The RETRAN Newsletter

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INSIDE

RETRAN-3D Safety Evaluation Report

M. P. Paulsen, CSA

The NRC issued the RETRAN-3D Safety Evaluation Report (SER) on January 25, 2001. This document concluded an extensive review that began with the submittal of RETRAN-3D on July 8, 1998. Possibly the most important outcome from the user viewpoint is that organizations with NRC-approved RETRAN-02 methodologies can use the RETRAN-3D code in the RETRAN-02 mode without additional NRC approval, provided none of the new RETRAN-3D models are used. Thus, the investment in RETRAN-02 plant models and topical reports is preserved, while allowing the improved code version to be used.

The SER lists 45 conditions on the use of RETRAN-3D that EPRI negotiated and agreed to on behalf of the RETRAN-3D Maintenance Group in a letter to the NRC dated December 13, 2000. The first 39 conditions were based on the limitations on the use of RETRAN-02 from the RETRAN-02 SER. Of the 39 conditions, 18 were removed nine were relaxed, and no change was made to 12 conditions. The 27 conditions that were either removed or relaxed should simplify the use of RETRAN-3D for licensing submittals.

Some of the more important SER conditions are summarized below.

- RETRAN-3D can be used for BWR CRD, PWR SLB, and PWR REA analyses;
- RETRAN-3D thermal nonequilibrium model can be used for non-LOCA analyses;
- Chexal-Lellouche drift flux model …is acceptable for use in BWR bundle geometry;
- RETRAN-3D has ..general noncondensable gas modeling capability …;
- RETRAN-3D is approved for PWR ATWS analyses;
- organizations with NRC-approved RETRAN-02 methodologies can use the RETRAN-3D code in the RETRAN-02 mode without additional NRC approval, provided none of the new RETRAN-3D models are used;
- The licensee must validate the chosen void model …outside the range of conditions for which assessment is available…the licensee must also evaluate the uncertainties in the modeling;

RETRAN-3D Safety Evaluation Report (Cont'd)

- … the five-equation model will have to justify its use outside areas of operation where assessment has been documented;
- Assessment … must also address consistency between the RETRAN-3D and auxiliary calculations;
- Approval mandates a statement on the user's experience and qualification; and
- Code Assessment… is responsibility of the licensee or applicant.

The complete SER is included in Volume 1 - Theory and Numerics Manual of the RETRAN-3D MOD003.1 documentation (see related article). A related document that discusses the closure of issues raised in the SER is also included in Volume 1.

The NRC staff believes that establishment of a RETRAN-3D peer review process by the RETRAN-3D Maintenance Group (see related article) is a positive step in alleviation of staff concerns about user experience and consistency and uniformity in application of the code. The users are encouraged to get peer review on any analysis they plan to submit to the NRC. If submittals are made without peer review, the NRC may be very aggressive in their review of the topical.

RETRAN-3D MOD003.1 Transmitted to EPRI

M. P. Paulsen, CSA

A new version of RETRAN-3D has been submitted to EPRI for distribution to its licensees and is designated as MOD003.1. It contains revisions resulting from the NRC review of MOD003.0 and corrections for errors. RETRAN-3D MOD003.1 is approved for licensing use by the NRC.

RETRAN-3D has a large number of new and improved modeling capabilities. It also retains the capability to reproduce RETRAN-02 analyses. Consequently, RETRAN-3D MOD003.1 is approved for use in a RETRAN-02 mode where organizations have currently approved methodologies. New features added to RETRAN-3D include the following;

- improved unequal phasic velocity models;
- thermal nonequilibrium between phases;
- noncondensable gas flow,
- improved water properties at low temperature and in the vicinity of the critical point;
- improved wall friction models;
- linear and nonlinear implicit solution of transient field equations;
- implicit solution of the steady-state field equations,
- low power implicit steam generator initialization;
- steady-state flow split solution for parallel channels;
- nondiffusive solution option;
- implicit two-surface heat conduction model;
- models for three-dimensional, one-dimensional, and point reactor kinetics;
- improved cross-section model for three-dimensional kinetics;
- a channel model to simplify input for three-dimensional kinetics models;
- improved control system solution and new control blocks;

