Published by Computer Simulation & Analysis, Inc. for EPRI

The RETRAN Newsletter

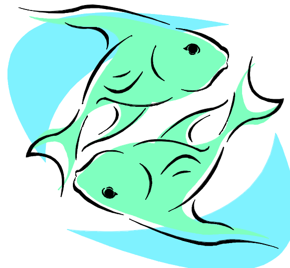
October, 1999

Summary of Activities

This issue of the RETRAN Newsletter contains articles on the NRC Review of RETRAN-3D, an article on CORETRAN, 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...



PISCIS: Graphic User Interface for CORETRAN

Antonio Crespo and José A. González, IBERINCO

PISCIS is a graphic user interface (GUI) developed by IBERINCO (Iberdrola Engineering and Consulting Company) to aid in the fuel management and plant operation activities of nuclear reactors. It has been widely used by Iberdrola (Spanish electrical utility) for the core design verification and operational support of Cofrentes NPP (BWR) and Almaraz NPP (two PWR units).

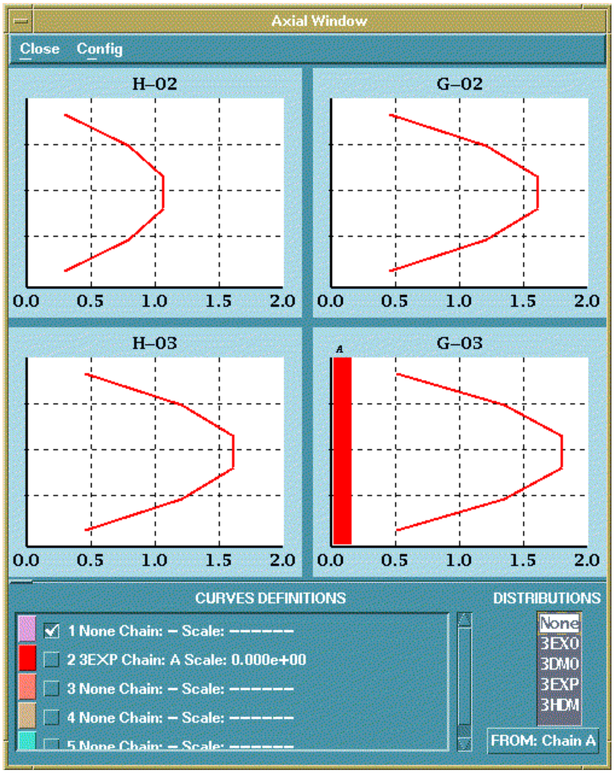
The PISCIS-CM03 version is being developed under EPRI contract as the graphic user interface for CORETRAN. An alpha version of PISCIS-CM03 was demonstrated during the CPM-3/ CORETRAN Workshop held in October, 1998, at Rockville, MD.

Actually, the PISCIS code is being adapted to the latest CORETRAN-01 beta version (1.47) and will be formally released together with CORETRAN during this year.

PISCIS allows the graphical representation of the CORETRAN results and the input data manipulation to run new simulator cases.
It is mainly focused on helping the CORETRAN users in production activities. Before starting PISCIS some preliminary work is required in order to define both the possible two-dimensional *maps* to be used when displaying the CORETRAN results, and the possible *case types* to be used when running new cases. Nevertheless, once the GUI has been configured, it will become an efficient tool for the quality assurance and documentation of the production work.

Among the CORETRAN results to be displayed by PISCIS are:

C global parameters (eigenvalue, core thermal power, core flow, cycle exposure, ...),



PISCIS: Graphic User Interface for CORETRAN (Cont'd)

C core average axial distributions,

C 2D bundlewise or nodal distributions (bundle id., bundle type, relative power, exposure, ...),

