Spring 2014 CAMP Meeting

The Spring 2014 CAMP Meeting was held May 14 through 16 at the Faculty of Electrical Engineering and Computing (FER) in Zagreb, Croatia. The CAMP members were welcomed to the meeting by Dr. Davor Petrinovic, Vice Dean, Faculty of Electrical Engineering and Computing. An additional welcome was provided by Mr. Sasa Medakovic, Director - State Office for Radiological and Nuclear Safety, Zagreb, Croatia. He informed the CAMP members of the long relationship Croatia has had with the USNRC, since 1988. He indicated how his agency works with the Faculty of Electrical Engineering and Computing and the Faculty of Science of the University of Zagreb, the Enconet firm, and the State Office itself, to support nuclear safety assessments for Croatia.

Carl Thurston then welcomed the CAMP members and thanked them for supporting the CAMP program. He mentioned there were about 40 attendees at the meeting, with some 27 presentations planned with 4 of those being remotely made by NRC staff our home office in Rockville, MD. 18 technical presentations were planned to be given along with 3 member country reports.

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TRACE User Problems

This 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 (TRACEZilla) on the NRC Codes website (https://www.nrccodes.com).

For the time period between January 1, 2014 and June 30, 2014, 15 new trouble reports were submitted to TRACEzilla. 12 trouble reports were either resolved or closed during this same time period. As of June 30, 2014, there were 687 trouble reports in the TRACE bug reporting system; 26 of those were open, with the remainder resolved, closed, or duplicates. This implies that ~96% of the TRACE trouble reports have been resolved or closed or duplicates.

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 or it has been closed by incorporating a pending update into the NRC developmental version of TRACE. 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.

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Carl motioned to accept the meeting minutes from the Fall 2013 CAMP meeting. Dr. Whee Choe, UAE seconded the motion. The minutes were accepted.

Carl also thanked the University of Zagreb and our hosts, Dr. Davor Grgic for their support and planning of the Spring 2014 CAMP Meeting.

The first technical presentation was given by Dr. Chris Hoxie of the USNRC. Dr. Hoxie gave a presentation on the Status of NRC Code Development. CAMP related contacts at the NRC were provided as follows:

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

Dr. Hoxie described the major elements of the “Reactor Core and System Analysis Code Suite”. The codes included in this suite include SNAP (platform/graphical user interface), Triton/Helios/CASMO and GenPMAKS (cross section library generation), PARCS & PATHS (core physics and steady state thermal hydraulics) and TRACE (reactor system thermal hydraulic analysis).

Dr. Hoxie provided an overview of NRC/ISL presentations at this meeting. In addition, he provided a brief overview of recent TRACE development, PARCS / PATHS / GenPMAKS development and SNAP development, along with a brief status summary for RELAP5.

Dr. Hoxie emphasized that TRACE V5 Patch 04 was just released, and he strongly recommended that CAMP members upgrade to Patch 04, which is supposed to be more robust and have better CPU performance. Dr. Hoxie then reviewed the enhancements that are specific to the Patch 04 version, and then the priority for future improvements targeted for next phases of development, what he referred to as “A Peek Under the Hood”. The major enhancements included (1) the mechanistic CONTAN models for sprays and films on walls, (2) PIPE-based pressurizer modeling, (3) higher order numerical methods, (4) component-by-component selection of numerical method applied, (5) multi-step backup capability (AUTO), the helical coil heat transfer component model, and (6) fuel rod model and metal water reaction improvements.

Dr. Hoxie also reviewed the development status of the PARCS suite codes and future targeted improvements for it. He indicated that the current version of PARCS in TRACE V5 Patch 04 is v32m11co, and that the current official standalone version release of PARCS is v32m13co.

Dr. Hoxie then reviewed the developmental status of SNAP, current release version being SNAP 2.2.8. He confirmed that 2.2.8 supports all TRACE versions through Patch 04. Some of the recent enhancements included automated PARCS Control Rod Search, PARCS Multi-Cycle Depletion, automated GUI testing for TRACE Plug-in, and advanced Job Stream Support for the SCALE/TRITON/POLARIS Plug-ins. Dr. Hoxie also mentioned that the SNAP interface will undergo code refactor (restructuring existing code without changing its external behavior) for Improved maintainability, Enhanced extensibility, and Enhanced Quality Assurance (verification and validation).

Next Dr. Hoxie reviewed the developmental status of RELAP5, current version being Patch 4 released in November 2010. He indicated that the development has focused on bug fixes, without any significant other changes planned. Dr. Hoxie also indicated that the NRC would be more understanding of members that continue to use RELAP5, so that if members developed coding enhancements to the code they would be officially added and released in a subsequent version by ISL.

