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The RETRAN Newsletter

June, 1996

Summary of Activities

This issue of the RETRAN Newsletter contains information on obtaining code versions from the EPSC and several interesting articles from a number of code users. You contributions are greatly appreciated. We, EPRI and CSA, encourage everyone's participation 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.

In This Issue . . .

Procedure for Obtaining QA Version of Code

Call the EPSC at 1-800-763-3772 to confirm membership status and verify license. EPSC requires a written record of the request which can be faxed, e-mailed, or sent via regular mail. A help desk technician will assist the caller in identifying the most appropriate communications channel. Please note: Controlled copies can only be distributed to utilities with signed letter agreements to all known nuclear utilities.

Availability of RETRAN-02 MOD005.2

RS-6000/AIX Version:	Available 6/13/96
Sun/UNIX Version:	Available 6/13/96
HP/UNIX Version:	Available 6/17/96
PC-DOS Version:	Waiting for software keys from Rainbow Technologies

EPSC Contacts

EPSC Hours:	6 a.m. to 5 p.m. PST
EPSC Hotline:	1-800-763-3772
EPSC Fax:	(619) 453-4495
E-Mail (EPRINET):	ordepsc@eprinet.epri.com

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

Auxiliary Feedwater Pump Turbine Steam Supply and Drain System Redesign Using RETRAN-02

J. Boatwright, TU Electric

Several trips of the turbine-driven auxiliary feedwater pumps (TDAFWP) at Comanche Peak Steam Electric Station have been experienced during system startups. One of the primary contributors to these trips was determined to be excessive accumulation of condensate in the steam supply, and possibly, exhaust steam lines to and from the TDAFWP turbine. The causes of the excessive condensate ranges from long runs of steam supply piping subjected to cold start conditions to malfunctioning of steam traps in the drain system. To improve the system reliability, a major design modification was undertaken for the steam supply and drains systems.

Briefly, the redesign of the system involved (1) decreasing the total volume of steam supply piping by connecting the two steam supply lines immediately downstream of the steam supply valves, (2) providing additional drain pots in the steam supply piping with flow restricting orifices to allow removal of steam traps while still limiting steam flow to the drains, and (3) providing a flash tank with steam vent and loop seal to separate condensate in the drains from the steam to prevent steam blowdown to the floor drains system.

The design was analyzed using two RETRAN models: one of the steam supply, exhaust, and drain piping (the system model) and another of the flash tank (the flash tank model). Steam supply and turbine exhaust conditions for the full operating range of the turbine were imposed on the system model using time-dependent volumes. Condensation rates were determined using conservative hand calculations and imposed on the system model using a fill flux into one of the drain pots. No attempt was made to model the dynamic separation of the condensate from the steam. It was simply assumed that all condensate was separated from the steam and entered a single drain pot. Results from the steam model runs were used: (1) to verify that the steam flows to the turbine met design requirements over the full range of operating pressures, (2) to ensure that the capacitance of drain pots in the steam supply lines coupled with their flow restricting orifices was sufficient to prevent adverse condensate accumulation in the steam supply lines, (3) to size the drain pot flow restricting orifices and steam vents to limit steam blowdown to the drains system and direct it to the atmosphere, and (4) to obtain the mass and energy blowdowns to the flash tank. These mass and energy blowdowns were imposed on the flash tank using fill fluxes, one for the blowdown from the steam supply side drains and another from the exhaust side drains. The flash tank and loop seal were modeled using separated volumes. Results from the flash tank model were used to size the flash tank, loop seal, and steam vent in order to prevent steam blowdown to the floor drains system.

User Group Meetings

The RETRAN and VIPRE User Group Meetings will be hosted by Commonwealth Edison this year. The meetings are scheduled to begin the afternoon of September 30 and end the morning of October 3, 1996, and will be held at the CECo office in Downers Grove, Illinois. A block of rooms has been reserved at the Marriott Suites in Downers Grove for this meeting. The hotel is one block from the CECo office. Users are requested to prepare brief presentations of current RETRAN and VIPRE activities at their organization. Further information on this meeting will be mailed to all members of the RETRAN and VIPRE Maintenance Groups. If you have any questions, contact Pam Richardson or Garry Gose at CSA or Lance Agee at EPRI.

