The RETRAN Newsletter

Published by Computer Simulation & Analysis, Inc.

TEPCO Presents Results from RETRAN-3D/SIMULATE-3K Coupling

Introduction

In a presentation given at the May 2004 RETRAN/VIPRE User group meeting in Dallas, Texas, Mr. Yuichi Kagami described a coupling between RETRAN-3D and the transient nodal physics code SIMULATE-3K. He briefly described the code coupling and selected results from two comparisons with plant data.

The project, funded by TEPCO R&D Center was a cooperative effort between TEPCO, Studsvik Scandpower (SSP), and Computer Simulation & Analysis.

TEPCO has a considerable investment in benchmarking models with the CASMO/SIMULATE-3 core fuel management methodology. TEPCO supports 17 BWRS with this system and it makes sense to extend the data generation and physics methodology to the transient analysis area. Many advantages would be obtained by a direct coupling of

S3K collapses Power information to R3D channel geometry, and passes it back.

Simulate-3K

R3D passes channel boundary information to S3K, which applies it to each assembly.

RETRAN-3D

RETRAN-3D and SIMULATE-3K, but an important consideration is that the expertise that has already been gained in the steady-state physics methods can be directly applied and extend to a RETRAN-3D/SIMULATE-3K program.

TEPCO believes that there may be margin to be gained by the application of a three-dimensional model to transients that have been previously analyzed with point or one-dimensional kinetics models. As an example, the control rod withdrawal transient where the important rod may be in a non-central or non-symmetric location can be very precisely modeled with a three-dimensional best-estimate capability.

The coupling of the code is a first time application for BWRs. A PWR linkage has been previously reported by Duke Energy. ("SIMULATE-3K RETRAN-3D Coupled Systems Calculations", Hagrman and St. Clair, ANS Topical Meeting Proceedings, pp 20-21, Myrtle Beach, SC, March 23-26,1997.)
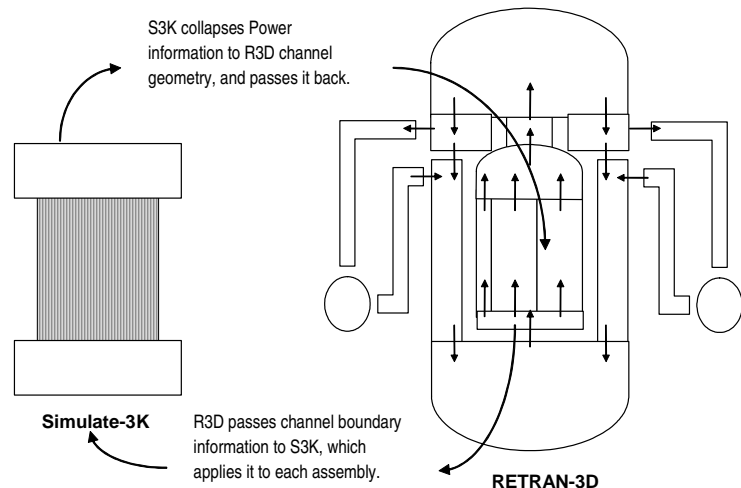
TEPCO Presents Results from RETRAN-3D/SIMULATE-3K Coupling (Cont'd)

Coupling Strategy

The two codes have been coupled in a manner referred to by the developers as "plenum coupling". Plenum coupling implies the core neutronics calculation is modeled within SIMULATE-3K and coupled to RETRAN-3D via the inlet thermodynamic state (flow and enthalpy) and upper plenum pressure.

The SIMULATE-3K model is a complete, detailed core model, in which the SIMULATE-3K thermal-hydraulics calculation produces the independent variables for feedback to the SIMULATE-3K cross sections. The cross sections were obtained from the SIMULATE-3 depletion/restart files, and CASMO neutronics libraries.

The RETRAN 3D model is a complete system model but the core is a simplified stack of control volumes, flow junctions, and conductors Based on a user-defined core mapping scheme, RETRAN-3D uses the collapsed power (power deposited in fuel pins, and power deposited directly into coolant) from more complex SIMULATE-3K calculation in the RETRAN-3D core region. SIMULATE-3K, in turn, uses the RETRAN-3D boundary thermal-hydraulics data (exit pressure, inlet enthalpy, and inlet flow).

