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The RETRAN Newsletter

January, 1999

Summary of Activities

This issue of the RETRAN Newsletter contains articles on the NRC Review of RETRAN-3D, an article on the CPM-3/CORETRAN Workshop, and interesting articles from code users. Your contributions are greatly appreciated. We, EPRI and CSA, encourage everyone to participate in this newsletter.

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

In This Issue...

NRC Review of RETRAN-3D Underway

Gregg Swindlehurst, Duke Energy
Mark P. Paulsen, CSA

A major milestone in the life cycle of the RETRAN-3D computer program was reached in November 1998 when the U.S. Nuclear Regulatory Commission started a formal review of the code. Initial meetings have been held with the NRC staff and more recently with the ACRS Subcommittee on Thermal/Hydraulic Phenomena. The current review schedule is aimed at issuing an SER in October 1999.

In early July, Gregg Swindlehurst of Duke Energy and Chairman of the RETRAN Maintenance Group, sent a letter to the NRC requesting a review of the RETRAN-3D computer program. The request for review was accompanied by a list of 18 organizations that expressed support for the review [see Utility Support Expedites RETRAN-3D Review].

RETRAN-3D is the third generation of the RETRAN code series developed for the utility industry by EPRI and provides additional modeling capability compared with the NRC-approved RETRAN-02 computer program. Some of the new models include:

- multidimensional neutron kinetics,
- nonequilibrium thermodynamics,
- noncondensable gas flow, and
- implicit numerical solution methods.

In addition to these new models, a number of the RETRAN-02 models have been extended to broaden and enhance the analysis capabilities of the code. These new models and extensions will enable users to better simulate plant and system transient response with enhanced accuracy and efficiency. (*continued on page 5*)

Utility Support Expedites RETRAN-3D Review

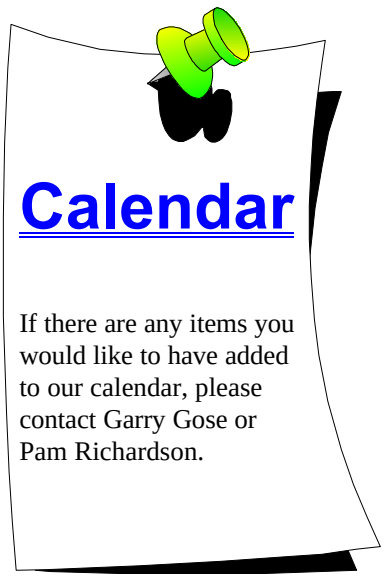
Mark P. Paulsen, CSA

The RETRAN Maintenance Group Chairman, Gregg Swindlehurst of Duke Energy, coordinated a request to the U.S. Nuclear Regulatory Commission to review the RETRAN-3D computer program [see **article** NRC Review of RETRAN-3D Underway]. Due to Mr. Swindlehurst's efforts and the support of the maintenance group members, the review is in progress with completion scheduled for October 1999. One of the key factors influencing the NRC's recent decision to review the RETRAN-3D computer program, was the number of organizations that expressed support of the review. These organizations include:

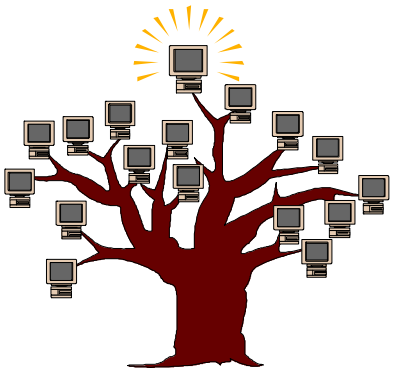
Baltimore Gas & Electric
Detroit Edison
Duke Energy
Illinois Power
Northern States Power
Pennsylvania Power & Light
TU Electric
Virginia Power
Wisconsin Public Service
Commonwealth Edison
Duke Engineering & Services
GPU Nuclear
New York Power Authority
PECO Nuclear
South Texas Project Nuclear Operating Co.
Union Electric
Washington Public Power Supply System
Wolf Creek Nuclear Operating Corp.