The PWR plant modeling guidelines are available for Westinghouse, Combustion Engineering, and Babcock & Wilcox type designs currently operating in the U.S. The modeling guidelines are available on the NRCCodes Sharepoint site (https://www.nrccodes.com). The NRC is still seeking CAMP member feedback for these guidelines. Dr. Hoxie also mentioned that there is ongoing work to develop BWR Modeling Guidelines, with
target completion later this summer, 2014.

Dr. Hoxie presented a graph of CPU performance for a SBLOCA transient highlighting improvements with Patch 04 over Patch 03. He strongly recommended that CAMP members upgrade to Patch 04. The distributions by ISL are underway and members are expected to have their CDs likely by the time they return home.

Lastly, Dr. Hoxie reminded CAMP members that TRACE is the future of NRC safety systems thermal hydraulic analysis but that the NRC is agreeable to limited development for RELAP5 if the coding and assessment are provided by CAMP members. He emphasized that NRC would focus on the greater good for all of CAMP so that RELAP5 would stay in the suite if it continues to be useful tool for members. To assist in NRC near term development efforts for TRACE, he would like member assessments on four key areas (1) fuel rod models, (2) grid spacer models, (3) pre-CHF droplet field void fraction predictions, and (4) additional integral tests.

There were two questions on this presentation: (1) Dr. Aleksandar Delja (CSN) asked if uncertainty analysis capability would be added to RELAP5 in the future. Dr. Hoxie reiterated that current practice was that if CAMP developed the coding it would be implemented by ISL. Chris opened it up to the members as to how it would be implemented i.e., if they wanted the same coefficients added at the same place as in the TRACE code. (2) Another CAMP member asked about FRAPCON FRAPTRAN functionalities being added to TRACE, Chris indicated that many functions from FRAPTRAN had already been added to the code. (3) Mr. Pavel Kral (UJV) asked if NIST property tables were available, Chris mentioned that NIST property table usage had been added in the Patch 03 updates.

Later in the day, Mr. Chris Murray (USNRC) gave a presentation on TRACE Code Development Status. Mr. Murray indicated that future focus will be on bug fixes, modeling improvements, and shortening the release cycle. He showed a summary of trouble reports being tracked, and indicated that Patch 04 is developmental version 5.840. He then reviewed major changes added in since the last CAMP meeting, i.e., from developmental version 5.824. He then reviewed results of some typical separate effects and integral facility benchmarks showing Patch 03 versus Patch 04.

Mr. Murray reviewed the Roadmap short term goals (1) TRACE User Training – June 2014, (2) improved Regression testing and assessment automation, (3) boron tracking improvements, (4) full linearization of interfacial drag force term, (5) 3D interfacial drag improvements, (6) formulation of the energy equation in fully conservative form, and (7) PARCS improvements: cartesian vessel auto-mapping and coupling interface re-design (remove GI).

Vattenfall AB asked about separator model problems, he was asked to run with Patch 04 and then submit a trouble report, if results were not improved.

Aleksandar Delja asked if TRACE could compute supercritical properties for heavy water. TRACE IAPWS steam property routines for water have been extended to consider critical conditions but this is not the case for heavy water.

KINS asked if any progress had been made on installing their reflood submitted to the NRC in the November/December 2013 timeframe. NRC admitted they had misplaced the emails and needed review records (reports), and then decide on a priority for adding the KINS reflood models to RELAP5.

Dr. Nathanael Hudson then gave a presentation on the status of PARCS. He first reviewed the features added in new version: (1) conversion of TRITON specific input, (2) source specific XS options for a variety of lattice data inputs, (3) generalized Re-mapping of ADFs / ZDFs, (4) built in limits to ADFs/ZDFs, and (5) axial discontinuity factor calculations. He then reviewed modifications to PARCS to accommodate PATHS, and planned PARCS/PATHS assessments, primarily modern fuels used in Cofrentes cycle 18. He also mentioned other assessment work ongoing TMI cycle 1, DIMPLE, and Otto Han.

Mr. Chester Gingrich presented the status of SNAP. Mr. Gingrich indicated that the current release was version 2.2.8 (May 2014), and it included numeric-related updates, updates to 2D view behavior and multiple component selection, and job stream steps updated to support changing the order of parametric. TRACE plug-in version 3.3.3 was released at the end of April 2014, and it supports updates including Patch 04 modifications, i.e., helical heat-exchanger models and chan heat structure defining gap-gas fraction by specifying in gram-moles. The PARCS plug-in was also updated. Mr. Gingrich indicated that due to refactoring, users can expect delays in upgrades and bug fixes.

Mr. Doug Barber then reported on the RELAP5/MOD3.3
status. The latest full release is RELAP5/MOD3.3Patch04, which is Version 3.3iy, October 2010. The most recent developmental version is 3.3jt. A table showing the code names, version numbers and release dates for all RELAP5/MOD3.3 releases was provided.

Resolution for one user problem was reported and discussed. UPN 2014-03 from Wojtek Balyn dealt with code indexing errors when processing input from the radiation enclosure cards. An index error in rhtcmp.ff used an index of “1” but it should have been “i”. The issue was resolved in 3.3jt (3-10-14).