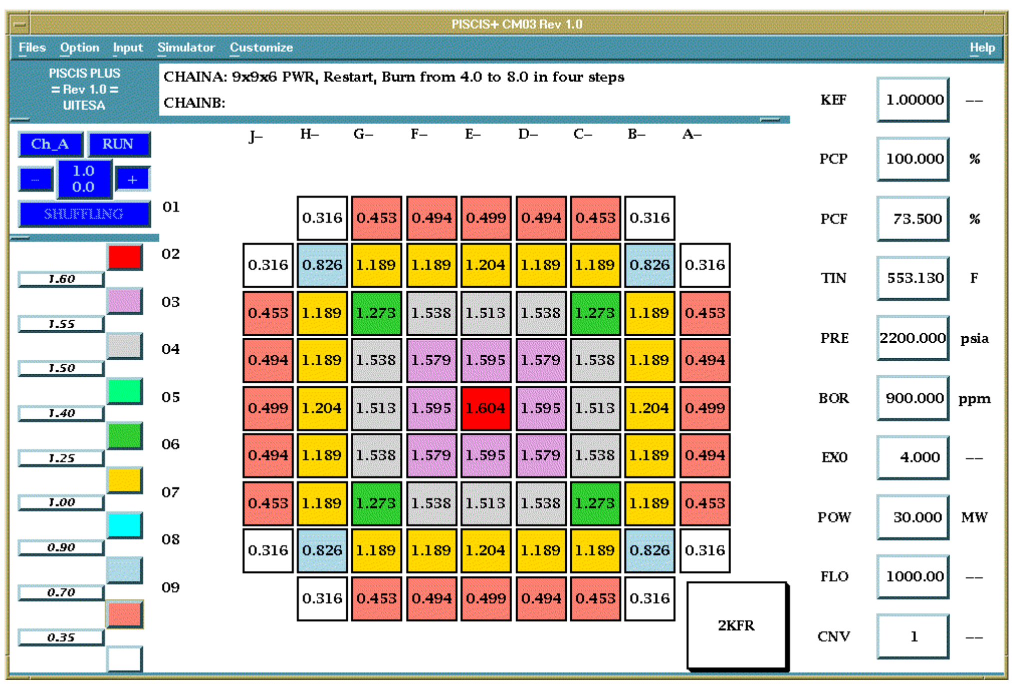
C 3D bundlewise or nodal distributions (they can be displayed by planes (2D maps) or by assemblies (1x1 or 2x2 axial distributions)), and

C comparison of two CORETRAN cases is also allowed.

The main features of the CORETRAN input data preparation are:

C The input data that can be provided by the user are defined through the different *case type* templates. Among these input data are: core parameters, calculational options, control rod positions, and file names. Depending on the *case type* definition, some of these data will not be used as CORETRAN input, some other will be used with a fixed value, and some other will be used with a user-provided value.

C Different CORETRAN runs can be prepared and managed by PISCIS as a single piece of information (this is called a PISCIS *chain*). A *chain* includes several runs in the same way that a run comprises several cases and a case has several steps. This feature allows the user to put together all the CORETRAN cases needed for a given task (i.e., core design for a given cycle), modify some of the initial or intermediate data, and rerun the complete *chain* of cases.



C Bundle shuffling and depleted fuel loading is performed by PISCIS in a graphic way, taking into account the user-provided core symmetry options. Assembly rotations and reflections can also be carried out.

KNGR LOCV Analysis with RETRAN

Yo-Han Kim and Hwang Yong Jun, KEPRI/KEPCO

Since 1992, Korean nuclear industries have developed the Korean next generation reactor (KNGR) based on the concepts of ABB-CE System 80+. This reactor has the thermal power of about 4,000 MW, two steam generators, and four RCPs. KEPCO (Korea Electric Power Corporation), the leading company developing the reactor, issued the first version of the SSAR (Standard Safety Analysis Report) of KNGR in the first quarter of 1999.

In Chapter 15 of the SSAR, five categories of accidents have been analyzed such as increase/decrease in heat removal by the secondary system, decrease in reactor coolant flow rate, reactivity and power distribution anomalies, increase/decrease in RCS inventory, and radioactive material release from a subsystem. The loss of condenser vacuum (LOCV) event is marked as the most severe accident in the second category, i.e., decrease in heat removal by the secondary system. The SSAR calculation was performed with the ABB-CE code, CESEC-III. This work has been analyzed with RETRAN-02 and RETRAN-3D to verify the results of the SSAR and show the feasibility of the design improvements.