Some of these organizations either had made or were planning to make submittals to the NRC using RETRAN-3D to take advantage of the new or extended models. Duke Energy was one of these organizations and they have since received permission to use RETRAN-3D, in the RETRAN-02 mode, to perform analyses currently being done with RETRAN-02. Other organizations are awaiting review and approval before committing to transition to the new code.

The successful effort to initiate the review of the RETRAN-3D computer program demonstrates an important benefit to all RETRAN users afforded by the RETRAN Maintenance Group.



Duke Energy Upgrades to RETRAN-02 MOD005.2



Christy L. Ray, Duke Energy

Duke Energy recently upgraded from RETRAN-02 MOD005.1 to RETRAN-02 MOD005.2 and has begun using RETRAN-02 MOD005.2 in licensing applications. The version of RETRAN-02 MOD005.2 being used by Duke Energy contains two additional modifications that were developed by CSA but have not yet undergone formal verification under the RETRAN-02 QA procedures. Since these modifications fall outside of the maintenance program discussed above, any licensing basis analyses performed with this version of the code must clearly identify these modifications in any submittals to the NRC. The first modification allows access to the condensation heat transfer correlations with the use of the forced convection heat transfer map. The second modification corrects an error in the calculation of the liquid region work term in the pressurizer model (Trouble Report No. 443).

In order to validate the RETRAN-02 MOD005.2 computer code under the Duke Energy software quality assurance program, several transients that had been previously evaluated with RETRAN-02 MOD005.1 were analyzed with RETRAN-02 MOD005.2. The results from the two code versions were then compared to demonstrate the predictive capabilities of the RETRAN-02 MOD005.2 code. This approach was chosen to help determine if any of the error corrections made to the RETRAN-02 MOD005.1 code to produce RETRAN-02 MOD005.2 had a significant impact on any of the licensing basis analyses. The transients analyzed were:

- McGuire/Catawba Increase in Feedwater Flow
- McGuire/Catawba Uncontrolled Bank Withdrawal
- McGuire/Catawba Locked Rotor
- Oconee Turbine Trip
- Oconee Steam Line Break with One-Dimensional Kinetics
- Oconee Steam Generator Tube Rupture
- Oconee Large Steam Line Break with Condensing Heat Transfer
- Oconee Tornado Analysis
- McGuire/Catawba Steam Line Break Mass and Energy Release

For most transients, there was very good agreement between the RETRAN-02 MOD005.1 results and the RETRAN-02 MOD005.2 results. For a few transients, minor differences were seen between the results obtained with the two code versions. However, decreasing the maximum time-step size resolved most of the differences. The time-step sensitivity was most noticeable in cases with significant pressurizer relief (e.g., pressurizer PORV cycling).

Thus, regardless of the code version being used, the maximum time-step size should be selected carefully to ensure a converged solution.

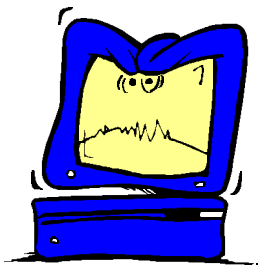
The Oconee large steam line break analysis uses the forced convection only heat transfer map, and thus it was used to test the modification added to access the condensing heat transfer correlations. The overall results showed good agreement between RETRAN-02 MOD005.1 and RETRAN-02 MOD005.2. The only noticeable difference seen, due to the use of the condensing heat transfer option, was lower pressure in the intact steam generator as expected. Thus, the condensing heat transfer option appears to be working as intended RETRAN-02 MOD005.1 contains a code error (Trouble Report 426) involving interpolation between heat transfer mode 11 (free convection nucleate boiling) and mode 14 (free convection to vapor). This error was apparent in the McGuire/Catawba steam line break mass and

(continued on page 4)