The Development of the Evaluation Methodology of the LTOP Accident in PWR

C. Lee and Y. Kim, Korea Electric Power Research Institute, KEPCO

The low-temperature overpressure (LTOP) accident may cause brittle failure of the reactor pressure vessel during startup and cooldown operations in pressurized water reactor. To protect the reactor pressure vessel from the LTOP accident, a pressure versus temperature curve given by plant technical specification conservatively bounds the maximum allowable pressure for the temperature range where the reactor pressure vessel can suffer brittle fracture. Nuclear power plants have been equipped with either redundant power operated relief valves or redundant safety relief valves in the residual heat removal systems to prevent pressure increase from exceeding the embrittlement fracture limit.

The purpose of KEPRI's project is to develop the evaluation methodology of LTOP accident in PWR. KEPRI has defined the severe LTOP events into two classes, such as the mass addition and the heat addition events.

The limiting mass injection events assumed is the inadvertent start of one safety injection pump when RCS is water-solid condition. The possible source of injected flow should be decided by plant specific technical specification. For the analysis of these events, KEPRI has developed a simple computer program, LTOP_MI, and verified it with the results of RETRAN-03 MOD001f of the same inputs.

The limiting heat addition event is assumed to be initiated by the start of a reactor coolant pump with steam generator secondary-side temperature 50^{o}F higher than the primary side when RCS is water-solid condition. This leads the rapid expansion of the RCS inventory and is causing overpressure event. For the analysis of these transients, we have used RETRAN-03 MOD001f.

The results of this project will be presented in the near future.

CSA Launches Web Page

The CSA Web page that includes information of interest to RETRAN users will be available to users August 1, 1996. The page will have

- general information on RETRAN activities,
- lists of RETRAN-02 and RETRAN-3D trouble reports,
- a bibliography of RETRAN-related publications, and
- a form to submit RETRAN trouble reports electronically.

Other features that are planned for the future include a news group.

We will send the URL to all members of the Maintenance Group as soon as the RETRAN pages are available.

Oscillations Due to Poor Control Block Ordering

N. Newman, Scientech, Inc.

In its description of the control system model, the RETRAN-02 MOD005.1 User's Manual clearly states that "the order in which the output of each block is calculated affects the numerical results ..." and that "the burden is upon the user to order computations in the control system in cascading order ...". An illustration of the truth of this was encountered recently.

A control system had been constructed to model the torque applied to the recirculation pump in a BWR. Upon running the model for what should have been a null transient, fairly significant and rapid oscillations in the pump speed were observed to begin after a few seconds.

Fortunately, this particular control system had been computer-generated, and it was a trivial matter to have the control system generated in cascade order. With this re-ordering, the control system behaved perfectly. A comparison of the computed pump speeds is shown in Figure 1. It is emphasized that the only difference in the input decks for these two cases was the selection of the card sequence numbers for the 703XXX control cards.

This illustrates that the warning in the RETRAN User's Manual needs to be respected. If care is not taken to order the control system blocks correctly, incorrect results may be obtained.