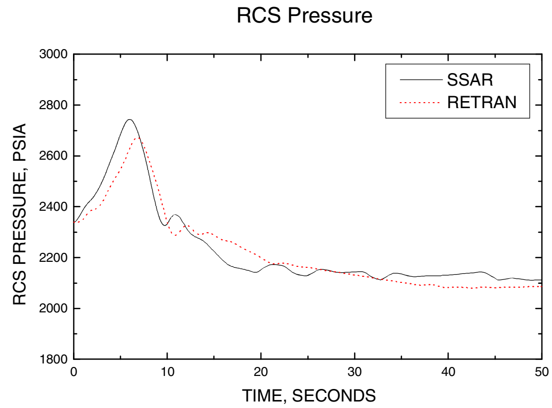


Fig. 1. RCS Pressure vs. Time

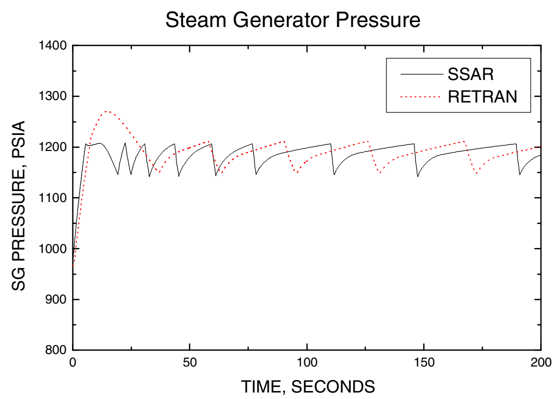


Fig. 2. SG Pressure vs. Time

A LOCV may occur due to the failure of the circulating water system to supply cooling water, the failure of the main condenser evacuation system to remove noncondensable gases, or the excess in-leakage of air. To analyze the event the immediate cessation of feedwater flow is assumed, and the turbine is assumed to trip immediately coincident with the beginning of the event. In compliance with GDC 17, the LOCV events with and without a loss of offsite power (LOOP) coincident with turbine trip are analyzed. For more efficient comparison the same initial conditions and setpoints have been used as those of the SSAR to analyze the event.

The results of this analysis are as mentioned in the table below. As shown in the figures, the RCS and SG pressure of RETRAN typically have the same trends comparing with those of the SSAR. In spite of higher MSSV setpoints and less valve cycling, the RETRAN results show the RCS and SG pressures do not exceed the limit values (2,750 and 1,320 psia, respectively).