Duke Energy Upgrades to RETRAN-02 MOD005.2 (Cont'd)

energy release analysis in which the steam generator tube bundle uncovers. The error that was seen with RETRAN-02 MOD005.1 is corrected in RETRAN-02 MOD005.2 and eliminates the spikes in primary-to-secondary heat transfer in the affected loop. The RETRAN-02 MOD005.2 case showed less overall primary-to-secondary heat transfer in the affected loop which impacted reactor power, pressurizer pressure, pressurizer level, and affected loop hot leg temperature. However, these differences had a negligible overall impact on the break flow rate and enthalpy. Transients with prolonged tube bundle uncovery may need to be examined to ensure that the error correction involving the interpolation between heat transfer modes 11 and 14 does not impact analysis results obtained using RETRAN-02 MOD005.1.

The Oconee tornado analysis simulates the loss of main and emergency feedwater in conjunction with a loss of offsite power. For this particular transient, there were noticeable differences between the RETRAN-02 MOD005.1 and RETRAN-02 MOD005.2 results. The error correction that resulted in these differences has not been identified. RCS pressure and pressurizer level were lower for the RETRAN-02 MOD005.2 case due to greater relief through the pressurizer safety valves. Thus, it appears that the error corrections made to RETRAN-02 MOD005.1 to produce RETRAN-02 MOD005.2 may have an impact on transients with significant pressurizer relief, especially for those transients that experience substantial primary system voiding. It is also noted that this was the only transient examined that showed any impact from the modification to correct the error in the pressurizer liquid region work term.

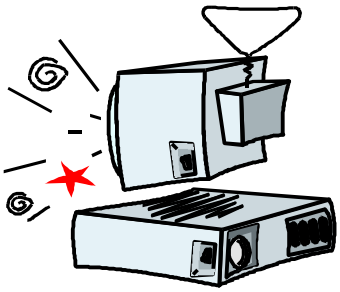


Summary of RETRAN-3D Code Trouble Reports

A total of 154 trouble reports had been filed as of December 31, 1998. Of these, 138 reports have been resolved, while 16 remain unresolved. A summary of the unresolved trouble reports is shown below. Additional information for RETRAN-3D trouble reports is available at http://www.csai.com/retran/r3dtrpt/index.html.

TROUBLE REPORT NO.	TYPE OF PROBLEM	CORRECTION NO.	IDENT	COMMENTS
22	Problem using Wilson bubble rise model & error when using low power initialization	***	******* MOD001	(partial fix)
30	2-loop Oconee w/5-eq. fails in steady state	***	*******	
40	Results do not agree with data	***	*******	
48	Steady state fails after 6 iterations	***	*******	
		006	MOD001g	(partial fix)
52	MOC does not return to the initial temp.	***	*******	
54	MOC solution; no null transient for two-phase	***	*******	
60	Anomalous countercurrent flooding	***	*******	
70	Fails in subroutine DERIVS	***	*******	
81	Steady-state failure at iteration #6	***	*******	
116	Fails in steady-state initialization	***	*******	
122	Problems with EOS convergence	***	*******	(water packing)
142	Timestep selection causes 3-D kin to fail	***	*******	
144	TAUGL model doesn't apply for horiz. flow	***	*******	
145	SS fails to converge for low press. and flow	***	*******	
150	SS solution void fraction oscillation	***	*******	
152	Junct pressure lags vol pressure 1 time step	***	*******	

Summary of RETRAN-02 Trouble Reports



The following is a summary of RETRAN-02 Trouble Report/Code Maintenance Activity. There are 12 outstanding trouble reports, 2 from MOD004 and 10 from MOD005. A list of trouble reports and the status can be obtained directly from the EPSC (800-763-3772). Additional information is available from the RETRAN-02 Trouble Report Page at http://www.csai.com/retran/r02trpt/index.html.

