPress went into version 5.0p6+RC2. Updates AddLevGloba and FxLT are pending NRC review.

Trouble Report 919 – Re-use of variable names for different purposes.

It is poor programming practice to re-use variable names in different sections of the code. This can lead to errors when maintaining the code, as well as confusion as to what the actual use of the variable is. It was found that temporary arrays c5p1, c5p3 and c5p5 are used in both the set up and solution of the 3D linear equation set and the cella3 subroutine with different definitions. Update FxDupVars resolves this issue and is pending NRC review.
Trouble Report 920 – Namelist input option isscvt logic is not consistent and not all of the variables in ssPowArrayT are used.

Namelist input option isscvt = 1 implies that steady-state rate of change for independent variables (pressure, void fractions, phase velocities, phase temperatures, and NCG partial pressure) will be calculated when trans = 0. The routines that calculate these parameters are ssr1D, plssr, and vssssr. The call to ssr1D from routine tf1d in the Gen1DTask module is skipped isscvt = 1. Routine ssr1D should be called when isscvt = 1 and trans = 1. Update FxSSR resolved this trouble report and went into version 5.1356. This trouble report is closed.

Trouble Report 923 – Issue with IENTRN setting IOFFTK by default.

During development of update FxRstNmlst, it was discovered that setting IENTRN = 1 for a side junction of a PIPE component did not activate the entrainment model unless NAMELIST IOFFTK was also set to 1. The input manual states that the side junctions with IENTRN = 1 are to use the offtake model for determining the side junction mass flow. Update FxRstNmlst included logic that checked if any PIPE side junctions activated the entrainment model by setting IENTRN = 1, and if so, made sure that the IOFFTK model was active by setting IOFFTK = 1. A user encountered a problem with a deck like this trouble report by changing these variable components (SEPDs). The TEE and other TEE-like components do not include the card that sets IENTRN if IOFFTK = 0. This means that for the user's input file, the SEPDs did not include any input for IENTRN. When update FxRSTNmlst was applied, it set IOFFTK = 1, which resulted in the code looking for the IENTRN card in the SEPD components. Since it was not there, the code failed. Update Fxloftk resolves this trouble and is pending NRC review.

Trouble Report 924 – Incorrect units for dpxrl and dpytl.

The dpxrl and dpytl arrays are used in the 3D horizontal stratified flow model. The variable names imply a pressure drop. However, the units for these terms are m/s, rather than Pa. Updates Add3DBC and AddLevGlobal both resolve this trouble report by changing these variable names to dhlxr and dhlyt, which is similar to the 1D horizontal stratified flow model naming convention. Both of these updates are pending NRC review. The AddLevGlobal update includes the Add3DBC, LevGlobal1D, and LevGlobal3D updates. If the AddLevGlobal update is applied first, then Add3DBC, LevGlobal1D, and LevGlobal3D updates should not be applied.

Trouble Report 925 – Problem with FanCooler model in CONTAN component.

User reported that the CONTAN FanCooler model was not calculating any condensation when the TRACE steam tables were used. When namelist input use_IAPWS_st is set to false (water equation of state (EOS) is based on TRAC-P fits), the FanCooler model appears to work. It was determined that iteration logic for the condensation interface temperature was failing when the TRACE steam tables was used. The TRAC-P EOS fits were approximately linear over a narrow range of conditions and the FanCooler model was converging. The TRACE steam tables were not linear over a narrow range of conditions. This required improves in the FanCooler iteration logic, which allowed the CONTAN FanCooler model to converge and work correct for the TRACE steam tables EOS model. The FxFanCooler update went into Version 5.1351 and closed this trouble report.

Trouble Report 926 – CONTAN wall film condensation works on horizontal heat structures.

User reported results for CONTAN component with a horizontal heat structure calculating significant film condensation, while the Theory Manual indicated that the film condensation should only be applied to vertical surfaces. The CONTANF update made the Theory Manual and coding consistent. This update is pending NRC review and resolved this trouble report.

Trouble Report 927 – Missing and incorrect NAMELIST input checking.

NAMELIST variables NOLT1D and NOLT3D are missing input checking to make sure that the values provided as input are within the correct range. This input checking should be added. In addition, NOSETS = -1 logic has been removed from TRACE. Update FxDupVars resolves this trouble report and is pending NRC review.