RETRAN-3D drives the system model with the averaged or collapsed channel power distributions obtained from the SIMULATE-3K calculation at each time step. SIMULATE-3K uses RETRAN-3D calculated total core inlet flow, inlet enthalpy, and core exit pressure as boundary conditions. There is no direct 'in core' thermal-hydraulic coupling between RETRAN 3D and SIMULATE-3K data in this code version.

There are also connections to the RETRAN-3D control system to the SIMULATE-3K calculation to provide scram or control rod motion triggers.

The coupling is depicted in the adjoining figure.

Benchmarking

In his presentation Mr. Kagami mentioned that initial testing involved successful comparisons for Peach Bottom Turbine Trip Test 2. The results from this test case gave confidence in the coupling method and that the correct data is being transferred.

Mr. Kagami presented results from a one pump trip load rejection case for TEPCO BWR5. The calculation used cycle-specific cross-section data for the core and a RETRAN-3D model of the system. A generator load rejection and a one pump trip transient were analyzed. The generator load reject transient is an over-pressurization transient in which the system pressure increases causing a void collapse and subsequent positive reactivity insertion in the core. The one pump trip transient is a flow decrease case in which a reactor scram does not occur and the plant control system reacts, ultimately stabilizing the reactor power at a lower level.

Typical plots for power versus time and a key system parameter are shown in the adjoining figures.

Summary

TEPCO has participated in the development of a coupled three-dimensional kinetics and thermal-hydraulics code system that will allow detailed modeling of the BWR core dynamics and the system thermal-hydraulic response. This has been achieved by coupling the RETRAN-3D thermal hydraulics code to the SIMULATE-S3K code. Preliminary results are good and run times are reasonable. TEPCO will continue to improve the coupling, moving to the latest version of RETRAN when it is released. TEPCO will continue to explore ways to improve code performance without sacrificing accuracy. TEPCO feels strongly that this new tool will be of valuable use in the future to support all of the 17 BWR plants in its fleet.

TEPCO Presents Results from RETRAN-3D/SIMULATE-3K Coupling (Cont'd)
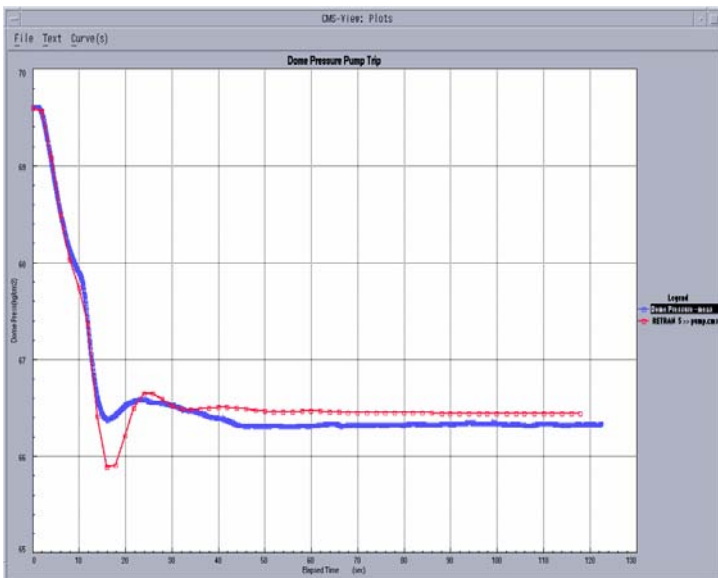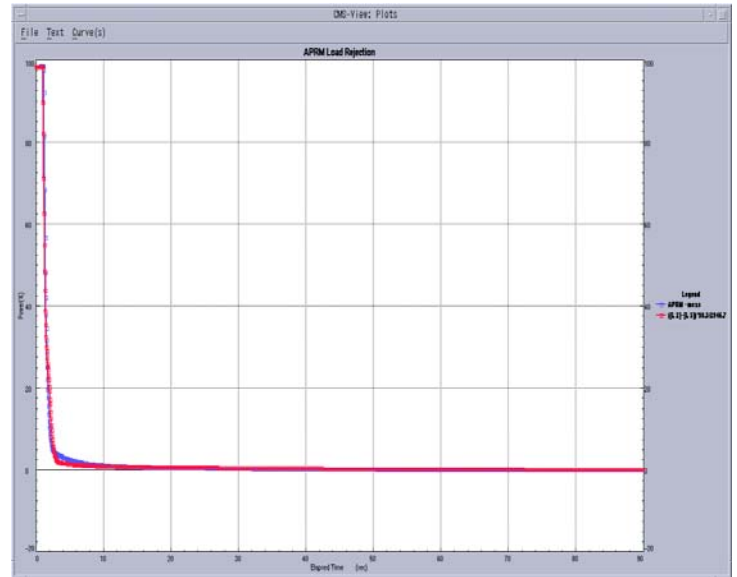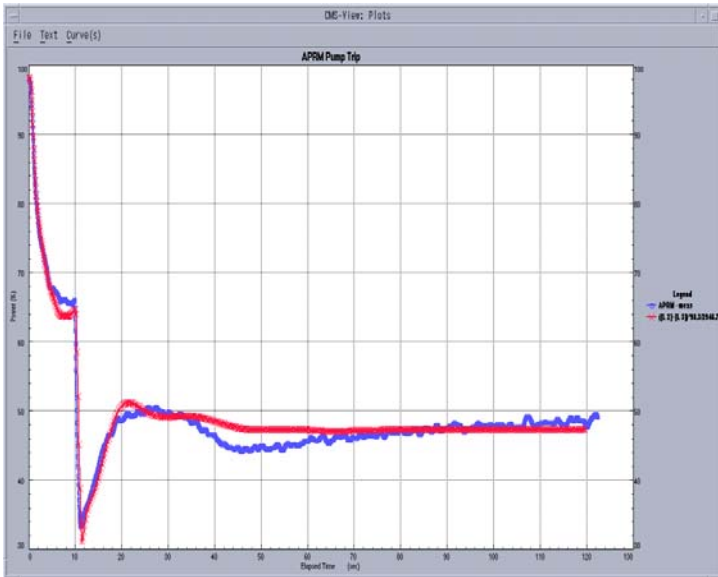
RETRAN Training Sessions Draw Students Worldwide