TROUBLE REPORT NO.	TYPE OF PROBLEM	CORRECTION NO.	IDENT	COMMENTS
354	Large Step Change in PHIR	***	*******	
376	Control Reactivity, No Motion	***	*******	
394	Anomalous Heat Trans. Behavior	***	*******	
408	OTSG Heat Transfer Problems	***	*******	
439	Decay Heat Input	***	*******	
440	Kinetic Energy/Time Dep Area	***	*******	
442	Poor Diagnostics	***	*******	
443	Liquid Region Work Term	***	*******	
444	Positive Slip Velocity	***	*******	
445	Boron Transport Inconsistency	***	*******	
446	Theory Manual for Bubble Rise	***	*******	TH Manual Modification
447	Smoothing Algorithm in SVOID	***	*******	

NRC Review of RETRAN-3D Underway (Cont'd)

After a preliminary review of the four-volume RETRAN-3D documentation, the NRC staff requested a meeting to discuss the submittal and planned review process. A meeting was held on September 15, 1998. At the meeting Mr. Swindlehurst discussed the review request and the role of the RETRAN Maintenance Group. Lance Agee of EPRI and Mark Paulsen of CSA presented an overview of RETRAN-3D including some RETRAN-02 background, the design review, discussion of the new models and model extensions, code assessment, and maintenance procedures. The NRC staff presented a preliminary review schedule for determining if the RETRAN-3D documentation was adequate for the review to continue.

In early December, Mr. Swindlehurst was notified of NRC's decision to proceed with the review. The review will be preformed in-house by staff members in the Reactor Systems Branch headed by Ralph Caruso, with Ralph Landry as the technical lead. While the ACRS Subcommittee on Thermal/Hydraulic Phenomena has previously been involved in reviewing LOCA-related submittals, they will also be participating in the RETRAN-3D review, a first for transient analysis codes.

A meeting with the ACRS Subcommittee on Thermal/Hydraulic Phenomena was held December 17, 1998, where an overview was given of the RETRAN-3D computer code similar to that presented to the NRC staff in September. The NRC staff presented their review plan and review schedule that targets October 1999 for the issuance of the RETRAN-3D SER. The transcript for this meeting can be obtained at http://www.nrc.gov/ACRS/rrs1/Trans_Let/index_top/ACRS_sub_tran/Thermal_Hydr_Phen/th981217. The NRC is focusing on doing a well-managed review and will be working with the ACRS in an attempt to limit their requests for additional information to a single round of questions. The presentations were well received by the ACRS. Completion of the review will represent a significant achievement in the development of RETRAN-3D, allowing code users to use the advanced analytical capabilities to address emerging safety and licensing issues.

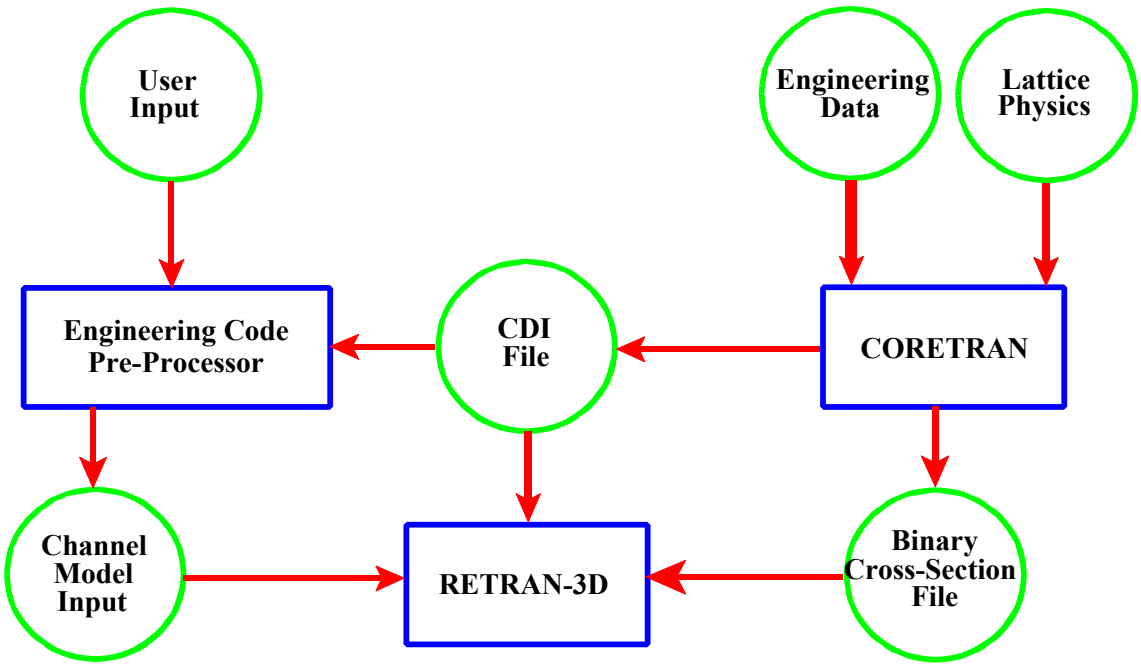
RETRAN-3D Cross-Section Model to be Changed