UPN 2014-02 submitted by Wolfgang Rapp in February 2014 specified that version 3.3iy eats mass in some cases. The problem occurs for vertical sections when heat structures are present and the modified PV term (option 90 on card 1 set) is used; option 90 is needed to model isenthalpic expansion. The results showed that using version 3.3iy, a mass error of 110 kg accumulates up to the time t=500 s. The total mass error calculated using version 3.3dx at t=500 s is 1.5E-6.

Other user problems continuing to be worked or are on hold were also briefly discussed. A complete list of user problems from 1998 to date is posted on the NRCCodes Sharepoint site (https://www.nrccodes.com). RELAP5 priorities from the Fall 2013 TPC meeting were presented and briefly discussed:

- The request to increase number of components to >1000 and maximum number of control blocks with hexadecimal representation for component numbers and control has been largely completed and will be provided via in-kind contribution from Dr. Davor Grgic, Croatia.

- The request to install Korean reflood model was discussed. The validations have been completed and the results (with coding) were sent to USNRC in November 2013.

- Pavel Kral asked about status of work on uncertainty quantification. Mr. Barber indicated that they are waiting for input as to what parameters to include, and also mentioned that this needs to be coordinated with SNAP modifications.

- Checking of spring-loaded valve may be removed from list (Mr. Attila Guba).

Additional presentations included:

- Davor Grgic, FER, Croatia, “CAMP Activities in Croatia”
- Jordi Freixa, UPC, Spain, “CAMP activities related to the development of BEPU analyses at the Technical University of Catalonia”
- Victor Sanchez, KIT, Germany, “Neutronics Calculations of a Konvoi Type PWR Reactor Core”
- César QUERAL, UPM, Spain, “AP1000® studies with TRACE V5.0 patch 2”
- César QUERAL, UPM, Spain, “Effects of RCP trip when recovering HPSI during SBLOCA”
- Damir Konjarek, Enconet, Croatia, “Influence of SG U-tubes Heat Structure boundary conditions in RELAP5”
- Wadim Jaeger, KIT, Germany, “Recent activities for liquid metal heat transfer with TRACE”
- Andrej Prošek, IJS, Slovenia, “Sensitivity analysis using FFTBM and FFTBM-SM”
- Aleksandar Delja, CNSC, Canada, “RD-14M Channel Voiding Assessment with TRACE Code”
- Pavel Kral, UJV, Czech Republic, “Analysis of Wall Condensation Models – Part 2”
- Young Seok Bang, KINS, Korea, “Improvement of SIT/FD modeling and effect on LBLOCA”
- Andres Rodriguez-Hernandez, ININ, Mexico, “Advances in the use of RELAP and TRACE”
- Konstantin Nikitin, KKM, Switzerland, “Siphon breaker modeling with TRACE and RELAP”
- Petr Heralecký, TES, Czech Republic, “Assessment of the TRACE V5.0 against MCPs trip transients in Temelin NPP”
- Ovidiu-Adrian Berar, IJS Slovenia, “TRACE input model development for Krško NPP”
- Andong Shin, KINS, Korea, “Application of TRACE code for SFR Safety Assessment and Challenges”
- Guido Mazzini, CVREZ, Czech Republic, “Thermal-hydraulic Analyses of the RCR HTHL facility Active Channel using RELAP5”
- Armin Seubert, GRS Garching, Germany, “Experience with the PARCS multi-group TPEN solver applied to fast spectrum systems”
• Aleksandar Delja, CNSC, Canada, “Modeling Leakage through Steam Generator Tube Cracks using TRACE and RELAP5”
• Victor Sanchez, KIT, Germany, “Exploring ECI for the Coupling of TRACE with a Subchannel Code”

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TRACE. Inclusion of a pending update into TRACE typically requires additional review and testing by the NRC staff.

The most current developmental version of TRACE is Version 5.843 as of June 30, 2014. Updates included in Version 5.843 can be found on the TRACE user support web site (https://www.nrccodes.com).

New Trouble Reports Still Open

Trouble Reports 677 – Regression test problem CONTANDirectControllers-RST1 dies with a programming error.

Several test problems from the Regression test problem set die with a programming error. This would typically be reported to the development staff and addressed as a code problem. Having a few test problems in the Regression test problem set that die with a programming error provides some testing of the programming error logic. However, some of these test problems indicate a programming error that should be addressed. In this case the CONTAN component in this input model throws a programming error when the CONTAN component was unable to converge. This would not normally be considered a programming error. The failure of the CONTAN component to converge will be investigated and the error type for this error will be changed. This trouble report is not resolved.

Trouble Reports 680 – Center Line Fuel Rod Temperatures do not look reasonable.