Two RETRAN training sessions were held in May and June 2004. The first session was attended by individuals from INER as part of an extended North American stay.
Drs. Edward Yu-Chen Kung and Wang Cheng attended the 2004

International Youth Nuclear Congress in Toronto, Canada, then a week long RETRAN training session at CSA in Idaho Falls. The final leg of their trip was to attend the May 2004 RETRAN/VIPRE User Group Meeting in Dallas, Texas.

The June RETRAN session at CSA involved seven individuals from four organizations represent a good cross section of the RETRAN user community. These were:

Erik Zambelli, WEC
Javier Iglesias, Iberdrola

Jong Jin Kim, KNFC
Keith R. Robinson, PSEG
Kil Sup Um, KNFC
Lara C. Thomas, WEC
Matthew J. Phillips, PSEG

Congratulations to all of the new RETRAN training graduates.

Please supply us with a technical tip for our Tech Tips section and you will receive a RETRAN mouse pad.

Your contributions are greatly appreciated. We encourage everyone to participated in this newsletter.

RETRAN/VIPRE User Group Meeting Held at TXU Power

The RETRAN/VIPRE User Group Meeting was held in Dallas, Texas, on May 25 & 26, 2004. TXU Power hosted the meeting at the company headquarters in Dallas, Texas. Twenty-two individuals representing 16 organizations from Japan, Taiwan, and the United States participated in the meeting. Presentations from PSI (Switzerland) and KEPRI (Korea) were also given. The participants included members of electric utilities, government research agencies, research institutes, vendors, and consultants. A summary of the meeting is given below.

Introduction
James Boatwright of TXU Power gave the chairman's welcome. He reviewed the activities since the December 2003 RVUG meeting. The meeting notes from the December 2003 RVUG meeting had the following action items.

- form a Steering Committee,
- draft a User Group Charter,
- Obtain from EPRI the funds committed by organizations for 2004,
- set a 2004 work scope and budget, and
- propose a fee structure to meet that budget.

All of these items have been addressed since that meeting and the resulting issues were discussed during this meeting. James indicated that a significant goal of the current meeting would be to review and approve the RVUG charter.