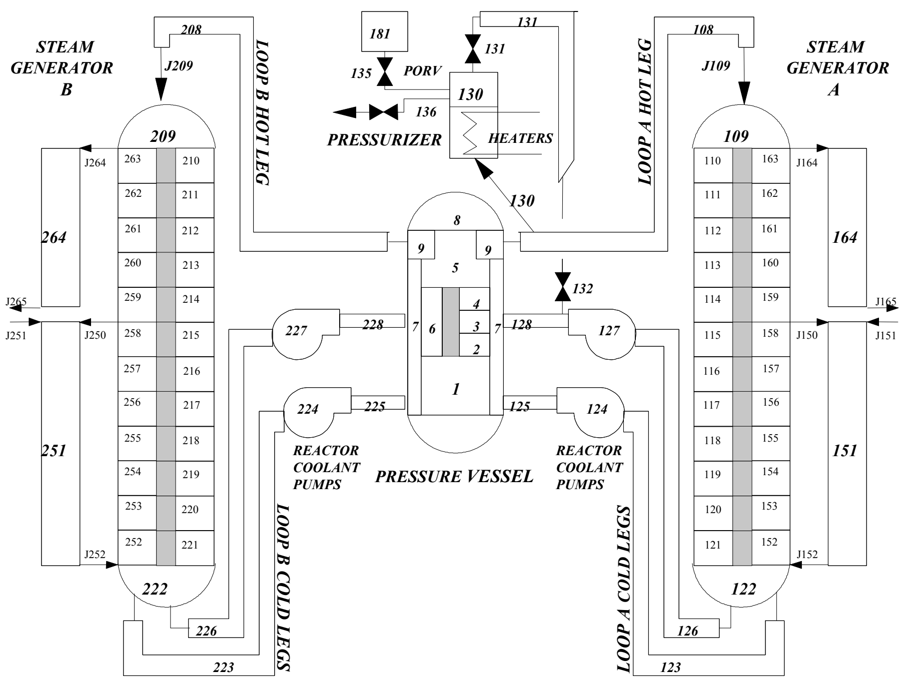
Tb. Results Comparison

Results	SSAR	RETRAN-02	RETRAN-3D
Max. RCS Pressure (psia)	2,744	2,672	2,672
Max. SG Pressure (psia)	1,207	1,265	1,271
MSSV Setpoints (psia)	1,206	1,211	1,211
No. of MSSVs Opened (e/a)	20	8	8
Max. Mass Flow of MSSV (lbm/sec)	3,369	2,019	2,028

NRC Gives Thumbs-Up to TMI-1 OTSG Tube Plugging Request

Adi Irani, GPU Nuclear

GPU Nuclear recently received approval for an increase in the allowed tube plugging limit for TMI-1's once through steam generators (OTSGs). TMI-1 operates with two, 72-foot-tall OTSGs, part of TMI-1's primary operating system. The approval establishes a new criteria, allowing TMI-1 to plug an average of 20% of the 31,000 tubes in the plant's A and B steam generators. While plugging no more than 25% of the tubes in any one generator is allowed, a combined average of up to about 6,200 tubes could be plugged. TMI-1 currently has a total of 1695 tubes plugged.



The new limit is a significant accomplishment for GPU Nuclear because no other B&W plant has ever received approval for this level of tube plugging. In order to gain approval from the NRC, the GPUN engineering team had to evaluate critical safety analyses aspects of plant design that could be affected by additional tube plugging. OTSG tube plugging decreases reactor coolant system flow, reduces RCS inventory and decreases primary-to-secondary heat transfer.

A Technical Specification Change Request was submitted to the NRC in December 1998. This addressed transients and accidents in the Final Safety Analysis Report (FSAR), Technical Specification safety limits, operations performance for the steam generators, impact on reactor coolant temperatures, component material effects of operating at a slightly higher temperature, to name just a few of the analyses that were required. RETRAN was used to re-analyze some limiting accidents such as the startup, loss of feedwater and loss of offsite power. The most limiting DNBR accidents, the loss of coolant flow accidents, were re-analyzed with VIPRE. RELAP5 was used to re-analyze the large break and small break loss of coolant accidents (LOCA's).

Numerous teleconferences and written requests for additional information from the NRC were received and responded to quickly to stay on schedule and complete the project deadlines. The 20% average steam generator tube plugging approval was one of the conditions for the sale of TMI-1 to Amergen.

Nick Trikouros, Manager of Safety and Risk Analysis for Engineering in Parsippany said "Hopefully, we will never have to use the 20% margin, but it's there on a contingency basis."