Garry C. Gose, CSA

The next release of RETRAN-3D (RETRAN-3D MOD003) will include many new model features and the area of multidimensional kinetics modeling will be included. RETRAN-3D will be coupled more closely with the upstream physics codes, as the figure below indicates, relying upon them for cross-section data (the BXF file) as well as geometric data (the CDI file). The previous cross-section models will be replaced.

Recent versions of CORETRAN (1.45 or greater) use a 'TABLES' form of the cross-section model used to represent the group constants for the ANM diffusion solution. The new format has been described and documented in other publications so it will not be repeated here (Eisenhart, et al., Proceedings of Eighth International RETRAN Meeting, EPRI-TR-106038, March 1996 and CORETRAN-01 Theory and Numerical Analysis, Volume 1, October 1997). The new formalism is no longer a polynomial representation but is instead a data base of cross-section dependencies that will allow the generation of cross sections based upon a variety of historical and instantaneous parameters using interpolation and partial cross-section summation.

The format is passed on to RETRAN-3D and a modified format that contains only instantaneous data dependencies (as opposed to both historical and instantaneous) are written for the RETRAN-3D kinetics model. The older, 'TAPE67' (based on polynomials), format that exists in RETRAN-3D MOD002.0 will no longer be supported. Support for the older SIMULATE-E model will also be removed in an effort to simplify the code maintenance efforts.



Current RETRAN-3D Channel Model Data Flow

The move to the new cross-section model will allow a more direct coupling to the CORETRAN code and will allow the user to spend less time constructing cross sections and more time analyzing kinetics cases.

CPM-3/CORETRAN Workshop

John L. Westacott, CSA

A CPM-3/CORETRAN Workshop was held on October 27-30, 1998, at Rockville, MD. The goal of the workshop was to familiarize utility reactor physics engineers with the EPRI lattice physics code, CPM-3, and the core simulation code, CORETRAN-01. CORETRAN-01 includes steady-state depletion, operational transient, and design basis transients capabilities.

Four EPRI contractors presented the workshop which was attended by 11 US and international utility organizations. During the morning lectures, code capabilities and applications were summarized, theory presented, testing and validation results presented, and input requirements outlined. In the afternoon, hands-on sessions were used to demonstrate the code's capabilities with various sample problems. Ten high-performance PCs and one IBM RISC workstation were provided.

The hands-on sessions were especially popular. Attendees were able to observe and modify the CPM-3 benchmark lattice physics PWR and BWR cases on Tuesday. CORETRAN core depletion demonstration problems were used for the Wednesday session. On Thursday, CORETRAN transient models were provided. A sample problem was also provided which demonstrated the cross-section generation by CORETRAN, with the transient calculation performed using RETRAN-3D. Cross-section and core geometry data were passed directly from CORETRAN to the RETRAN-3D code.

Preprocessors were demonstrated and available for use with the sample problems. The PISCIS interface for CORETRAN allows input manipulation and generation, and graphical representation of results. The RETRAN preprocessor was used to demonstrate automated core mapping of neutronics channels to thermal-hydraulic channels for RETRAN-3D system transient calculations.