He observed that 2004 is a transition year for the RVUG since it is the last year that members will participate through the EPRI structure. James indicated that as the group moves to a self-sustaining entity, it is important to establish a 2005 work scope and budget. This is required to define the user group fees for both RETRAN and VIPRE as early as possible.

Summary

Charter
The draft charter was discussed and revised during the meeting. Issues still remain with Section 6.6.1. They will be discussed in the next few weeks in an attempt to resolve them. The revised Charter will then be transmitted to the RVUG members for review and approval.

Funding
A number of budget issues were discussed during the meeting. One was related to the cost of UNIX workstations used to test the code on those platforms. The members decided that this cost could be eliminated if they did the installation testing on their platforms. The proposed budget for 2005 is $400k plus a $25K hold back to be used for unforeseen issues that might arise during the year. The membership assessments for 2005 will be approximately 30% greater than the standard EPRI assessment for 2004. This is consistent with the projections made and the December 2003 RVUG meeting. The formula constants for the 2005 membership assessments and individual organization dues will be sent to organizations by the end of June.

New Code Release
CSA will distribute the next release of RETRAN-3D near the end of the 3rd quarter. It will contain a number of new model changes and approximately 50 error corrections. See the related article on the description of RETRAN-3D MOD004.0.

The informal proceedings of this meeting, including the presentations and a list of participants, will be available from CSA's website, www.csai.com. You may also obtain a copy by contacting Mark Paulsen, paulsen@csai.com, or Garry Gose, gcg@csai.com.

Next Meeting
The next RVUG meeting will be held at the Luxor Hotel in Las Vegas, Nevada, on November 16 & 17, 2004. More information will be provided in the coming months.

RETRAN-3D MOD004.1 To Be Released

The next version of RETRAN-3D will be the most significant update since the original release of the code. There will be about 60 modifications that will take the code from MOD003.1 to MOD004.1.

There will be over 40 modifications for corrections to trouble reports. There will also be about 20 modifications that will either extend existing models or add new options for user convenience or new models.

The code is scheduled for release during the third quarter of 2004.

Below is a summary of the update. The modifications are categorized as those that resolve trouble reports or modifications that add or extend new models. The new models are described first, followed by the modifications that correct code errors.

New Models
A brief description of the modification is given for each model or extension. Modification numbers are parentheses.

BWR Leakage Model (196)
Provides Analytic Calculation of Core Channel Flows
  Active Core
  Bypass Channels
Allows FIBWR Style calculation of Leakage Flows
  Core Support Plate
  Lateral Leakage Paths
Allows Modeling of More Advanced Fuels
  Part Length Rods
  Accounts for Water Rod Flow Paths
  Accounts for Grid Loss Model
Reynolds Number Dependent Grid Form Loss Coefficient
Two-Phase Multiplier
Two-Option Forms (PWR and BWR support)
Can Locate at Any Junction

Variable Junction Inertial (206)
Implemented with Control System

Control System Improvements
Super Summer - Sum Multiple Inputs (205)
Increase Number of Input and Control Blocks (207)

Choking Model Improvements
Use Stagnation Properties (202)
Replace Curve Fits with Tables and Interpolation (221)
Improves Accuracy Near the Critical Point

Automatic Bypass Heating Model (204)
Used with Channel Model and 3D Kinetics

New Options
The next set of updates are not necessarily new models but are extensions or new options for existing models. Modification numbers are parentheses.

FTB Dynamic Memory Allocation (235)
Use F90 Feature to Dynamically Allocate Memory at Run Time
Removes need to Recompile with Fixed Arrays

Simplified Problem Dimension Input (241)
Code Computes Dimensions from Input File
Only 12 Parameters Required on 01000Y Record
Supports Older Format, but not both at the same time

New Option to Include Condensation Heat Transfer with Forced Convection Map (218)

New Option to Force Single-Phase Heat Transfer for a Given Conductor (219)

New Option to Use a Multiplier with the Chexal-Lellouche Slip (ISFLAG =3) (220)

New Option to Use a Multiplier on Thermal Conductivity (Similar to RETRAN-02) (231)

Allow Run Time Screen Message Option (236)

BWR Separator Centrifugal DP Term (237)

Revise Stagnation Enthalpy Major Edit Term to Velocity Head (238)

RETRAN-3D MOD004.1 To Be Released (Cont'd)

NUCOAST Enhancements

The following updates are the result of development tasks funded by NUCOAST and provided to the RETRAN User group to be included in the next code release. Modification numbers have not yet been assigned.