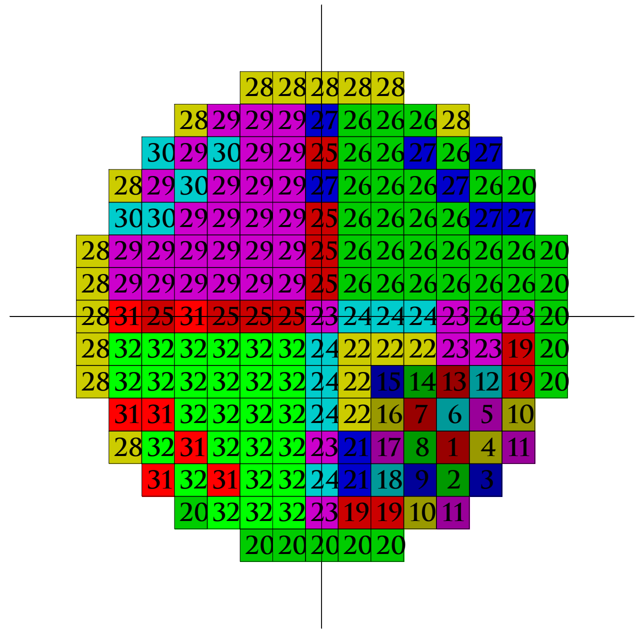
CORETRAN Design Review Underway

John L. Westacott, CSA

The CORETRAN code has entered the design review stage with a kick-off meeting at CSA's offices on July 27-29,1999. The design review team has an extensive background in the areas of reload core design; reactor physics and kinetics; thermal-hydraulic and thermal margin analyses; and design, development, and application of large, complex computer codes such as CORETRAN. Members of the design review team include:

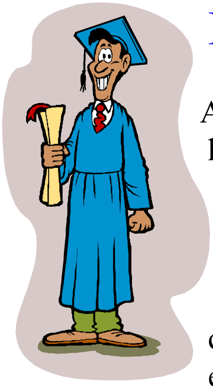
> Clifford Bonneau, Northern States Power,
> Richard Cacciapouti, Duke Engineering & Services,
> Patrick S. Lacy, Utility Resource Associates,
> Samuel L. Forkner, Signal Mountain Software & Engineering Consultants,
> James F. Harrison, Virtual Technical Services, Inc., and
> E. Daniel Hughes, Hughes and Associates.

The design review is being performed to verify that adequate documentation exists (EPRI criteria), that the coding accurately reflects the documentation, and is stable and convergent. Also, the review covers validation with comparison to experimental and analytical data. The intended applications of the CORETRAN code include:



- C steady-state analyses
  - core nuclear design
  - core thermal and hydraulic design
  - core startup and operations support
- C static safety analyses
  - misloaded bundle/assembly
  - misoriented bundle
  - control rod withdrawal error at high power
  - loss of feedwater heating
- C dynamic safety analyses
  - PWR control rod ejection
  - BWR control rod drop
  - steam line break
- C PWR and BWR Chapter 15 events

The design review plan has been written and approved and the review has been initiated. The design review is scheduled to be completed this calendar year.



Hurray! New RETRAN Graduates!

A RETRAN training session was held at CSA's office in Idaho Falls during August.

The 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. 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.

Congratulations to the following RETRAN Training participants:

Tyrone L. Stevens, Commonwealth Edison
Jim Kapernekas, Illinois Power
Steven Bier, Public Service Electric & Gas
Todd R. Flowers, Virginia Power
Jeffrey L. Voskuil, Wisconsin Public Service Corp.
Frank Laflin, Wolf Creek Nuclear Operating Corp.

NRC Review of RETRAN-3D Progress Report

Mark P. Paulsen, CSA

The NRC review of RETRAN-3D is in progress with the latest activity being formal meetings with the Nuclear Regulatory Commission. These 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 December 1999.

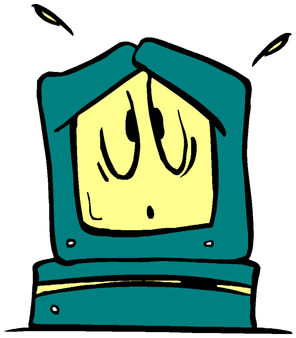
RETRAN-3D is the third generation of the RETRAN code series developed for the utility industry by EPRI and provides additional modeling capability compared with the NRC-approved RETRAN-02 computer program. Some of the new models include:

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

An ACRS Subcommittee on Thermal/Hydraulic Phenomena was held May 26, 1999, where an overview of RETRAN-3D was made by Dr. G. Wallis. In a follow up meeting with the NRC staff on June 14,1999, comments made in the ACRS subcommittee were discussed along with the status and schedule for completion of the RETRAN-3D review.

The response to the first request for additional information has been completed. The response to the NRC's second request for additional information has been the main focus of recent NRC review effort. A preliminary analysis of the SPERT Tests 81 and 86 were performed with RETRAN-3D as part of the second request.