The workshop was successful in introducing and demonstrating the capabilities of CPM-3 and CORETRAN to a number of organizations. The codes were well received and the hands-on sessions were particularly effective (the sessions often ran past the scheduled time).

Both CPM-3 and CORETRAN-01 are in the late beta test stage and are to be formally released in 1999.

Please supply us with technical tips for our TechTips section and you will receive a RETRAN mouse pad.

Hurray! New RETRAN Graduates!

Two RETRAN training sessions were held at CSA's office in Idaho Falls during September. A basic RETRAN training session was held during the week of September 14, 1998, followed by an advanced RETRAN training session the next week.

The basic session lectures covered the theoretical basis of the RETRAN code including the balance equations, constitutive, and component models. Other topics included the selection of input options, common modeling practices, the interpretation of results, and common pitfalls and their resolution. Part of each afternoon was devoted to working sessions where the attendees prepared input for sample problems designed to illustrate material covered in the previous lectures.

The lectures also presented comparisons of the RETRAN-02 and RETRAN-3D codes and the improved analysis capability of RETRAN-3D. Attendees were also given the opportunity to use the RETRAN input preprocessor and the PEGASYS plotting software during the problem sessions.

Congratulations to the following Basic Training participants:

Robert Lee, Commonwealth Edison
Timothy Byam, Illinois Power
David Balfour, Northeast Utilities
Sunyoung Kwon, Northeast Utilities
Keith Higar, Northern States Power
Melissa Higar, Northern States Power
Dixon Yee, Pacific Gas & Electric
Jeffrey Bonner, Pennsylvania Power & Light
Owen Stevens, Public Service Electric & Gas
Mark Strohecker, Public Service Electric & Gas
Shih-Fang Huang, STP Nuclear Operating Co.
John Fisher, Washington Public Power Supply System

Lectures for the advanced RETRAN training session were designed for experienced users and provided information about advanced modeling methods that were beyond the scope of the basic course. The new modeling capabilities of the RETRAN-3D code were presented, including the revised balance equation set, improved solution methods, and new models. Modeling recommendations were discussed for both BWR and PWR applications. These included implications arising from the RETRAN-02 SER/TER and RETRAN-3D activities that have addressed specified SER/TER limitations. The final day of the session was devoted to the theory, use, and qualification of the multidimensional kinetics model in RETRAN-3D.

Each afternoon, participants were able to run their own plant models using RETRAN-3D, and many used the RETRAN input preprocessor to convert existing RETRAN-02 input decks to RETRAN-3D. During the afternoon work sessions, individualized consultation was provided by CSA staff members.

The following participants are congratulated for their successful completion of the Advanced RETRAN session.

Robert Lee, Commonwealth Edison
Enrique Vela, Consejo de Seguridad Nuclear
Jennifer Furl, Public Service Electric & Gas
Kent Halac, Public Service Electric & Gas
Javier Iglesias, UITESA/IBERINCO
John Fisher, Washington Public Power Supply System
Linda Woosley, Washington Public Power Supply System
Steven Chen, Wolf Creek Nuclear Operating Corp.

