

# The RETRAN Newsletter

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## Summary of Activities

*This issue of the RETRAN Newsletter contains information on the Steering Committee for the RETRAN Maintenance Group and the latest information on the RETRAN-3D Design Review. Your contributions are greatly appreciated. We, EPRI and CSA, encourage everyone to participate in this newsletter.*

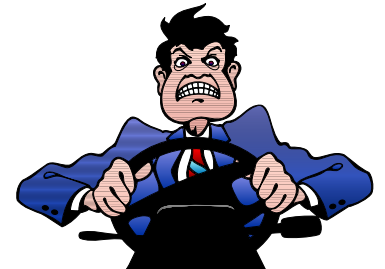
*In addition to these topics, a description of the RETRAN Maintenance Program is included, as well as information about how to make contributions to this newsletter.*

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### In This Issue . . .

<b>Results of 1997 Steering Committee Election</b> . . . . .	1
<b>1996 RETRAN and VIPRE User Group Meetings</b> . . . . .	2
<b>RETRAN-3D MOD002.0 Available from EPSC</b> . . . . .	3
<b>RETRAN-02 Trouble Reports</b> . . . . .	4
<b>RETRAN-3D Trouble Reports</b> . . . . .	5
<b>RETRAN-3D Design Review</b> . . . . .	6
<b>Exploratory Research Project Examines Model Sensitivities</b> . . . . .	7
<b>Calendar</b> . . . . .	8
<b>Newsletter Contributions</b> . . . . .	8

## Results of the 1997 Steering Committee Election



### L. Agee, EPRI

The results of the 1997 election for the RETRAN Steering Committee are as follows.

Chairman: Gregg Swindlehurst  
Duke Power Company  
Phone: (704) 382-5176  
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The other four steering committee members are:

James Boatwright TU Electric Phone: (214) 812-8232 Fax: (214) 812-8687 E-mail: t_jboatwri@ cpvax.cpses.tu.com	Mike Howard Wolf Creek Nuclear Operating Corp. Phone: (316) 364-8831 ext. 4731 Fax: (316) 364-4095 E-mail: mihowar@wcnoc.com
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Please keep one or more of these people aware of your evolving requirements and what you think is important with respect to RETRAN-02 and RETRAN-3D. The steering committee's role is to assure that the utilities' RETRAN needs are fulfilled in as timely and cost effective a manner as possible. The committee advises EPRI as to priorities and assists in determining the future years' work scope for the code maintenance project.

# 1996 RETRAN and VIPRE User Group Meetings

## G. Gose, CSA

The 1996 RETRAN User Group Meeting was held September 29 through October 3, 1996. Hosted by Commonwealth Edison, there were 22 individuals representing 15 organizations in attendance at ComEd's new facility in Downers Grove, Illinois.

Presentations were made for the following general topics:

- summaries of activities of the organizations attending the meeting;
- special discussion of RETRAN applications;
- an overview of RETRAN-02 maintenance and RETRAN-3D maintenance, validation, and development activities; and
- a review of the status of RETRAN-3D and CORETRAN projects.

A VIPRE meeting was held on October 2, 1996, following the RETRAN meeting.

Several interesting technical issues were discussed. In general, there is active interest in more detailed and faster running models while at the same time improving computational and analytical efficiency.

A description of GPU Nuclear analyses related to the Three Mile Island Unit 1 power uprate project was provided by Adi Irani, the GPUN project engineer. The work involves a significant amount of RETRAN-02 analysis of the TMI FSAR Chapter 14 events and many were analyzed with RETRAN-3D to provide RETRAN-02/RETRAN-3D comparisons. The rod ejection transient and main steam line break will be analyzed using the multidimensional kinetics capability of RETRAN-3D and CORETRAN.

KEPCO discussed work with two analyses. The first involved studies of optimum pressurizer levels for KORI-1. A second analysis dealt with low temperature overpressure transients.

Tom Downar from Purdue University discussed issues involved in high performance computing and he presented run-time results from his work on the ARROTTA and RETRAN-3D codes. The most significant improvement was shown for RETRAN-3D cases in which cross flow is modeled. In these test cases, a 20X speedup was reported. A 10X speedup was given for ARROTTA full core transients. Plans for extending the work to VIPRE-02 were discussed.