A user reported that there appeared to be jumps or step changes in the fuel rod center line temperatures in the axial direction at steady state. The user reported that changing the number of axial levels from 14 to 42 did not impact these steps in the fuel rod center line temperatures. It was determined that the step changes in fuel rod center line temperatures were due to step changes in the axial power profile. If the NZPWI input for the POWER component was changed from 0 to 1, then the fuel rod center line temperature are smoothly varying axially. When NZPWI = 1, then the axial power profile is a linear function between the user provided axial power profile data points. When NZPWI = 0, then the axial profile is stair-stepped.

When NZPWI = 0, there were small spikes in the center line fuel temperatures at the steps in the axial power. These spikes may be due to the graphics fit functions. User noted some axial variations in the HTCs that were not expected. This behavior will be investigated and this trouble report is currently open.

Trouble Reports 681 – Solute mass balance is not consistent with SETS or when fully implicit is turned on.

During the development of the FxBoronDensity update it was determined that there was no solute mass balance checker in TRACE. As part of the FxBoronDensity update a solute mass balance checker was added to TRACE. The solute mass balance checker indicated that when the solubility limits were applied, the new time donor cell densities could be changed and the SETS or full implicit solute mass balance would appear to be error. The solubility limit sets the maximum concentration or mass fraction for a given solute as a function of the liquid phase temperature. If the local fluid cell solute mass fraction is above the solubility limit, then solute is moved from in solution to plated out phase or solid phase. The solute solid phase is assumed to accumulate on surfaces within the fluid cell and is not allowed to transport out of the fluid cell. If the solute mass balance uses a new time solute macroscopic density for transport of the solute between cells, then application of the solubility limit after the solute mass balance would result in the appearance of a solute mass error. When solute is moved from in solution into the solids phase, the total amount of solute within a given fluid cell is the same. A solution to this problem was implemented in the FxBoronDensity update. Specifically, the solute mass conservation equation solution and mass balance checker are run before the solubility limits are applied. This approach allows some relatively small amount of solute to transport to the next fluid cell before plating out. If the plated out process or the process of coming out of solution happened instantaneously, then solute at mass fractions above the solubility limit would not be allowed to transport between fluid cells. It is anticipated that this assumption will not significantly impact the results. Note with nosets = 1 (i.e., semi-implicit numerics), then the solute mass conservation equations are solved with old time macroscopic densities and this specific problem does not occur. This trouble report is still open, since there still may be a mass balance error for the solute when the level tracking model is turned on.

Trouble Reports 682 – Incorrect HTC is being calculated for liquid sodium test problem.
A user reported that for a liquid sodium test problem the calculated heat transfer coefficient (HTC) appeared to be in error. TRACE was predicting a HTC ~4.2 kW/m²-K and the expected value was 13.5 kW/m²-K. It was determined that the heat flux at the surface of the heat structure (HS) was high enough such that the surface temperature went above saturation temperature for sodium. TRACE sodium properties are currently only valid for single phase liquid. When the heat transfer went out of the single phase liquid heat transfer regime, TRACE moved into the boiling water heat transfer regime. The code should have alerted the user or at least thrown a fatal error as soon as the heat transfer was no longer single phase liquid. The user noted that once the input power was reduced to something more reasonable, then the HTC evaluation stayed in single phase liquid and results were consistent with expectations. Logic will be added to TRACE for the fluid types that can only be single phase and TRACE will throw a run time error if two-phase conditions are calculated. TRACE currently has only liquid phase properties for sodium and lead-bismuth. The following TRACE fluids have only gas phase properties: 1) helium, 2) nitrogen, and 3) Air. Note that by using the external property table option any set of two phase fluid properties available from NIST can be used by TRACE. The update to address this trouble report has not been developed and this trouble report is open.

**Trouble Reports 685** – Reset of SV ISVN 115 and 51.

User reported that signal variables 51 and 115 are reset to zero at the beginning of a restart. User reported that plotting of these POWER component core average fuel temperatures always ends up with a zero as the first plot point. Since the user did not provide a test problem that demonstrated that problem, an attempt was made to duplicate the problem with the Regression test problems DHMultiSS1 and DHMultiTR1. These inputs were modified to include signal variable types 51 and 115. For the DHMultiTR1 restart test problem signal variable 51 does not start out at zero. However, signal variable 115 does start out at zero. Signal variable 115 – volume weighted core average fuel temperature is provided as user plot variable and is not used in the reactivity feedback models. Therefore the POWER component parameter referenced by signal variable 115 is not included on restart file and is calculated after the signal variables have been determined at the beginning of the time step. Signal variable 51 – power weighted core average fuel temperature is used directly in the reactivity feedback models and the POWER component parameter referenced by this signal variable is on the restart file. Therefore, for a restart when the signal variables are evaluated at the beginning of the time step the value for this parameter from the previous restart is available. A solution to this trouble report is to include on the restart file the volume weighted core average fuel temperature. Another option is to calculate this parameter during initialization when the POWER component is obtained from a restart file. The resolution of this trouble report is under consideration.