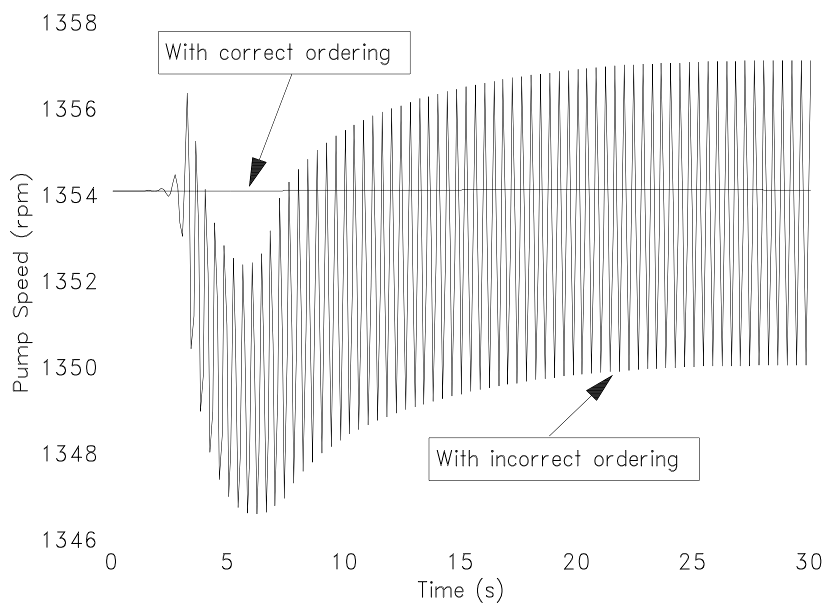


Figure 1. Illustration of the Effect of Control Block Ordering

LOFTRAN-AP Analysis

S. Oh, EPRI

Westinghouse used LOFTRAN-AP, a modified version of LOFTRAN, to analyze certain SSAR Chapter 15 transient analyses for AP600. One of the analyses is a steam line break transient (SLB). EPRI has performed the SLB analysis using RETRAN-03 MOD001b. The objective of this study is to understand similarities and differences between results from the two codes and models and to show that LOFTRAN SLB analyses are conservative.

Similar to current operating plants, the main SLB at the hot zero power condition is examined. The scope of this study is limited to the thermal-hydraulic behavior. The core power history, obtained from the LOFTRAN run, was input into RETRAN. The main focus is possible flow stagnation and two-phase conditions in the unaffected loop, and their impact on core makeup tank (CMT) behavior. The CMTs are connected to the unaffected loop in this study.

Two sets of RETRAN analyses were made. The first set was the counterpart of the LOFTRAN-AP analysis. RETRAN was run for 700 seconds. The second set was to examine long-term behavior. RETRAN was run out to 3000 seconds. The first set of results indicate that the LOFTRAN analysis is conservative and has a more rapid cooldown than that computed by RETRAN. The main difference is that the unaffected loop became stagnant and two phase in the RETRAN result. In LOFTRAN, forward flow through the unaffected loop was maintained. The second set of results indicate that the core makeup tank recirculation continued throughout the transient.

AP600 is a 600 MWe advanced light water reactor, currently in the design certification process. Unlike current operating plants, AP600 utilizes passive safety injection systems, such as core makeup tanks, IRWST, and a passive RHR system. The reliance on passive safety systems requires a different challenge to the codes. Correct prediction of low flows induced by density differences and natural/mixed convection heat transfer are important. The RETRAN prediction of PRHR heat transfer and core makeup tank recirculation have been examined and found to be reasonable for the SLB analysis. However, it is recommended that a more systematic evaluation be performed before further application of RETRAN to AP600 transients.

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
- 3 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 NO.	IDENT	COMMENTS
1	Error 209 in TEMZ	***	********	MOD001 Error
61	Delta T for Conductor with TDV	***	********	Need Input Deck
121	OTSG Low Power Initialization	***	********	
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

Summary of RETRAN-3D Code Trouble Reports

The Design Review of RETRAN-3D MOD001f is nearly finished. A summary of the Trouble Report/Code Maintenance Activity is shown below. It includes all errors that were not resolved in MOD001f and errors that have been reported since its completion. MOD001g has not been finalized and includes all error corrections and modifications that have been made to date.