INER/TPC RETRAN-3D Training Seminar

James H. McFadden, CSA

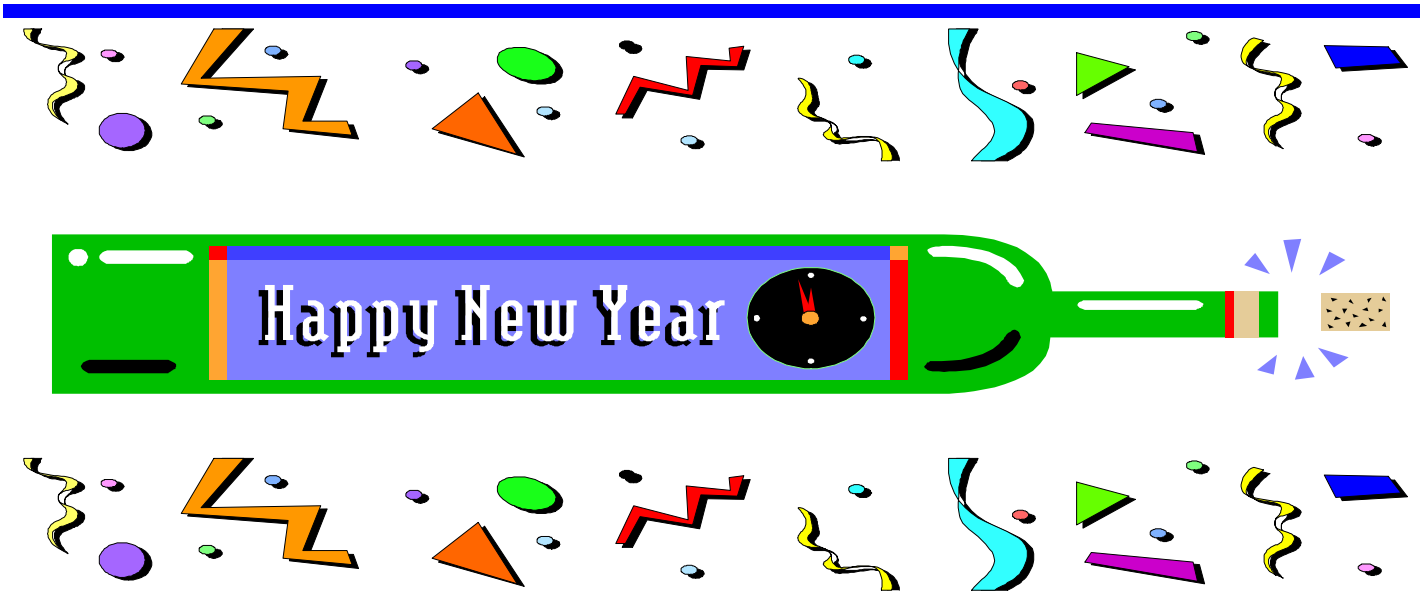
The Institute of Nuclear Energy Research (INER) and Taiwan Power Company (Taipower) have joined the group of RETRAN-3D users. A training seminar for analysts from these two organizations was conducted in November 1998 at the office of INER in Lungtan, Taiwan, ROC.

The seminar included general sessions as well as several special sessions. On the first day, a special introductory session was conducted which gave an overview of RETRAN-3D and the NRC review of the program. This session was chaired by Dr. Yuan-Ching Chou and was attended by about 60 engineers and analysts from INER, Taipower, and the Taiwan regulatory agency as well as university faculty members. The final day included a special session on quality assurance and configuration control.

About 20 people attended the general sessions. The topics discussed included

- changes in RETRAN-02 models,
- the nonequilibrium field equation option and related constitutive models,
- the noncondensable gas option and associated constitutive models,
- the three-dimensional neutron kinetics option, and
- general RETRAN modeling practices for BWR and PWR applications.

Dr. Jan-Ru Tang (INER) and Mr. Julian Chiang (Taipower) organized the seminar, which was conducted by Mark Paulsen and Garry Gose of CSA. INER and Taipower are long time users of RETRAN-02 and participants in the RETRAN project, and the RETRAN bibliography includes many reports from these organizations. In the near-term, they plan to focus on BWR stability and ABWR analyses with RETRAN-3D.