Copies of the User Group Meeting Notes have been distributed to all attendees and to Maintenance Group Representatives. For more information on the User Group Meeting or if you wish to obtain copies of the meeting notes please contact:

Garry Gose, CSA (RETRAN Information)  
gag@csai.com or (208) 529-1700

Judy Cuta, Battelle (VIPRE Information)  
d35162@eoyn.pnl.gov or (509) 375-3673

## RETRAN-3D MOD002.0 Available from EPSC



**M. Paulsen, CSA**

The RETRAN-3D computer code is the latest version of the RETRAN code series. It has evolved from RETRAN-02 and includes all applicable error corrections through MOD005.2. Additionally, a number of new models and improvements to old models have been implemented to extend the range of analysis capability and improve the accuracy of analyses. New RETRAN-3D models include the method-of-characteristics solution option, three-dimensional kinetics, air/water mixture capability, and thermal nonequilibrium. They are intended to provide RETRAN-3D with the capability to perform analyses beyond the scope of RETRAN-02.

A formal design review has been completed for the RETRAN-3D code (see accompanying article). The review process started with RETRAN-3D MOD001f. During the review process, a number of coding errors were identified and corrected. Additionally, revisions to the code were recommended by members of the DRC. These error corrections and code revisions were implemented in RETRAN-3D MOD002.0, which represents the culmination of the review process. This code version has been released to the Electric Power Software Center (EPSC) as a Safety Grade Code.

A single ISO-9660 compliant CD-ROM was used for the EPSC transmittal. It contains the source code, input data, utility programs, installation and execution procedures, Volumes 1, 2, 3, and 4 of the code documentation, and platform-specific executable files, sample problem output, and baseline installation checkout data for IBM RS/6000, HP 9000/700, and Sun SPARCstation workstations.

The RETRAN-3D documentation is provided in electronic form utilizing Adobe's Portable Document Format (pdf). The documents can be read online using Adobe's Acrobat Reader program, which is provided on the transmittal CD-ROM and is also available from Adobe free of charge for IBM compatible PC's, Macintosh and most UNIX workstations. Printed copies of the documentation can also be generated using the Acrobat Reader program.

The EPSC has recently completed checkout of the transmittal package on the three target platforms. The code will be available from EPSC in the near future. Requests for RETRAN-3D MOD002.0 should be made to EPSC at 1-800-763-3772 or [ordepsc@epri.net](mailto:ordepsc@epri.net). Specify Item 14025 and Order Number SW 107599-CD.

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## RETRAN-02 Trouble Reports

The following is a summary of RETRAN-02 Trouble Report/Code Maintenance Activity.

### Unresolved Trouble Reports

- 1 From MOD001
- 5 From MOD002
- 4 From MOD003
- 3 From MOD004
- 8 From MOD005

A list of trouble reports and the status can be obtained directly from the EPSC.



## Summary of RETRAN-02 Code Trouble Reports

NO.	TROUBLE REPORT TYPE OF PROBLEM	CORRECTION		COMMENTS
		NO.	IDENT	
1	Error 209 in TEMZ	***	*****	MOD001 Error
61	Delta T for Conductor with TDV	***	*****	Need Input Deck
121	OTSG Low Power Initialization	***	*****	
139	Failed Using Large Time Step	***	*****	Need Input Deck
140	Spurious Trips on High Level	***	*****	Need Input Deck
177	Overflow in WAT9	***	*****	Need Input Deck
209	Pump Coast down Rates	***	*****	Need Correct Deck
272	Junction Properties at Break	***	*****	Need Input Deck
317	Junction Property Error	***	*****	
334	Time-Dep. Volume Input	***	*****	
342	Control Block Output near Zero	***	*****	Cannot Reproduce Error
354	Large Step Change in PHIR	***	*****	
366	Mixture/Liquid Level Difference	***	*****	Need Input Deck
376	Control Reactivity, No Motion.	***	*****	
394	Anomalous Heat Trans. Behavior	***	*****	
408	OTSG Heat Transfer Problems	***	*****	
413	Incorrect Vsn No. in IBM Output	***	*****	Cannot Reproduce Error
436	Prandtl Number is Discontinuous	***	*****	
437	Heat Transfer Logic/CHF	----	-----	Not A Code Error
438	Junction Property Error	***	*****	
439	Decay Heat Input	***	*****	
440	Kinetic Energy/Time Dep Area	***	*****	