User should be aware that the zero core average temperature can be removed from the plot. For the first restart following a steady-state calculation, the x axis can be shifted to eliminate the zero time point from the plot. For multiple restarts, the data can be written to ASCII files and the zero points removed and the ASCII files plotted.

**Trouble Reports 686** – TRACE HS to CONTAN fluid compartment failure.

User reported that a test problem resulted in no heat transfer between a TRACE heat structure (HS) and a CONTAN fluid component. Initial debugging indicated that under certain conditions a negative HTC was calculated for the HS surface connected to a CONTAN fluid compartment and the negative HTC was forced to zero and the calculation continued. CONTAN fluid compartments allow heat transfer to either the gas or liquid phases and only allow heat transfer to both phases when a level is present in the fluid compartment connected to the TRACE HS. Calculation of a negative HTC resulted in no heat transfer allowed to this CONTAN fluid compartment. An update to fix the logic that resulted in a negative HTC is under development.

**Trouble Reports 687** – Command line argument –noUniqueOut does not turn off cpu time edits when namelist input cpuflg = 0 is in the ASCII input file.

Using the most current python scripts for Regression test problem testing resulted in 19 test problems having output file differences. These output file differences were not expected and were determined to be due to cpu time edits in the TRACE output files. With the perl scripts for Regression test problem testing, --nocpus was the command line used to ensure that TRACE did not write cpu times to the TRACE output files. CPU times can vary slightly from one run to next even when the executable, the platform, and the test problem are all the same. To eliminate the appearances of differences when there are no differences the cpu time edits need to be removed when running the Regression test problem set. Either the --noUniqueOut command line directive needs to override the cpuflg = 0 input or the 19 Regression test problems that have cpuflg = 0 in the namelist input needs to have that input removed.

**Trouble Reports Closed**

During the time period from Januray 1, 2014 to June 30, 2014 the following trouble reports have been closed. 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. In some cases a combination of  
these three fixes may be used.

Trouble Report 599 – Crossflow tube bank wall drag.

Update HelicalSG went into version 5.840 and closed  
this trouble report. The HelicalSG update implemented  
Zukauskas model for wall drag for cross flow across a  
tube bank. In the case of the a helical SG in a NuScale  
design, the flow down the downcomer is a cross flow  
across a tube bank. The HelicalSG update implements  
both the Zukauskas wall drag and heat transfer models  
for cross flow across a tube bank.

Trouble Report 675 – Regression test problem  
NCGFlowBad fails with a programming error.

This test fails because the 3 side junction in this input all  
have JUNID = 1. Three separate side junctions and they  
should each have a unique junction number. This was  
not caught by the PIPE component input processing and  
eventually resulted in a programming error in routine  
GenJunInfo. Update FxPDRATIO adds input checking  
logic in the PIPE component to catch this input error  
before it results in a programming error. Update  
FxPDRATIO was included into version 5.841 and closed  
this trouble report.

Trouble Report 676 – Regression test problem  
FILLSJCPSIDEJ fails with programming error.

Test problem FILLSJCPSIDEJ in the Regresion test  
problem set fails with a programming error. The  
programming error was in routine IndAob-InitJunSrc,  
where there was a failure to find an element in the aob  
array. This is not a very useful error message. For older  
versions of TRACE, if this error message was not fatal,  
then the user would have eventually saw an error  
message that indicated that SJC component cannot be  
connected to a FILL. With the current versions of  
TRACE an input or programming error is fatal and  
therefore the user would not see the more meaningful  
error message. The FxFILLSJC update resolves this  
trouble report by moving the input checking for FILLs  
connected to SJC components up before the error  
message coming out of IndAob-InitJunSrc. This update  
turns this test problem failure from a programming error  
to an input error. Update FxFILLSJC went into version  
5.842 and closed this trouble report.

Trouble Report 683 – Boron concentration injected by a  
FILL at a side junction is being zeroed out.

Update FxFILLSJC went into version 5.842 and closed  
this trouble report. When SETS is on and a FILL  
component is connected to JUN1, JUN2, or JUN3 of a  
1D fluid component, then the flow of solute across the  
FILL cell edge and into the 1D fluid component is  
simulated by the appropriate source terms on the RHS  
of the solute mass conservation equation solution.  
Under certain conditions, for a FILL connected to a side  
junction in the post phase of the time step advancement  
logic the FILL flow area for the side junction is zeroed  
out. This is because the mass and energy source terms  
for the FILL have already been included in the SETS  
mass and energy RHSs. However, the solute mass  
conservation equation is only solved once at the end of  
the time step advancement logic and the side junction to  
FILL solute source terms have not been included. The  
FxFILLSJC update adds in the appropriate FILL SJC  
solute source terms into the RHS of the solute mass  
conservation equation solution in the post phase of the  
TRACE time advancement logic.