Trouble Report 928 – The 1D to 3D source term arrays srcI, srcJ, and srcK are not initialized if level tracking is off.

The 1D to 3D source term location arrays srcI, srcJ, and srcK in the 3DSrcAr data structure are not initialized when level tracking is turned off. The Lev3Dbasic routine uses these arrays to determine blocks(iVol)%levLoc. The levLoc parameter is used in a number of places in TRACE to determine interfacial shear, to set up the stabilizer momentum equations, to determine fluid conditions at a HTSTR surface, etc. The levLoc parameter is calculated independent of the level tracking model. However, the Lev3Dbasic routine needs these three arrays to compute levLoc at 1D to 3D connections. Update FxLT resolves this trouble report and is pending NRC review.
Trouble Report 929 – FILL for restart test problem HDR_Mod.Rst was not working as expected.

Regression test problem HDR_Mod.Rst restarts from test problem HDR_Mod. Test problem HDR_Mod has a FILL with the number of data pairs in the FILL tables as a negative number (nftb < 0) and uses ifty = 6, which does not expect a FILL trip to be input. A negative number for nftb, implies that the independent variable to be used in the FILL table interpolation logic will be relative to when the FILL trip is on. However, the FILL trip was input as zero (ifr = 0) consistent with ifty = 6. Test problem HDR_Mod evaluates the FILL tables correctly. However, for the restart, the FILL mass flow rates are not consistent across the restart. Changing nftb > 0, results in a consistent restart. Update CONTANFx adds appropriate input check to catch this input error and is pending NRC review.


CONTAN component restart issues were fixed with update CONTANFx, which is pending NRC review. Note this trouble report is a duplicate of trouble report 930.

Trouble Report 932 – URL reference for isosceles triangle laminar shape factors no longer available.

Update LamsFx updated coding and documentation to reference an available reference for isosceles triangle laminar shape factors. This update resolves this trouble report and is pending NRC review.

Trouble Report 933 – Conflicts between fluid conduction model and level tracking.

During testing of the level tracking model with fluid conduction turned on, it was determined that there was an inconsistency between these two models. Specifically, the fluid conduction model approximated the cell edge void fraction as a linear average of the void fraction in the two neighboring fluid cells. If a level is present in either of these two fluid cells, then this approximation could be in significant error. The FlCondFx update resolves this trouble report by taking into account the presence of a level when estimating the cell edge void fraction. This update is pending NRC review.

Trouble Report 936 – Derivative of the liquid phase density given a change liquid temperature holding pressure constant (drldt) for liquid Na appears to be missing some terms.

A scan through the RhoLiNa routine indicates that drldt does not include the derivatives with respect to temperature for the drldp term. Liquid sodium density fit coefficients in the drldp term are a function of liquid phase temperature. However, the drldt returned by this routine does not include d(rldp)/dt. Since drldp is a function of temperature and pressure, d(drl/dt)/dt is not zero. drldt is the partial of the liquid phase density given a change in liquid temperature with the pressure held constant. drldp is the partial of the liquid phase density given a change in pressure with the temperature held constant. In addition, the viscosity of Na is dependent upon the density of Na. The density fit used on routine VISCLNa is not complete and lacks the pressure dependence terms. User reported that the sodium liquid phase enthalpy was not consistent with a more current ANL report for liquid sodium density. This trouble report was resolved with the FxNaProp update, which is pending NRC review.

Recent RELAP5 User Problems

RELAP5 user problems reported or resolved are summarized in each issue of the newsletter. If you encounter a problem with RELAP5, please report it to Joseph Staudenmeier (Joseph.Staudenmeier@nrc.gov) and Doug Barber (dobarber@islinc.com). The complete list of RELAP5 user problems, including a description of the problem, status (resolved, in work, on hold, or unresolvable) and, if resolved, the manner of resolution is available on the https://www.nrccodes.com web site.

Since the last NRC Codes Newsletter was published, three new RELAP5 user problems were submitted, of which two user problems were resolved. In addition, one user problem from 2018 was also resolved. A description of these user problems is provided below.

No. 2018-04 (06-12-18), Resolved

Code Versions Affected: RELAP5/Mod3.3Patch5

The user reported differences between 3.3Patch02 and 3.3Patch05 in the prediction of void fraction at the break which significantly influences evolution of the transient in general. This was for code validation against PKL H1.2 test (1% downward oriented SBLOCA). The difference is troubling since 3.3Patch05 appears to give worse results than 3.3Patch02.