## Summary of RETRAN-3D Code Trouble Reports

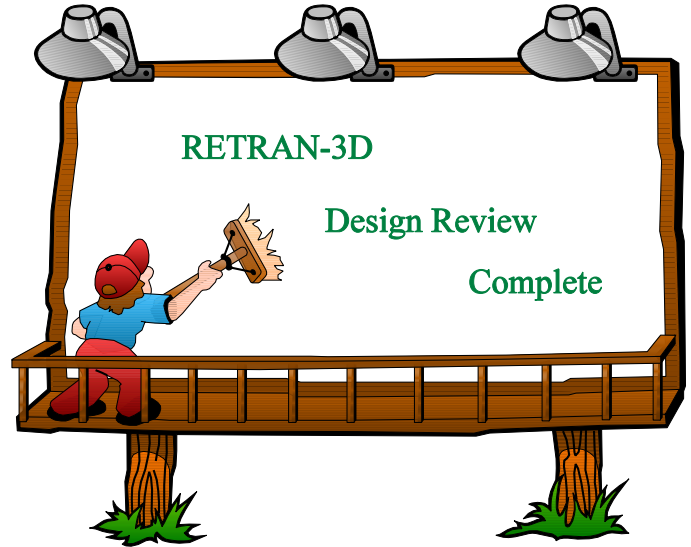
RETRAN-3D MOD002.0 has been completed and transmitted to the Electric Power Software Center. A total of 119 trouble reports had been filed at the end of the reporting period. Of these, 88 reports have been resolved, while 31 remain unresolved. A summary of the unresolved trouble reports is shown below.

NO.	TROUBLE REPORT TYPE OF PROBLEM	CORRECTION		COMMENTS
		NO.	IDENT	
7	Steam separator model fails	***	*****	
8	Two-phase junction choking error	***	*****	
10	1st iteration failure during steady state	***	*****	
11	Negative enthalpy when flow reverses	***	*****	
	error when using low power initialization	***	*****	
24	Pressurizer mixture level not consistent with the liquid level (RETRAN-03 and -02)	***	*****	
28	Low power steam generator init. fails	***	*****	
30	2-loop Ocone w/5-eq. fails in steady state	***	*****	
32	Fails in the two-region nonequilibrium model	***	*****	
33	000040 data not read during restart	***	*****	
38	Core dump occurs for one case not others	***	*****	
39	Time-step error; pressure is 5997 psia	***	*****	
40	Results do not agree with data	***	*****	
41	Anomalous downcomer level	***	*****	
42	Fails with time-step error in pressurizer	***	*****	
43	Steady-state convergence error	***	*****	
45	Restart incorrect transient values	***	*****	
46	Steady state does not converge	***	*****	
47	Standard Problem One difference	***	*****	
48	Steady state fails after 6 iterations	***	*****	
51	Pressure search failure for two-phase MOC	***	*****	
52	MOC does not return to the initial temp.	***	*****	
54	MOC solution; no null transient for two-phase	***	*****	
57	Enthalpy error at steady-state iteration #6	***	*****	
60	Anomalous countercurrent flooding	***	*****	
70	Fails in subroutine DERIVS	***	*****	
81	Steady-state failure at iteration #6	***	*****	
94	Energy balance for 12 node core	***	*****	
114	Discrepancy in pressure calculation	***	*****	
116	Fails in steady-state initialization	***	*****	
117	Step change in power during first time step	***	*****	
118	Calculated void profile sensitive to nodalization	----	-----	Not a code error
119	SS fails to converge for some cases (algebraic)	***	*****	

# RETRAN-3D Design Review

M. Paulsen, CSA

An independent Design Review Committee (DRC), established by EPRI, recently completed a design review of the RETRAN-3D computer program. The design review covered verification of the theory, programming and code use, and validation and qualification of the RETRAN-3D computer program. The validation and qualification review emphasized the use of RETRAN-3D for some of the transients and abnormal events defined in Chapter 15 of "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants - LWR Edition", NUREG-0800. The design review was performed in conformance with CSA's QA program and in compliance with 10CFR50 Appendix B.



The DRC consisted of individuals who have over 125 years of cumulative experience in the nuclear safety analysis industry. They are:

- Sam Forkner, Signal Mountain Software & Engineering Consultants
- Jim Harrison, Virtual Technical Services, Inc.
- Dan Hughes, Hughes and Associates (formerly of CSA, Inc.)
- John Sorensen, S. Levy, Inc.
- Marv Thurgood, John Marvin, Inc.