Trouble Report 684 – Fatal crash for FILL injection to a  
side junction connection of a ‘zipper’.

User reported that if an input model had multiple side  
junctions to a given fluid cell (i.e., a ‘zipper’) and one of  
the side junctions is connected to a FILL then the input  
fails with a meaningless error message of “*spipe*  
npipes must be greater than zero”. Input model was  
provided. The FILL connected to a side junction that  
was part of a “zipper” model was not the problem. The  
problem was multiple side junctions connected to the  
same fluid cell and the user input using the JUNID = 0  
side junction input option. When JUNID = 0, then the  
side junction must be spawned and the user provides  
sufficient input to fix both ends of the spawned side  
junction. The side junction spawning logic was in error  
when multiple side junctions were connected to the  
same fluid cell. The FxFILLSJC update resolves this  
trouble report by removing the block of coding that was  
in error. This trouble report was closed when the  
FxFILLSJC update was included into version 5.842.

Trouble Reports Resolved with Updates  
Pending

During the time period from January 1, 2014 to June 30,  
2014 the following Trouble Reports have been resolved  
with updates or documentation modifications pending.  
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. Please note that at the time of publication,  
many of these trouble reports may have already been  
resolved.

Trouble Report 626 – Boron density does not seem to be  
a part of the momentum solution.

A user reported that for a 20 cell closed loop pipe model  
with a manometer geometry injection of boron into one  
leg did not result in a hydrostatic head difference and a
flow in the manometer legs. This is the expected behavior for the TRACE boron solute tracking model. It assumes that the concentration of boron is relatively low and has no significant impact on the hydrodynamics of the problem. The FxBoronDensity update was developed to make the liquid phase density a function of the solute concentration. Review of the available data indicated that over a relatively wide range of conditions the density of the solution of water and boric acid could be approximated with a linear function of boric acid mass fraction. With the update, initialization of a manometer test problem with one leg with boric acid and one leg without results in the manometer oscillatory flow as expected. This update resolved this trouble report and was submitted to the NRC and is currently pending. Note to support backward compatibility of old input models, the ISOLUT = 1 option for the solute concentration having no impact on fluid properties was maintained in the FxBoronDensity update and ISOLUT = 2 is the new model where the concentration or mass fraction of the solute impacts the liquid phase density.

Trouble Report 669 – Default solubility curve in TRACE is not used consistently.

The solute tracking model in TRACE before the FxBoronDensity update implicitly assumes that the solute mass fractions or concentrations has units of kg-solute / kg-water. The mass of solute is obtained by multiplying the solute mass fraction times the density of pure water. The default solubility curve in TRACE was determined to be in units of kg-solute / kg-solution and should have been converted to kg-solute / kg-water before it was used in TRACE. The solubility curve in TRACE was a linear function of the liquid phase temperature and the available data for boric acid and sodium pentaborate indicate that the solubility is a not a linear function of liquid phase temperature. The FxBoronDensity update resolves this trouble report. The FxBoronDensity update gives the user four options for the solubility curve: ISOLCN = 0 default boric acid solubility table, ISOLCN = 1 linear fit for solubility curve to allow for old input models that use this model, ISOLCN = 2 default sodium pentaborate solubility table, and ISOLCN = 4 user provided solubility table. User input solubility tables and user input fits can be in units of kg-solute/kg-solution or kg-solute/kg-water and will be converted by TRACE to the units needed by TRACE.

Trouble Report 672 – Differences between V5.0 Patch 3 and V5.791.

A user reported that the same input model for a ROSA-2 test case using TRACE 5.0 Patch 3, 5.791, and 5.802 did not have the same results. TRACE 5.0 Patch 3 correctly calculated no secondary side relief valve operation, while versions 5.791 and 5.802 both calculated secondary side relief valve operation. It was determined there was an inconsistency in the restart times for these calculations. When all three code versions are restarted from the same restart time, then the results are consistent and as expected. During the investigation of these trouble report it was determined that the input for a motor controlled valve were not consistent and input checking did not catch this input error. For motor control valve type 8 user inputs for valve operation are required to be in the following range: BCSP <= ECSP <= EOSP <= BOSP. BOSP – is the pressure at which the VALVE begins to open, EOSP – is the pressure below which the valve stops opening, ECSP – is the pressure above which the stops closing and BCSP – is the pressure below which the valve begins to close. For example for user input BOSP = 9 MPa, EOSP = 8.9 MPa, ECSP = 8.5 MPa, and BCSP = 8.1 MPa. Then when the pressure goes above 9 MPa the motor valve will start to open at the user provided opening rate. This will continue until either the motor valve is fully open or the pressure drops below 8.9 MPa. The motor valve will not start to close until the pressure drops below 8.1 MPa and will continue to close, unless the pressure goes back up to 8.5 MPa. If the pressure goes back up to 8.5 MPa, then the valve will stop closing. If the pressure continues to rise above 9 MPa, then the valve will start to open again. The FxMVInpChecks update adds input checking to ensure that the users input for BCSP, ECSP, EOSP, and BOSP are within the correct range. This resolves this trouble report.