Resolved 07-22-20: There are two issues that were found. First, the abrupt area change model (a=1) was being used at the choke plane. It is recommended that abrupt area be turned off at junctions where choking is expected to occur and where the choking flag is activated. When abrupt area change is active, the code uses the downstream conditions rather than the upstream conditions. This is in contravention to the modeling...
guidance found in the Choked Flow section (2.3.2) of Volume II of the RELAP5/Mod3.3Patch05 manuals. The modeling guidance in this section will be updated to state that the smooth area change model should be used at choke planes. In this case, the loss due to abrupt area change can be modeled explicitly using loss factors.

Second, Ransom-Trapp does not do as good of a job of calculating the critical flow rate for this tw-phase blowdown case. It is recommended that Henry-Fauske be used instead. When turning off abrupt area change (a=0) and replacing Ransom-Trapp with Henry-Fauske (turn off Card 1 Option 50), the code now predicts a collapsed core level that is closer to the data.

No. 2019-02 (09-11-19), In Work

Code Versions Affected: RELAP5/Mod3.3P05

At the Fall 2018 CAMP Meeting, the user proposed to change the calculation of the boron reactivity feedback in subroutine rkin. The user was seeing large boron concentrations at low liquid fractions, and proposed to multiply the boron reactivity by the liquid fraction to mitigate this effect.

Status 9-11-19: The user’s proposed calculation does not yield the correct units of $ of reactivity. It is not recommended that this correction be implemented in RELAP5. The user has notified of this, and we are awaiting concurrence from the user.

No. 2020-01 (07-20-20), In Work

Code Versions Affected: RELAP5/Mod3.3lf

The problem concerns the calculation of minor pressure loss across a user-specified K factor, in adiabatic single-phase (liquid) flow conditions: in fact, the code-calculated pressure appears to be inconsistent with the formula:

$$\Delta p = \frac{1}{2} K \rho v^2$$

(with K = minor pressure loss coefficient; $\rho$ = liquid density; v = velocity)

If the flow rate is imposed, then the resulting pressure is somewhat larger than the theoretical value.

If the pressure is imposed, then the resulting flow rate is somewhat smaller than the theoretical value.

The discrepancies can be as large as a few percent, depending on specific flow parameters. The smaller the velocity, the larger the discrepancy.

Status 10-06-20: It was confirmed that RELAP5 is not adding any friction terms (artificial or physical). There are no additional source terms to the momentum flux either (i.e., interfacial drag, gravity head, etc.). When examining the pressure response over the first few time steps, the convergence behavior is oscillatory and eventually steadies out at the new conditions. A similar response is seen in TRACE as well. The RELAP5 theory manual does indicate that the code should reduce to Bernoulli for single phase, frictionless, horizontal flow. The observed differences appear to be numerical, but further investigation is needed.

No. 2020-02 (08-19-20), Resolved

Code Versions Affected: RELAP5/Mod3.3P05

The user noted that in the ‘prop-int’ control component, the user-supplied minimum and maximum limits are applied twice in the integral term and the final value of the control variable. Also, the unscaled integral term is applied to the minimum and maximum limits. According to the RELAP5 code manual volume 5, User guidelines, page 137, the minimum and maximum is applied to the final value of the control variable after the scale factor has been applied. Nevertheless, if the programming logic is intended as-is, there should be an explicit description about the logic in the manual for users.

Resolved 09-17-20: After examining the user problem, it was decided that the best resolution at present is to update the manuals to reflect what the code is doing internally. This way, the historic behavior of the proportional-integral component is preserved. A note was added to indicate that if the described behavior is not acceptable, the user will need to manually build the proportional-integral controller. Changes were made to both the input manual (Vol. II, App. A) and the user’s guidelines (Vol. V).

No. 2020-03 (08-19-20), Resolved

Code Versions Affected: RELAP5/Mod3.3lf

While testing the RELAP5/PARCS coupling on Linux, a RELAP5 deck was employed that used continuation cards for the 6-word format of HS Cards 601-699. Changes made by Wojtek Baltyn to expand these HS cards to a 7-word format (3.3lb) did not consider continuation cards and therefore the deck failed input processing. This will need to be corrected so that Wojtek’s change also works with continuation cards.