The NRC sent two staff members to the RETRAN training sessions at CSA. They attended the formal lectures and participated in the sample problem sessions. They will include an evaluation of the training in the RETRAN-3D SER.



Summary of RETRAN-02 Trouble Reports

The following is a summary of RETRAN-02 Trouble Report/Code Maintenance Activity. There are 7 outstanding trouble reports. 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.

NO.	TROUBLE REPORT 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	***	*******	
440	Kinetic Energy/Time Dep Area	***	*******	
442	Poor Diagnostics	***	*******	
445	Boron Transport Inconsistency	***	*******	

Summary of RETRAN-3D Code Trouble Reports

A total of 196 trouble reports had been filed as of August 31, 1999. Of these, 172 reports have been resolved, while 24 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 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	***	*******	
		6	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	***	*******	
164	3-D kinetics causes floating point exceptions	***	*******	
165	3-D kinetics unable to specify profile fit for subcooled boiling model	***	*******	
168	Incorrect null trans w/3d Kin., mod ht & 5eq	***	*******	
170	PARCS numerics will not hold a null transient	***	*******	
174	5-EQ error in steam lines	***	*******	
181	No rod cusping treatment in 3D kinetics	***	*******	
182	Kinetics problem type is fixed at 3	***	*******	
190	Error when reversing from/to junc. w/ angle	***	*******	

TechTips

Decay Heat Standard

John G. Shatford, CSA

It may be necessary when using the 1979 ANS 5.1 decay heat model, to account for uncertainties for each isotope included. The model as implemented in RETRAN, can use a single fissionable isotope ^{235}U or it can use three isotopes, ^{235}U, ^{238}U, and ^{239}Pu. The choice is up to the user.

When ^{235}U is the only isotope, the uncertainty can be specified via the KMUL input parameter. To account for a one-sigma uncertainty of 2%, KMUL would be specified as 1.02, a two-sigma uncertainty would be 1.04. If the three isotope model is used, it is not as straight forward to determine the necessary multiplier since each isotope has a different uncertainty, but the code only provides one multiplier, KMUL. Here is a way to account for one-sigma uncertainty for a given isotope mix.

Let's assume we have three isotopes with the following yields: 70% ^{235}U, 8% ^{238}U, and 22% ^{239}Pu. From the standard we can get an approximate average uncertainty value for the data for each isotope: 2% for ^{235}U, 10% for ^{238}U, and 5% for ^{239}Pu.

Fissile Isotope	Fractional Split	Uncertainty (1F)
^{235}U	0.70	2%
^{238}U	0.08	10%
^{239}Pu	0.22	5%

To account for the separate isotope uncertainty values, the fraction of the isotope was increased by the percent uncertainty. RETRAN requires that the isotope fractions sum to 1.0, therefore, we renormalize the revised isotope fractions and include the normalization adjustment as KMUL.

The adjusted fraction of fission for the three isotopes are:

^{235}U	0.70 x 1.02	=	0.714
^{238}U	0.08 x 1.1	=	0.088
^{239}Pu	0.22 x 1.05	=	$\underline{0.231}$
			1.033

Now the decay heat multiplier, KMUL, is 1.033 and the normalized fractions for the three isotopes become:

^{235}U	0.714 / 1.033	=	0.6912
^{238}U	0.088 / 1.033	=	0.0851
^{239}Pu	0.231 / 1.033	=	$\underline{0.2236}$
			1.0000

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 December 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 December 6, 1999. ***Contributors of a feature article will receive a RETRAN polo shirt.*** We are looking forward to hearing from all RETRAN licensees.

Mark Paulsen	paulsen@csai.com (208) 529-1700
Garry Gose	gcg@csai.com
Pam Richardson	pam@csai.com

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

Calendar

User's Group Meeting
October 19-21, 1999
Hosted by Northern States Power Co.
Crowne Plaza/Northstar Hotel
Minneapolis, MN

EPSC Contacts

EPSC Hours: 7 a.m. to 8 p.m. EST
EPSC Hotline: (800) 763-3772
EPSC Fax: (619) 453-4495