Trouble Report 673 – Regression test problem tf3d2x1LT fails with a FORTRAN error.

For one time step the 3D Courant number in the edit for the test problem tf3d2x1LT is larger than 9999.9999. Overflow of the edit field of f9.4 resulted in a FORTRAN error. The FxCourantLimEdit update was modified to change these edit fields to avoid any overflows. This resolves this trouble report. The update is pending.

Trouble Report 674 – Regression test problem flecht31701 fails with a programming error.

Regression test problem flecht31701 uses TRAC-B free format input. The CHAN component in this input references a material type 50. A material type 50 refers to a user provided material properties table. However, TRACE TRAC-B free format input processing does not have the capability to read this input format for user provided material properties. Update FxTracBMat was submitted to the NRC for review. This update resolves this trouble report by adding TRAC-B free format input processing for user provided material properties into TRACE. This update is pending.

Trouble Report 678 – Regression test problem bellefontetr1 fails with programming error.

Test problem bellefontetr1 restarts from steady-state test problem bellefontess. Test problem bellefontess has 3
user-defined material properties (i.e., $NMAT = 3$). Test problem bellefontet.r1 has $NMAT = 0$. This is input error that was not caught and eventually resulted in a programming error when the referenced material properties could not be found. User should have input $NMAT = -3$ and then the material property tables would have been read from the restart or the user could have input $NMAT = 3$ and provided the material property tables in the TRACE ASCII input file. The FxTracBMmat update adds input checking to determine if the HS material property ids are valid or not. This changes this programming error into an input error.

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@nrc.gov. 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.nrcodes.com](https://www.nrcodes.com) web site.

Since the last TH newsletter was published three new user problems were submitted. Two of these problems were resolved and one was placed on hold. A description of these user problems is provided below in chronological order.

**No. 2014-01 (2/14/2014)**

**Code Versions Affected:** RELAP5/Mod3.3 Patch04

The user has been running a spectrum of LOCA calculations and has seen failures when voidg is low and quala is high. A SNAP med file was uploaded for use with testing. The LOCA test job stream does some steady-state initialization and the runs 2 LOCA cases, 80% and a 200% DEBG. The 80% case fails at 114.064 seconds and the 200% case fails at 1184.28 seconds. Both failures are due to nonconvergence of the iteration for the state properties of a very low void fraction ($<10^{-6}$) noncondensible-steam mixture in subroutine NWITHAIR. These failures are the same as seen by the user. Resolving this user problem would require a considerable amount of work. Noncondensible appearance at low void fractions is a recurring problem in RELAP5-mod3.3 and RELAP5-3D. No reliable fix had been found to date.

**No. 2014-02 (2/25/2014)**

**Code Versions Affected:** RELAP5/Mod3.3 Patch04

The user reported that version 3.3i.y eats mass in some cases. Version dx does not show a large mass error for the same cases. The problem occurs for vertical sections, when heat structures are present, and when the modified PV term (option 90 on car 1 set) is used. Option 90 is needed to model isenthalpic expansion. The user provided a short description and some simple files showing the issue. The result of these models showed that using version iy, a mass error of 110 kg accumulates up to the time t=500 s. The total mass error calculated with version dx at t=500 s is 1.5E-6 kg.

The cause of the large mass error reported by the user is that variable denrat was changed from rhog/rhof to 1.0 in eqfinl in version hx. It is not directly caused by usage of heat structures or card 1 option 90. The following logic in eqfinl truncates the void fraction under certain conditions (vdlim1=10-9, vdlm2=10-7): If (voidg>vdlm1*denrat) .or. (voidg>vdlm2*denrat .and. hight>0) then set voidg=1.0

Prior to version hx denrat was rhog/rhof. It was changed to 1.0 in version hx. For the users test problem rhog/rhof is about 0.001. So the change in denrat made the second part of the truncation logic go from (void>10-10 .and. hight>0) to (void>10-7 and hight>0). In the users model fluid with a void fraction of nearly unity flowed from a small pipe into a large pipe and activated the 2nd part of the truncation logic because the void in cells in the large pipe had void greater than 10-7. Nearly all the mass flowing into the large pipe was discarded via the void truncation logic, resulting in a large mass error. The easiest fix to this user problem is to restore denrat to rhog/rhof.

**Resolved (06-18-14):** Starting with 3.3hx, denrat in eqfinl was changed from rhog/rhof to 1.0. Version 3.3j adds Card 1 Option 31 to restore denrat to rhog/rhof in eqfinl. This makes the void truncation limit smaller, which reduces liquid mass error.