NO.	TROUBLE REPORT TYPE OF PROBLEM	CORRECTION NO.	IDENT	COMMENTS
2	Slip differences between prerel & pre56	----	------------	Change in defaults
5	Pressure increase in last SL volume	----	------------	Not a code error
6	1-D Kin power level not converging	----	------------	Model limitation
7	Steam separator model fails	***	********	
8	Two-phase junction choking error	***	********	
10	1st iteration failure during steady state	***	********	
11	Negative enthalpy when flow reverses	***	********	
19	Steady-state area adj. for powered cond. Error when using low power initialization	***	********	
24	Pressurizer mix. level not consistent with the liquid level (RETRAN-03 and -02)	***	********	
26	Choked flow failure	***	********	
27	Flow oscillation as jun void goes to zero	----	------------	Model limitation
28	Low power steam generator init. fails	***	********	
29	Fails with minimum time-step size	----	------------	Input error
30	2 loop Oconee w/5-Eq fails in st-state	***	********	
31	Failure in QDOT14	005	MOD001g	
32	Fails in the two region nonequil. model	***	********	
33	000040 data not read during restart	***	********	
34	Different laminar flow friction transition	001	MOD001g	
35	Initial NCG states not propagated correctly	***	********	

Summary of RETRAN-3D Code Trouble Reports (Cont'd)

NO.	TROUBLE REPORT TYPE OF PROBLEM	CORRECTION NO.	IDENT	COMMENTS
36	CHF calculation for a single volume	007	MOD001g	
37	Choked flow numerical instability	013	MOD001g	
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 a time step error in pressurizer	***	********	
43	Steady-state convergence error	***	********	
44	Direct moderator heating error	***	********	
45	Restart incorrect transient values	***	********	
46	Steady-state does not converge	***	********	
47	Standard Problem One difference	***	********	
48	Steady-state fails after 6 iterations	006	MOD001g	(partial fix)
49	Edits for Volume Data Actually Used	009	MOD001g	
50	Void fraction comparisons are poor	002	MOD001g	
51	Pressure search failure for 2-phase MOC	***	********	
52	MOC does not return to the initial temp	***	********	
53	MOC does not work with noncondensables	----	------------	Model limitation
54	MOC soln - no null tran for 2 phase	***	********	
55	Condensation heat tran -- core dump	008	MOD001g	
56	Stdy-state fails - dyn slip used -- 135 vol	035	MOD001g	(partial fix)
57	Enthalpy error at steady-state iter #6	***	********	
58	Condensation mass transfer model error	002	MOD001g	
59	Error in fill and tdv BCs for pure error	011	MOD001g	
60	Anomalous countercurrent flooding	***	********	
61	REEDIT job causes and FTB error	014	MOD001g	
62	Code error discovered on PC installation	003	MOD001g	
63	Multi-D kinetics input and ss error proc	004	MOD001g	
		016	MOD001g	
64	Format Error for Card 146000	018	MOD001g	
65	Error turning enth tran off when 5-eq used	028	MOD001g	
66	Error in TRIPDT when dt < TMIN	004	MOD001g	
67	No check for TMIN or TRTG < TMAX	019	MOD001g	
68	Error in five-eqn wall heat/mass transfer	024	MOD001g	
69	Five-equation option fails to initialize	***	********	
70	Fails in subroutine DERIVS	***	********	
71	Przr model doesn't match theory	025	MOD001g	
72	Allow old TDV input when no NCG	017	MOD001g	
73	Output format error in sub. INGAS	020	MOD001g	
74	Correct EOS failure in GENOPT	021	MOD001g	
75	Eliminate call to CCFPRP in stdy-st	022	MOD001g	
76	Remove extraneous deriv. in XANDH	023	MOD001g	
77	Reactivate slip after single phase	026	MOD001g	
78	Correct phase flag in STATNE	027	MOD001g	
79	Error in Wilson Bubble Rise Model	030	MOD001g	
80	Error with restart - Pressure reported as non.	032	MOD001g	
81	Steady state failure at Iteration #6	***	********	
82	Water properties routines don't give unique answers	***	*********	
83	Separated volumes fail to converge	***	*********	
84	A reedit error - FTB Error #11	***	*********	

ComEd BWR Transient Analysis Licensing Topical Report

B. Tsai, Commonwealth Edison Company

In June 1995, Commonwealth Edison Company (ComEd) submitted a licensing topical report that presents ComEd's BWR transient analysis methods. The report demonstrates the validity of the methods and the qualification of ComEd to perform transient analysis for reload licensing and operational support applications. This is accomplished by presenting the results of the benchmarking studies of ComEd BWR plant startup tests, Peach Bottom turbine trip tests, and the Peach Bottom NRC licensing basis transient. Related material including the core thermal limit, and reload application methodologies to qualify the reload licensing application will be provided in a separate report.