(Continued on page 5)

Peer Review Process for RETRAN-3D Submittals to NRC

G. B. Swindlehurst, Duke Energy

During the interactions with the NRC on their review of RETRAN-3D there was much discussion of NRC's concerns with the broad flexibility in applying the code. These concerns range from model nodalization development to code option selection to input specification. The NRC's preference would be for standardization across the RETRAN user community in all of these areas. In addition, the NRC indicated that future submittals of RETRAN-3D applications would be subject to a very detailed review as a result of the lack of standardization.

A concept that was proposed in response to these NRC concerns was for the RETRAN user community to offer a peer review process to provide organizations making NRC submittals an independent technical review. Such a peer review would identify non-standard modeling approaches and weaknesses in general. Peer reviews have been or are currently being performed by the industry under the auspices of the owner's groups to resolve similar NRC concerns regarding PRA quality. The NRC staff strongly encouraged RETRAN-3D users to consider a peer review process. The

following is an excerpt from p. 23 of the RETRAN-3D SER.

"The RETRAN-3D Maintenance Group informed the staff in a meeting in November 2000, that a peer review process was being established by which applications of the RETRAN-3D code would be reviewed for consistency with accepted nodalization and option

(Continued on page 4)

New Models are Planned for RETRAN-3D MOD004

G. C. Gose, CSA

A project to modify RETRAN-3D MOD003.1 to model advanced fuel assembly designs has been completed. The work extends the RETRAN-3D flow split model to include more complex flow paths and leakage flows based on the FIBWR (1) model. The FIBWR methodology is used in many three-dimensional core simulator codes such as CORETRAN and SIMULATE-3. It is an important BWR model enhancement for RETRAN-3D.

In addition, the ability to account for the thermal-hydraulic effects of part length rods has been added. Central to the work is a detailed geometric description of the fuel contained in the RETRAN-3D CDI file, which has been modified to accommodate non-uniform conductor geometries in a core channel. The work is summarized in the following sections.

Part Length Rod

In the RETRAN-3D MOD003.1 version of the CDI file, a single assembly geometry is given for each channel. Thus, the same geometric values are used for all the axial nodes for the volumes, junctions, and heat conductors that make up a channel. The CDI file structure was revised to allow input of an axial distribution of the geometry. This allows modeling of the geometric variations that occur due to the

(Continued on page 4)

Peer Review Process for RETRAN-3D Submittals to NRC (Cont'd)

selection practices. The staff is encouraged by this move on the part of the RETRAN-3D user community. The staff believes that this peer review will be responsive to many of our concerns about application of the code and confidence in the user."

The NRC also indicated during discussions that their review effort on future RETRAN-3D submittals would be influenced by whether or not a peer review had been conducted. A peer review has great potential as a win-win situation for both the users and the regulator, from both technical quality and cost perspectives.

There is no commitment for users to subject a future RETRAN-3D NRC submittal to a peer review. However, there is clearly motivation and benefits in doing so. It is likely that the NRC will ask if one has been performed. Contact me (gbswindl@duke-energy.com) or the future chairman of the RETRAN Maintenance Group for assistance in setting up a peer review.

New Models are Planned for RETRAN-3D MOD004 (Cont'd)

presence of part length rods. This flexibility also allows specification of different geometries for the nodes below and above the heated region of the core.

FIBWR Model to allow Water Rods and Additional Lateral Leakage Flow Paths

In boiling water reactors, a number of leakage paths divert flow from the active heated channels. Accounting for the flow in these paths is necessary to calculating the leakage flow and the active core flow rate. The FIBWR bypass flow model for computing the BWR leakage flows has been incorporated into RETRAN-3D. This model identified seven different leakage paths between the core support plate and lower plenum, and three leakage paths between the fuel tie plate and the bypass channel. The control rod drive flow also contributes directly to the bypass flow. These leakage paths are identified in Figure 1. The model uses a core-average bypass channel.