**No. 2014-03 (3/6/2014)**

**Code Versions Affected:** RELAP5/Mod3.3js

The user discovered an index error in the “do 49” loop of rhtcmp.ff. The second if-test on iscr used an index of “1”, but it should be “i”. 

**Resolved (03-10-14):** The incorrect index for iscr was changed from “1” to “i”.
TRACE/SNAP User Workshops

A Basic TRACE/SNAP User Workshop was held at the System Source Computer Training Center in Columbia, MD on June 3 – 6, 2014. 30 users attended the training and gave very positive feedback concerning the course.

Topics included:

- Basics of TRACE Computer Code and Analysis Methods
- Introduction to the SNAP User Interface
- Introduction to the SNAP Job Streams and Post Processing
- TRACE Components and Facility Model Development (3 parts)
- TRACE Modeling Issues and Guidelines
- Plant Simulations – PWR Steady-State
- Plant Simulations – PWR SBLOCA
- TRACE Strengths and Weaknesses

A second workshop is scheduled for Sept. 30 – Oct. 3, 2014 and will be held at the Hilton Garden Inn in Idaho Falls, ID. Registration for this workshop is currently open. This workshop is directed toward beginning users with some T/H system code experience, and will focus on model development, modeling guidelines and plant modeling.

For this training, space is limited to 30 trainees. Due to the limited space available, users are encouraged to register early. Priority will be given to attendees from the NRC staff and contractors, T/H Codes User Support Group and CAMP member organizations until August 30, 2014. After this date, remaining spaces will be opened to all other users.

The final deadline for registering is September 18th, 2014. This deadline is firm. We must know the precise number of attendees by that date in order to prepare the laptops and materials for the training. Any registration received after that date will not be accepted.

Users who are interested in attending the workshop in Idaho Falls should contact Doug Barber (dobarber@islinc.com) to obtain more information.

Upcoming Fall CAMP Meeting

The Fall 2014 CAMP Meeting will be held from October 22 through October 24 at the USNRC’s new Three White Flint facility, which is at the red line White Flint Station and adjacent to the White Flint Marriott. The TPC meeting is scheduled to be held on the afternoon of October 24. Additional information, including the registration form, can be found on the NRCCodes Sharepoint site (https://www.nrccodes.com).

Items of Interest

TRACE V5.0 Patch 4 was released in May of this year. The focus for Patch 4 has been to make the code more robust and to make key modeling improvements. This version includes the following major features:

- Make the IAPWS tables the default EOS algorithm
- Generic working fluids (NIST database)
- Refactored interfacial heat transfer logic
- Mechanistic CONTAN models for sprays and films on walls and improved CONTAN/TRACE communication (signal variables, trips)
- PIPE-based pressurizer modeling
- Higher order methods, with component-by-component selection of numerical method
- Fuel rod model improvements
- Metal-water reaction improvements
- Helical coil & cross flow heat transfer models
- AUTO multistep backup capability
- Improved error message behavior
- Implicit wall heat transfer modeling option

This work has been driven by user needs, which includes adding features needed to model small modular reactors (integral PWRs). Considerable effort is also being spent on making code modifications and improvements to support NRC staff who are using TRACE/PARCS to simulate transients where neutronics/thermal-hydraulics coupling is important. As such, TRACE V5.0 Patch 4 will include PARCS v32m11, which contains the following upgrades:

- Changes Wielandt shift with adaptive parameter
• Adds limiters for the ADF adjusting factor in CMFD based on GET
• Adds I and Pm densities, and core average beta, output to dep file
• Implements of z-direction discontinuity factors
• Adds Xe/Sm density calculation at shutdown cooling period
• Allows user to directly input incremental core average burnup
• Adds termination logic for control rod critical position search when neutronics have reached maximum iterations but TH solution is not converged
• Rewrites detector response, and enable detector edit output for each depletion point
• Adds more Xe/Sm options
• Adds option for starting transient from subcritical state
• Adds prediction of reactivity worth of each control rod by bilinear weighting
• Limits time step size increasing to 2 times at one step unless user requires sudden larger increment
• Rewrites critical control rod position searching
• Adds a user input option for linear or quadratic precursor approximation
• The exponential integration is approximated with 3rd order Taylor expansion when \( \lambda^* \Delta t < 0.001 \) which is more reliable than direct evaluation

Future improvements of TRACE will continue to focus on enhancing capabilities related to the simulation of new and advanced reactor designs. In addition, the focus will continue to be on improving the robustness and accuracy of the code.

Regarding RELAP5, two new features are currently being added to the code. First, functionality is being added to handle uncertainty quantification (UQ) calculations. This logic will provide a small set of UQ parameters for testing purposes. Users will be able to add additional parameters as needed. Second, the KINS reflood model is being added to the code as a Card 1 option. This model is being provided with minimal assessment. Users who exercise this model are encouraged to share testing results with NRC.

You are encouraged to visit the SharePoint site, [https://www.nrccodes.com](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 discussions area supports asking questions and sharing experiences.