TechTips

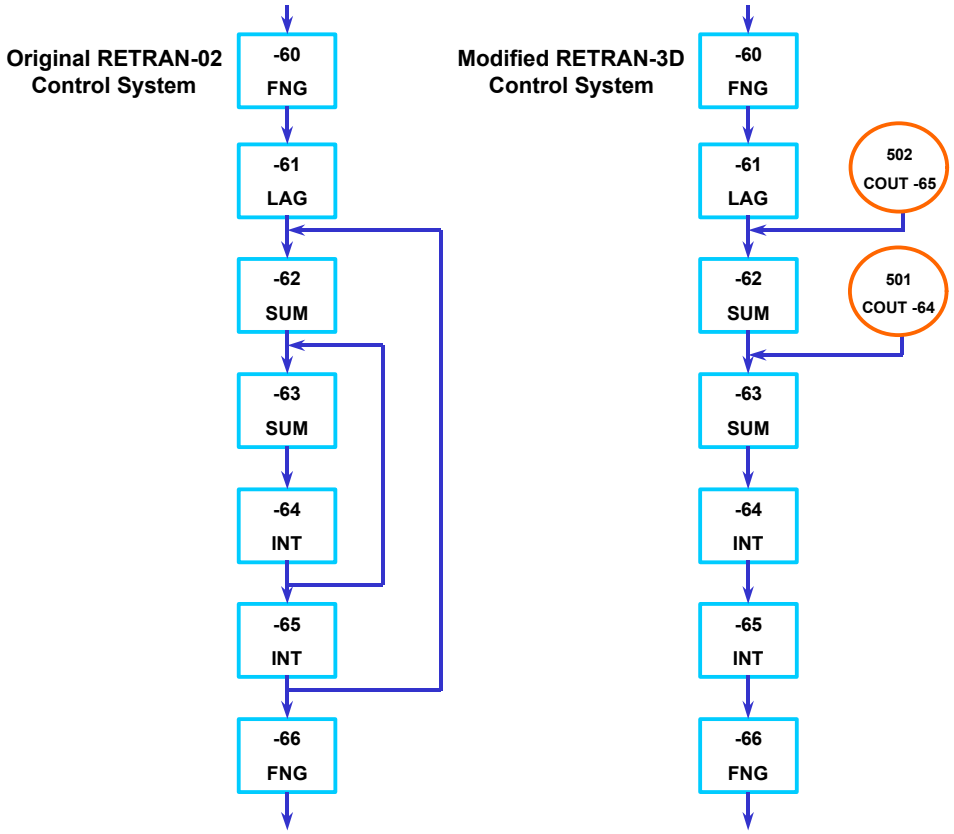
Converting RETRAN-02 Control Systems to RETRAN-3D

Sometimes when a RETRAN-02 control system model is converted and solved by RETRAN-3D, the new model may not converge. This problem can sometimes be overcome by increasing the number of iterations on the 701000 data. This, however, can increase running time and some control blocks still may not converge. These nonconvergence problems are typically related to blocks that use feedback signals. Another solution is to replace direct feedback signals with the output of a signal that is passed through a COUT block.

Why does the RETRAN-3D control solver fail to converge occasionally? Isn't it a newer and improved solver? Well yes it is and that's part of the answer. In the RETRAN-02 code, the control blocks are evaluated using an explicit solver in the order that they are numbered from input. In RETRAN-3D, the solution method has been revised and the output of all blocks are evaluated at the same time level. This results in a system of coupled equations that are solved simultaneously. A Gauss-Seidel iterative solution is used, rather than a direct matrix solver. The Gauss-Seidel method converges well as long as the system of equations is diagonally dominant. However, when an off-diagonal element in the matrix is dominant the method may converge slowly.

Feedback signals can introduce off-diagonal elements that are large compared with diagonal elements leading to nonconvergence of the Gauss-Seidel solution scheme. Passing the feedback signal through a COUT block places the value at the old time and effectively moves the element from the coefficient matrix to the right-hand side. This eliminates the nonconvergence problems caused by feedback signals.

The example shown below illustrates the situation.



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 31 organizations participating in the program, including 23 member utilities, 5 organizations from outside of the U.S., and 3 nonmember utilities from the U.S. A Steering Committee, composed of representatives from the participating organizations, advises EPRI 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

Lance Agee
EPRI
P. O. Box 10412
Palo Alto, CA 94303
lagee@epri.com or (650) 855-2106

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 EPRI 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 March 1999 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 March 5, 1999. ***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.

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EPSC Fax:	(619) 453-4495

For Nuclear Quality Assurance related questions, call Clark Wallace at (619) 622-6611.