In the FIBWR model, the leakage flow is calculated from a correlation that relates the flow rate and the pressure drop.

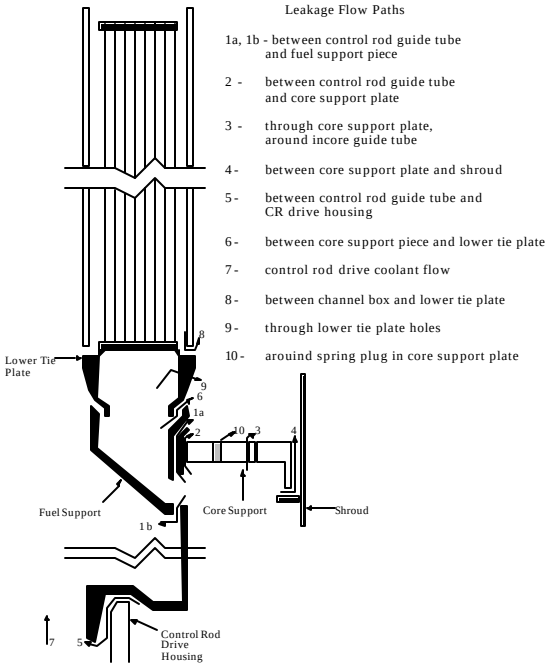

Figure 1. BWR Leakage Flow Path

New Models are Planned for RETRAN-3D MOD004 (Cont'd)

$$W = C_1 \Delta P^{0.5} + C_2 \Delta P^{C_4} + C_3 \Delta P^2$$

where

W	=	flow rate through a certain leakage path (lbm/hr),
ΔP	=	pressure drop (psi), and
C_1, C_2, C_3, C_4	=	empirical coefficients.

The RETRAN-3D flow split model calculates the flow distribution between the active core channels and the bypass channel based on either a total core flow or core ΔP boundary condition. The flow split model was modified to account for multiple leakage paths. These leakage paths were designed to allow modeling of water rods, bypass flow through the lower tie plate holes and bypass flow through the channel finger springs.

Water rods in general start above the core support plate and terminate near the top of active fuel region. The water tube data block includes the flow area and wetted perimeter for the water tube channel, water tube inlet, and water tube outlet. Loss coefficients and elevations for the water tube inlet and outlet are also required. This data will be used by the channel model to generate a water tube volume, inlet junction, and outlet junctions.

Lateral leakage paths include the path between the channel box and lower tie plate, and the paths from fuel support piece and lower tie plate holes. A detailed representation along the axial direction of a fuel bundle is required in order to capture the geometry variation and form loss effects. The new model allows multiple volumes to model the nonfuel regions of an active channel The nonfuel regions that can be modeled by multiple volumes are the space between the inlet orifice and the bottom of active fuel, and the space between the top of active fuel to upper plenum.

The FIBWR model allows total core flow or core pressure drop boundary conditions.

RETRAN-3D MOD003.1 Transmitted to EPRI (Cont'd)

- forced and free convection heat transfer,
- condensation heat transfer,
- improved gap conductance model,
- component models for accumulators,
- implicit solution option for pressurizers and steam-water separators, and
- special purpose models for modeling the movement of a temperature front or impurities.

The four-volume documentation set has been updated to reflect the changes made to create the MOD003.1 code version. Volume 1 contains the NRC SER, the NRC Staff requests for additional information (RAI) that were issued during the review, and the responses to the RAIs. This updated documentation is available in electronic form and is part of the RETRAN-3D MOD003.1 code transmittal package.

RETRAN-3D MOD003.1 is supported on HP, IBM, and SUN UNIX workstations as well as Windows 9x/NT/2k platforms. All four of these platform-specific installations were developed and tested in compliance with the requirements of 10CFR50 Appendix B. RETRAN-3D MOD003.1 will be available on CD-ROM from CAC after October 1, 2001. CAC can be reached by telephone at 1-800-313-3774 or via e-mail at askepri@epri.com.