Improved Error Message Information

Provide More Information on Location and Time
Provide a Trouble Shooting Guide
Remove Multiple Error Message
Remove Messages for which there is no User Action

Automated RETRAN-3D to VIPRE Interface

Automate the Boundary Conditions Transfer to VIPRE
Time, Pressure, Enthalpy, Flow DeltaP, Power Axial Power

RETRAN-3D U-Tube Initialization

Auto Initialization at Off Normal Conditions
Initialize at use Supplied Targets for Primary and Secondary

Error Corrections

Corrections for trouble reports are shown below.

| Modification No.	Trouble Rep No.	Description of Change
179	246	Fix control block CP2 floating point error.
180	250	FTB file definition moved up one line.
181	251	Correct VSLPV calculation for volumes with multiple junctions.
182	252	Correct ICVOL to edit the correct transport volume mesh data.
183	256	Fix flag which activates noncondensable gas logic in EPRIDV.
184	247	Fix error in scratch space reservation for flow splits case.
185	257	Correct logic in SSSEP that overrides local energy balance when P is input for a 2-region nonequilibrium volume.
186	255	Count the number of entries on the material property data cards to calculate how much memory to reserve.
188	202	Correct enthalpy error when mixture level passes through junction; correct 5-eqn model errors when critical pressure is reached.
189	261	Correct the error for enthalpy transport with flow splits.
190	203	Correct the logic when single phase exists in two-region nonequilibrium model.
191	262	Add derivatives of slip vel wrt p, x, and w for ISFAG = 2. Revised relaxation scheme for steady state slip velocity.
192	264	Correct errors in NC state routine and NC condensation non-convergence.
193	265	Mdot smoothing logic changes the transfer term from SS to transient.
194	266	Several equilibrium thermodynamic initial condition options were not included for 5-equation volumes.
197	269	Added test to ensure that countercurrent properties aren't use to compute co-current slip velocity.
198	270	The call to ENTHAL was replace with a Newton-Raphson iteration to solve for enthalpy.
199	271	Test for flow split option before defining do loop indices.
200	263	The branch junction model added in MOD003.1 was revised to use the single junction form for separators.
201	274	Correct logic to trap negative relative volume.
208	277	Remove KMUL from Actinides. (Consistent with Theory Man).
210	278	Modified to use "to' volume enthalpy for junction enthalpy when flow is zero. Fixed a restart error. Another modification turns the transport delay model off when a junction flow is two-phase.
211	280	Bypasses the liquid volume convergence test for single-phase volumes.
212	281	Revised to use consistent time level values for the wall temperatures and replaced the iterative solution with a linear approximation.
213	282	Revised the limiting void fractions, add logic to neglect countercurrent flow for low void fractions, and added a cut off to neglect slip for void fractions > 0.999 when the Chexal-Lellouche model is used.

RETRAN-3D MOD004.1 To Be Released (Cont'd)

Modification No.	Trouble Rep No.	Description of Change
214	283	Use the donor volume density for a TDV momentum flux.
215	284	Add option to initialize same as RETRAN-02.
216	285	Limit ajunt such that (0 <= ajunt <= ajun)
217	286	Apply density ratio to torque difference.
222	273	Reset pump stop/reverse flag trip.
223	276	Replace intrinsic SIGN with function SYGN.
224	287	Revise scratch space reservation.
225	290	Removed definition of phase=2 in common path.
226	291	Delete extra call to TRNSPT.
227	292	Add values in INVOL for correct interpretation by ICVOL for P>0,T=0, H=-1,ZM=ZVOL, Separated Volumes.
228	293	Revise zero flow test for volumes to use (wjsum1+wjsum2) rather than wvbar.
229	294	Revise Bernoulli term in momentum equation to include cosine of angle.
230	295	Added logic to define the boundary temperature to local conditions value for specified HTC.
232	296	Removed a fix-up path that uses a hardwired value of the critical specific volume.
233	299	Revise local conditions model for setting bulk fluid temperature for non-equilibrium volume.
234	300	Correct consistency check for Chun and Seban conductor stack
239	302	Correct an error in input checking logic. Also, cleaned up some complicated branching logic.
240	305	Eliminate logic that over indexes array during 3D Kinetics input processing.