ComEd's transient analysis methods are primarily based on the computer codes developed by the Electric Power Research Institute (EPRI): RETRAN-02 MOD005, ESCORE, FIBWR2 (EPRI/Scientech), and PETRA (Scandpower).

The ComEd benchmarking analysis of the plant startup tests was chosen to validate the ComEd transient analysis methods for a variety of plant transients. Comparison studies of the turbine trip tests performed at Peach Bottom Unit 2 Cycle 2 demonstrate the acceptability of the ComEd transient analysis methods for more challenging pressurization events similar to the licensing basis events. An NRC licensing basis transient case of Peach Bottom turbine trip without bypass was analyzed to demonstrate ComEd method's capability of predicting system response under conditions which challenge operating limits.

The comprehensive nature of the benchmarking scope and the good agreement of all the benchmarking results have fully demonstrated the capability of the ComEd transient analysis methods and the qualification of the ComEd staff to use the methods presented to perform transient analysis for reload licensing and operational support applications.

We would like to acknowledge the consulting services provided by Computer Simulations & Analysis, Inc. and Scandpower, Inc. during the course of development of the 1D kinetics model. The technical assistance of Scientech, Inc. on steady-state core thermal-hydraulic model development is appreciated.

The technical discussions with Chet Lehmann of Pennsylvania Power & Light Company, Andy Olson of Philadelphia Electric Company, and Chris Brennan of Public Service Electric & Gas Company on Peach Bottom benchmarking were very helpful and greatly appreciated.

We gratefully acknowledge the support of Dr. Terry Rieck, Manager of Nuclear Fuel Services (NFS), Nuclear Design & Support Services groups of NFS during the course of this development project.

Calendar

September 30 - October 3, 1996
RETRAN User Group Meeting
Hosted by Commonwealth Edison Co., Chicago, IL
Contact: Lance Agee, EPRI or Garry Gose, CSA

Void Fraction Modeling for Steady-State and Dynamic Environments

B. Chexal, Electric Power Research Institute
J. Harrison, Virtual Technical Services, Inc.

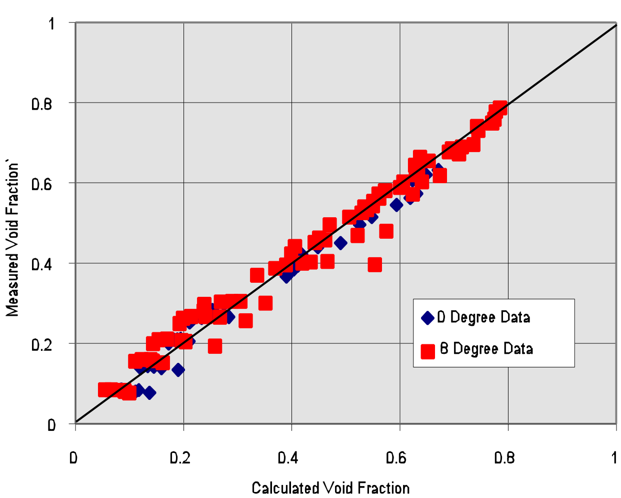
P. Jensen and C. Peterson, CSA
G. Lellouche, Technical Data Services

The Chexal-Lellouche (1996) void fraction model revises the earlier void fraction correlation to enhance the models ability to be implemented in transient thermal-hydraulic programs. The dynamic environment demands smooth transitions between the flow quadrants as well as reasonable rates of change of the drift flux model parameters that are used in the interphase friction calculation. The model has also been improved in the countercurrent flow quadrant based on additional data.