Summary of RETRAN-02 Trouble Reports

The following is a summary of RETRAN-02 Trouble Report/Code Maintenance Activity as of August 31, 2001. There are five outstanding trouble reports. A list of trouble reports and the status can be obtained directly from the EPSC (1-800-763-3772). Additional information is available from the RETRAN-02 Trouble Report Page at http://www.csai.com/retran/r02trpt/index.html.

NO.	TROUBLE REPORT TYPE OF PROBLEM COMMENTS	CORRECTION NO.	IDENT	
354	Large Step Change in PHIR	***	*******	
376	Control Reactivity, No Motion	***	*******	
394	Anomalous Heat Trans. Behavior	***	*******	
408	OTSG Heat Transfer Problems	***	*******	
438	RESTART Failure/Pipe Transport	407	MOD005P3	
439	Decay Heat Input	408	MOD005P3	
440	Kinetic Energy/Time Dep Area	414	MOD005P3	
442	Poor Diagnostics	***	*******	
443	Liquid Region Work Term	411	MOD005P3	TH Manual Modification
444	Positive Slip Velocity	412	MOD005P3	
445	Boron Transport Inconsistency	409	MOD005P3	TH Manual Modification
450	Momentum Flux Error Non Right Angles	410	MOD005P3	
451	Incorrect Condensation Switch	413	MOD005P3	

From the Editor

This issue of the Newsletter contains articles related to the NRC review of RETRAN-3D. A significant milestone was reached earlier this year when the NRC issued an SER, and a version of RETRAN-3D has been shipped to the EPRI code center that is approved by the NRC. This approval paves the way for users to move to RETRAN-3D in the licensing arena. Several issues were discussed during this multi-year review process, but an item of significant interest is the concept of “peer review” of submittals. In his article, Gregg Swindlehurst provides some insight into this important issue.

What better way to exchange thoughts and ideas on these and related subjects than to collect the RETRAN community together in a beautiful mountain hideaway? The International RETRAN meeting to be held this October in Jackson Hole, Wyoming, should be an interesting gathering given all of the recent news and activity regarding RETRAN.

I hope to see you there.

Dealing with Problems with Tight Feedback Loops in RETRAN-3D

J. G. Shatford, CSA

One of the more versatile features of the RETRAN code is the control system. We use control systems for simple things like converting a level to inches or a flow to gallons per minute. But many RETRAN models include sophisticated control systems to simulate plant systems such as pressurizer level control or feedwater control. A common component of these control systems is the feedback loop. As individuals start using RETRAN-3D, they must be cautioned that feedback loops in control systems can result in numerical problems where the solution does not converge. Someone familiar with RETRAN-02 may think "we use feedback loops all the time." Here's the situation. In RETRAN-02 control blocks are evaluated once per time step, sequentially, according to card number. In the feedback loop example in Figure 1 below, control block -941 actually sums the new value from block -940 with the previous time-step value of block -944. Control block -942 actually sums the new value from block -941 with the previous time-step value of block -945. In RETRAN-3D, in an effort to make things more implicit, control blocks are evaluated as a system of coupled equations. The control block solution iterates until the output of each block has converged. Convergence is measured by a iterate change normalized to the old time value (relative change). This allows control block -942 (in the example below) to sum the new value of block -940 with an updated value for block -944. And this works great when the feedback corrections are big. But as the control system narrows in on its target, these feedback values become quite small. So small in fact that the relative change from one iteration to the next is too big and the coupled equation solution can no longer converge. The solution here is to break the feedback loops. By defining a control input as the output of the desired feedback control block and using the control input in the control system, we essentially get the same solution as in RETRAN-02. Figure 2 shows the same control system with the feedback loops broken. It is frustrating to get near the end of a transient and suddenly fail because your control systems stop converging. Breaking the tight feedback loops will avoid the headache!