They concluded that RETRAN-3D is qualified to perform analyses of operational transients and abnormal events in its intended application areas. In particular, they concluded that RETRAN-3D can be used for analysis for which RETRAN-02 MOD5.1 is currently approved by existing SERs and TERs which state in part that the code is, "...acceptable [for]... Chapter 15 of NUREG-0800 and other transients and events as appropriate and necessary for nuclear power plant operation, but excludes Appendix K LOCA analysis."

New RETRAN-3D models are intended to provide the analyses beyond the scope of RETRAN-02. An objective of the RETRAN-3D review was to provide assurance that the code is capable of performing best-estimate analysis of evolving issues.

The DRC found that:

- RETRAN-3D is qualified to provide the core kinetics and system responses in predictions of the PWR Rod Ejection Accident (REA) and is considered to be capable of successful application to the BWR CRDA.
- RETRAN-3D is qualified to perform BWR stability analyses with the following provisions.
  - Void feedback in the multidimensional kinetics model has not been qualified for use in BWRs although the models appear theoretically adequate for this use.

## RETRAN-3D Design Review (Cont'd)

- The impact of the time-step size and numerical solution procedure on predictions of power oscillations and decay ratio has not been quantified.
- RETRAN-3D is capable of providing the core kinetics and system responses in predictions of the PWR steam line break accident.
- The models in RETRAN-3D are theoretically adequate for BWR full and partial ATWS analyses and most of the component models have been successfully applied to transients with similar phenomena. However, additional qualification of the multidimensional kinetics model for BWR use is needed.
- The RETRAN-3D models are theoretically adequate for PWR mid-loop analyses and a demonstration analysis which exhibited the expected trends has been performed.

The DRC reviewed all pertinent RETRAN-3D documentation and source code and concluded that it satisfied the EPRI release criteria, that the coding agreed with the models given in the documentation, that the numerical solution schemes are stable and convergent, and that the equation set programmed is correctly solved.

The DRC reviewed the RETRAN-3D MOD001f code. During the review process, a number of coding errors were identified and corrected and included in RETRAN-3D MOD002.0 (see accompanying article).

The final report has been written by the DRC and will be available in the near future. For more information please contact Lance Agee at EPRI (lagee@msm.epri.com) or Mark Paulsen at CSA (mp-csa@csai.com).

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## Exploratory Research Project Examines Model Sensitivities

### G. Gose, CSA

The process of performing complex analyses seems to never be finished. Experienced users know that once a baseline model has been established, the real work begins and many (sometimes hundreds) of 'what-if' alternatives are examined to cover regions of uncertainty in the model assumptions.

The experience gained over many years may guide the code user in judging, apriori, what is important and what can be ignored. But in many cases surprises turn up and the results can fool even the most experienced hand.

A recent EPRI exploratory research project, 'Applications of Differential Sensitivity Analysis Theory', is aimed at implementing more quantitative methods to the process of sensitivity studies. Originally developed to analyze the sensitivity of reactor shield performance to design features such as material and geometry, DSA is a powerful method for identification of important parameters relative to design features in complex physical processes and engineering systems. It quantifies the relative importance of all parameters in the models and software and it can be used to optimize a system relative to parameters contained in the models of the physical processes.

DSA theory is related to parameter estimation and optimization methods. Early references to the development and application of DSA are given in the books by Tomovic, Radanovic, and Tomovic and Vukoratic.

## Exploratory Research Project Examines Model Sensitivities (Cont'd)

The resurgence of interest in DSA in the nuclear power industry in the 1970s and early 1980s was lead by Cacuci, Oblow, and co-workers at the Oak Ridge National Laboratory. Some of the ORNL work during this time period was funded by EPRI.

In the recent EPRI work, DSA methods were applied to a system of model equations similar to that of the RETRAN-3D code to determine if DSA can be used effectively for sensitivity analysis. The results show that DSA produces reasonable predictions of the forward equations within the linear limitations and has the potential as a tool for analysis of complex physical systems.

The models and results presented are a first step in the area of differential sensitivity analysis for RETRAN-3D or other EPRI codes. The work is intended as a contribution to the body of work that already exists as well as a 'hands on' approach to adapt a new technique to gain insight and experience.

For more information, please contact Garry Gose, CSA, gag@csai.com or (208) 529-1700.



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## About This Newsletter

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### 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

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P. O. Box 10412  
Palo Alto, CA 94303  
lagee@msm.epri.com or (415) 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 1997 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 1, 1997. **Contributors will receive a RETRAN mouse pad.** We are looking forward to hearing from all RETRAN licensees.

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