In conjunction with the associated modifications, the ability of the model to predict the original void fraction database was again verified, and the enhancements were implemented and tested in both RELAP5 and RETRAN-03.

Countercurrrent Flow Quadrant Modeling

The new data in countercurrent flow is taken from Ghiaasiaan, et al, at Georgia Tech (1994). These tests were performed using air and water at room temperature with a 0.75 in i.d. clear acrylic tube, 6.8 ft long. Tests were conducted at angles of inclination from vertical of 0, 8, 28, 45, and 60 degrees. Only the zero- and eight-degree data was used in the development of the model. The following figure illustrates the calculated versus measured scatter diagram.



The fit in the countercurrent quadrant (away from the countercurrent flow limit) is quite good and provides a significant improvement over the previous engineering approximation.

Dynamic Void Fraction Modeling

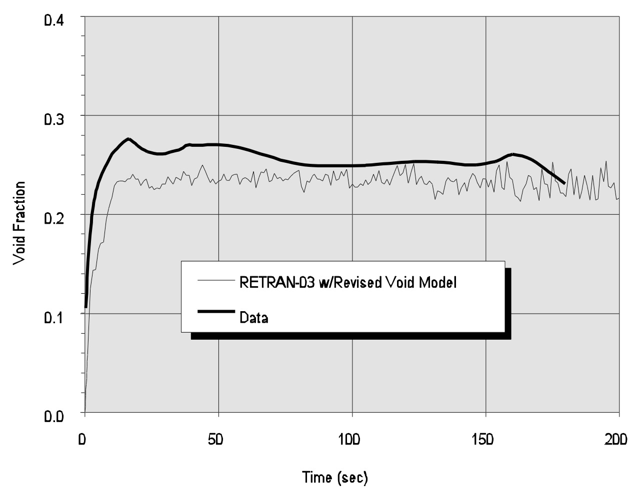
A single code module was constructed for use in both RELAP5 and RETRAN-03. The module can be used to

- compute the drift flux parameters V_{gj} and C_o, which can be used to calculate interphase friction, or
- compute phase velocities.

The following experimental cases were examined:

- FRIGG six-Rod Heated Bundle Test 13001,
- FRIGG 36-Rod Heated Bundle Test 41349,
- One-Foot (Diameter) GE Level Swell Test 1004-3,
- Four-Foot (Diameter) GE Level Swell Test 5801-15,
- Marviken Tests 22 and 24,
- ORNL THTF Void Profile Test, and
- MIT Pressurizer Test.

Following is a sample of the results for the General Electric One-Foot Level Swell Test 1004-3. (The previous model was sufficiently unstable that it would not run this test.)



The Chexal-Lellouche (1996) void model performed well in both RELAP5 and RETRAN-03 for the complement of tests. The magnitude and trend of the predictions as compared to the data demonstrate that the void model can work well in the framework of these programs. The void module was tested using the model parameters to calculate interphase friction coefficient, as well as using the phasic velocities from the module in an algebraic fashion. Both approaches functioned well and the differences are not remarkable based on the results from the tests that were simulated.

Hurray!
New RETRAN Users!

In April 1996, nine people attended a basic RETRAN training session. Congratulations to the following attendees.

Craig G. Holmes, Commonwealth Edison Co.
Tao Ting Hsu, New York Power Authority
Nasser Nik, New York Power Authority
Pamela B. Cowan, Public Service Electric & Gas Co.
Roger Dettenmeier, Union Electric Co.
Mark J. Konya, Union Electric Co.
Neal G. Slaten, Union Electric Co.
Pete Kennamore, Wolf Creek Nuclear Operating Corp.
Verl MacTaggart, Wolf Creek Nuclear Operating Corp.

Take the Plunge! For more information on future basic and advanced training sessions, please contact Garry Gose or Pam Richardson at CSA, (208) 529-1700 or E-mail gag@srv.net or pam@srv.net.

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
Electric Power Research Institute
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 September 1996 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 September 1, 1996. ***Contributors will receive a RETRAN mouse pad.*** We are looking forward to hearing from all RETRAN licensees.

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