New Version of RETRAN User Interface Available Soon

The RETRANUI is a software application developed by CSA that provides a convenient graphical user interface to RETRAN.

It allows RETRAN to be run on PCs or UNIX workstations and provides a convenient interface to Excel to form plotting results.
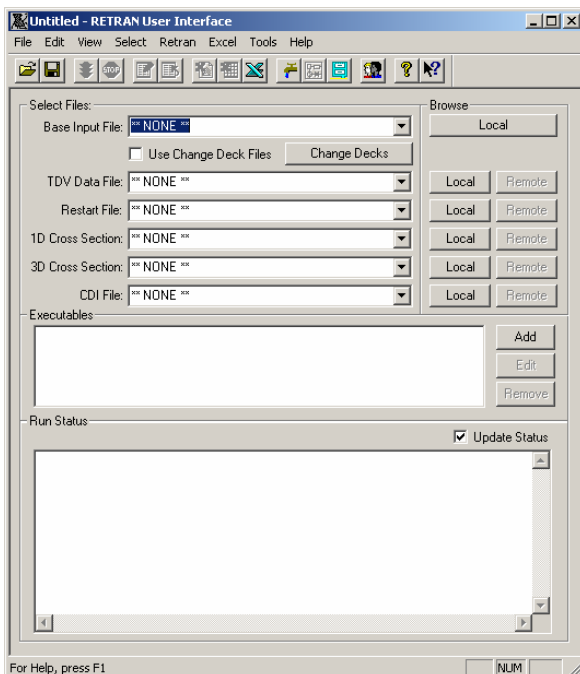
Version 2.1 has an upgraded FTP component for UNIX-platform RETRAN executables. The user is allowed to remotely select files to be used as auxiliary input for RETRAN analysis when RETRAN is executed on the UNIX platform.

Version 2.2 is the next release. This version will include the following improvements:

- Allow user to select two "input files", a base deck, and a change deck;
- Add date/time tag to all output files (i.e., yymmddhhmmss added to filename); and
- Support for Microsoft Windows XP and Microsoft Office XP.

Version 2.2 will be released in September.

About This Newsletter

RETRAN Maintenance Program

The RETRAN Maintenance Program is part of a program undertaken by EPRI to provide for the support of the software developed in the Nuclear Power Division. The main features of the Subscription Service include:

- the code maintenance activities for reporting and resolving possible code errors,

- providing information to users through the User Group Meetings and this newsletter, and

- preparing new versions of RETRAN.

The RETRAN Maintenance Program now has 26 organizations participating in the program, including 22 U.S. utilities and 4 organizations from outside of the U.S. A Steering Committee, composed of representatives from the participating organizations, advises CSA on various activities including possible enhancements for the code and the scheduling of future code releases. Information regarding the Maintenance Program can be obtained from

> Mark P. Paulsen
> Computer Simulation & Analysis, Inc.
> P. O. Box 51596
> Idaho Falls, ID 83405
> paulsen@csa.com or (208) 529-1700

Newsletter Contributions

The RETRAN Newsletter is published for members of the Subscription Service program. We want to use the newsletter as a means of communication, not only from CSA to the code users, but also between code users. If this concept is to be successful, contributions are needed from the code users. The next newsletter is scheduled for December 2004 and we would like to include a brief summary of your RETRAN activities. Please provide your contribution to CSA, P. O. Box 51596, Idaho Falls, ID 83405, or to the E-mail addresses below by December 1, 2004. ***Contributors of a feature article will receive a RETRAN polo shirt.*** We are looking forward to hearing from all RETRAN licensees.

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The RETRAN Web Page is located at http://www.csai.com/retran/index.html.

Previous issues of the RETRAN Newsletter are available from the RETRAN Web Pages at http://www.csai.com/retran.

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To Order EPSC Software: (800) 313-3774
EPSC Fax: (650) 855-1026
To Order RETRAN Products contact Colette Handy via email chandy@epri.com

Calendar of Events

User Group Meeting:
November 16 & 17, 2004
Luxor Hotel
Las Vegas, Nevada
Details will be emailed
to Maintenance
Group Members