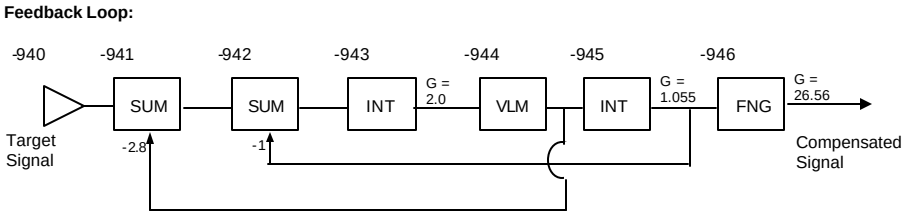

Figure 1

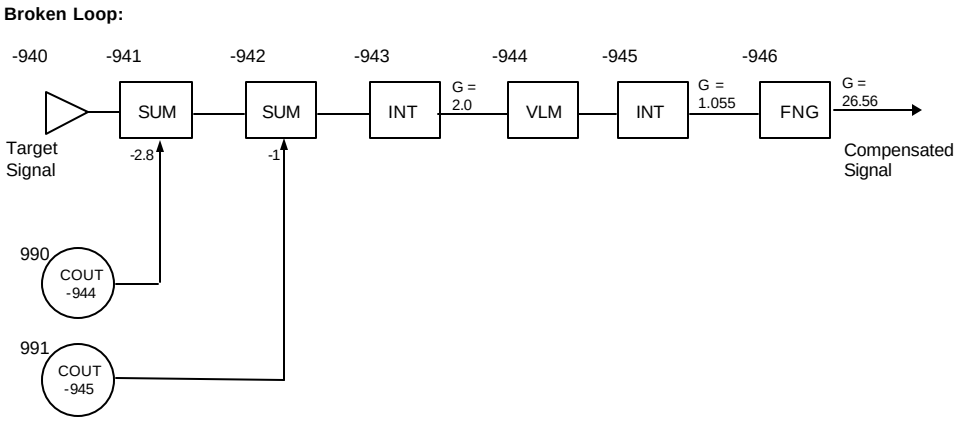

Figure 2

Summary of RETRAN-3D Code Trouble Reports

A total of 246 trouble reports had been filed as of August 31, 2001. Of these, 224 reports have been resolved, while 22 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.

NO.	TROUBLE REPORT CORRECTION TYPE OF PROBLEM	NO.	IDENT	COMMENTS
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)
152	Junct pressure lags vol pressure 1 time step	***	*******	Model limitation
168	Incorrect null trans w/3d Kin. mod ht & 5eq	***	*******	
170	PARCS numerics will not hold a null transient	***	*******	
181	No rod cusping treatment in 3D kinetics	***	*******	Preliminary update
200	SS failure for NCG (WAT0 error maybe WAT17)	***	*******	
201	SS failure when flow split option used	***	*******	
202	Error when pcrit reached during tran – 5-Eq	***	*******	
203	Pressurizer time step selectn when Przr solid	***	*******	
212	Possible errors in dynamic flow regime model	***	*******	
226	MOC error when flow reverses	***	*******	
240	Junction property error after 92sec transient	***	*******	
246	Control system floating point exception	***	*******	

International RETRAN Meeting

G. C. Gose, CSA

The 10th International RETRAN meeting will be held in Jackson Hole, Wyoming, during the week of October 14-17, 2001. There will also be presentations for GOTHIC and CORETRAN codes as well.

The international meeting format is intended to provide a forum for discussing new and interesting technical issues in the use of these codes. The technical sessions allow for a formal presentation and many of the papers will be published in future issues of the ANS sponsored “Nuclear Technology” journal. The meetings allow for open discussion by users of the codes on technical issues and information exchange is always encouraged.

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 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 January 2002 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 January 11, 2002. ***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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EPSC Fax: (650) 855-1026
To Order RETRAN Products contact Colette Handy via email chandy@epri.com

Calendar of Events

October 14-17, 2001

10th International RETRAN Meeting
Jackson, Wyoming

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

Your contributions are greatly appreciated. We, EPRI and CSA, encourage everyone to participate in this newsletter.