Resolved 09-24-20: The call to inplnk in subroutine rhtcmp is used to check the total number of words. For inputs that use continuation cards, this number could be multiples of 6 or 7. Therefore, we check if the modulo is 0
when dividing by either 6 or 7, and then set the number words on each card accordingly. It should be noted that there is a corner case here if the total number of words is a multiple of both 6 and 7 (i.e., 42, 84, 126, etc.). In this case, the code cannot tell whether the 6-word or 7-word format is being used. In this case, the logic will assume that the 6-word format is being used.

TRACE Online Training Status

An online TRACE training course for beginning users is currently under development. It is anticipated that this online course will be incrementally rolled out to the user community starting in early 2021. The course is intended to cover the basics of TRACE and will include simple exercises that complement the basic functionality of TRACE. SNAP is utilized throughout the course. The online course contains a mix of presentations on TRACE basics and short video segments illustrating the use of the TRACE components. The training course is enhanced with a basic understanding of model reasoning and analysis.

The basic TRACE training online course is intended to cover the following topics:

1. Introduction:
   • Welcome and
   • Course objectives

2. TRACE Overview:
   • Basic TRACE code theory,
   • Computation process,
   • TRACE input/output

3. SNAP Setup and Configuration:
   • Basic instructions on how to setup SNAP and
   • Using the Model Editor.

4. Introduction to TRACE Modeling:
   • TRACE component overview,
   • Global options,
   • Time step data,
   • Special 1D modeling options,
   • Introduction to basic 1D components, heat structures, and control system inputs,
   • Introduction to material properties.

5. MIT Pressurizer exercise:
   • Setup and simulate the ST4 MIT pressurizer experiment.

6. Valve Component and Exercise:
   • Introduction to the valve component,
   • Critical flow modeling and
   • Marviken critical flow exercise

7. PUMP, SEPD, POWER, and VESSEL Components, Reflood and Exercise:
   • Introduction to the PUMP, SEPD, POWER and VESSEL components,
   • Reflood considerations, and
   • FLECHT-SEASET reflood exercise.

8. Steady-State Modeling:
   • PWR system model introduction and steady-state considerations,
   • Loop closure issues,
   • Side-junction considerations.

9. PWR SBLOCA Transient Analysis:
   • Perform a transient simulation of a small break LOCA in a PWR

10. BWR System Modeling (future addition):
    • Introduction to BWR specific components, and
    • BWR steady-state and transient simulations.

The first seven modules are now available for users to access. To request a training account, please send an email to Lance Larsen at ISL (llarsen@islinc.com).

License Keys for NRC Codes

License keys are now required starting with TRACE V5.1341, RELAP5/Mod3.3lf and PARCS v3.3.2. Any approved user (requires a current CAMP or domestic user group agreement AND a signed NDA) can get license keys for any machine owned by the user's organization (no personal machines). The basic process is as follows (in the future it is expected that this process will become more automated):

- Add user(s) to the organization’s NDA (if not already included).
- Request and receive code distribution.
- Use the license request generator provided with the distribution to generate a license request file for each machine where the code is intended to be executed; multiple license request files may be provided to generate one license key that will work on each of those machines.
- Send the license request file(s) to Doug Barber at ISL (dbarber@islinc.com).
• If the user(s)/machine(s) have been approved, then a license key will be generated using the license request file(s) provided and will be sent to the user(s).
• The user(s) will copy the license key to either (1) the same folder as the code executable or (2) the folder specified in environment variable NRC_LICENSE_DIR. Note that the codes will use Option (1) in preference to Option (2). The license keys also work within the SNAP environment as well, provided the key can be found in one of these two locations.
• Run the application and report any issues to Doug Barber.

Status of NUREG/IA reports

Since the July 2020 CAMP meeting, no new NUREG/IA reports have been published. The last posted report in June 2020 was the following:

• **NUREG/IA-0520**, Simulation with Relap5/Mod3.3 of an Integral-Effect Test on Loop-Seal Clearing in the Upper Plenum Test Facility During Test A5 (Germany)

The following is a list of seven pending NUREG/IA reports:

• **NUREG/IA-05xx**, Analysis with TRACE Code of PKL III Test G1.1 & G1.1a Study on Heat Transfer Mechanism in the SG in Presence of Nitrogen, Steam and Water as a Function of the Primary Coolant Inventory in Single Loop Operation (Spain)
• **NUREG/IA-0521**, Analysis with TRACE Code of PKL III Test G1.2 Study on Heat Transfer Mechanism in the SG in Presence of Nitrogen, Steam and Water as a Function of the Primary Coolant Inventory in Double Loop Operation (Spain)
• **NUREG/IA-05xx**, Plant Application with TRACE Code of PKL III G1 test series Study on Heat Transfer Mechanism in the SG in Presence of Nitrogen, Steam and Water as a Function of the Primary Coolant Inventory in Single and Double Loop Operation (Spain)
• **NUREG/IA-0523**, Evaluation of 4-Inch Cold Leg Top Slot Break LOCA in ATLAS Facility with RELAP5 Mod3.3 Patch 5 (Korea)
• **NUREG/IA-0522**, RELAP5 and TRACE Constitutive Relations Comparison (Korea)
• **NUREG/IA-05xx**, TRACE VVER-440/V-213 Model Cross-Code Validation (Ukraine)
• **NUREG/IA-05xx**, TRACE VVER-1000/V-320 Model Cross-Code Validation (Ukraine)

CAMP members are reminded of the NUREG/IA process. Specifically, that members should submit an NRC Form 426 with an authorized signature in Item 4.8. Members should use Microsoft Word styles to configure the document, and recently posted reports can be examined in order to follow the style. Specifically, the Arial font should be used as much as possible, since it is the NRC preferred font; this makes conversion to the final PDF format less troublesome. Members should be sure to use the “IA TEMPLATE” to create their drafts or it will likely be rejected. The template and “How to” guide are both posted on NRCCodes.com. The country representative should make sure they have valid and current login information. CAMP members are asked to please follow the guidelines so that all NUREG/IA have a uniform format, and to keep the abstract brief as it is supposed to be less than 200 words, and the title should be shorter than three lines if possible. Members are reminded to have a technical editor review the report before submitting it and to scan for missing links within the document such as “Error! Bookmark not defined.” Left-aligned body text should be used throughout. Figure captions should have an initial capital letter, spaces should be left between the figure number and the caption. If members have a problem accessing NRCCodes.com, they should contact Doug Barber (dbarber@islinc.com) to resolve the issue. Alternatively, Dr. Tien can e-mail the Template and 426 form.

The most frequent problems observed by Dr. Tien relate to not paying attention to details such as font, margins, line spacing and paragraph justification. All figure and table titles should follow the “Captions” style, i.e., initial capitalized letter and left justified. The same format is used for the items in References. Lastly, there should be three or four spaces between the figure number and where the title begins.

CAMP members can e-mail Dr. Tien at Kirk.Tien@nrc.gov or Dr. Chris Hoxie at Chris.Hoxie@nrc.gov for help, or call Dr. Tien at 301-415-1606. Members should inform NRC of proposed NUREG/IA titles for next year as soon as possible. The NRC publishing branch would like to plan their resources and support based on this estimate. The preferred procedure is to bring up the proposed in-kind contribution during the TPC meeting and have CAMP members concur on the topic report. It is also preferred that reports and Form 426 be uploaded in Microsoft WORD format to the respective country folder on the NRCCodes.com SharePoint site.
2021 CAMP Meetings

During the Fall 2020 CAMP Meeting, it was noted that it seems likely that the Spring and Fall 2021 CAMP meetings will once again be virtual. Details will be provided to CAMP members as soon as they are available. The NRC is open to revisiting how CAMP meetings are conducted in the future, and feedback from CAMP members is encouraged. Furthermore, if there is interest in special topical sessions, this could be explored as well. If CAMP members have any suggestions for the upcoming virtual Spring 2021 CAMP meeting, please send them to Andrew Ireland (Andrew.Ireland@nrc.gov).

Other Items of Interest

Code users are encouraged to visit the SharePoint site, https://www.nrccodes.com. You can join in discussions, download relevant documents, access TRACE (Bugzilla) and RELAP5 User Problem descriptions, and for CAMP members, access information on the CAMP program including status of proposed and active in-kind contributions, announcements and a calendar of upcoming events. The discussion area supports asking questions and sharing experiences. As a reminder, TRACE bugs may now be reported to the following email: TRACE.Bugs@nrc.gov.

Christopher Murray is the contact point for the SharePoint site. If you have any problems accessing the site, or if you have any questions or would like additional information on the NRC TH codes, please contact Christopher Murray at Christopher.Murray@nrc.gov.