LA-7751-P

Proposal

MASTER

A Proposal for the Transmittal of Data to LASL and the Reporting of TRAC Analyses for the Multinational Reflood Experimental Program

University of California

LOS ALAMOS SCIENTIFIC LABORATORY

Post Office Box 1663 Los Alamos, New Mexico 87545

LA-7751-P
Proposal

Special Distribution
Issued: April 1979

A Proposal for the Transmittal of Data to LASL and the Reporting of TRAC Analyses for the Multinational Reflood Experimental Program

Paul B. Bleiweis
Walter L. Kirchner
James M. Sicilian

A PROPOSAL FOR THE TRANSMITTAL OF DATA TO LASL AND THE REPORTING OF TRAC ANALYSES FOR THE MULTINATIONAL REFLOOD EXPERIMENTAL PROGRAM

by

Paul B. Bleiweis, Walter L. Kirchner, and James M. Sicilian

ABSTRACT

The proposed form of the digital tape containing the reduced experimental data from any of the 2D/3D facilities (CCTF, SCTF, UPTF, and possibly PKL Core-II) and the procedures which LASL will use in performing TRAC calculations and reporting results are described in this document.

This report, the first of an anticipated series, is to document the LASL technical participation in a multinational program (Germany, Japan, and United States) to investigate reflood and refill phenomena in postulated loss-of-coolant accidents (LOCA) in light water nuclear reactors (LWR). Sponsored by the USNRC, the LASL (Energy Division, Reactor Safety) role in this program is threefold: analysis of experiments (TRAC computer code), advanced instrumentation (rod lens), and small-scale experiments for phenomenological modeling.

I. DATA TRANSMITTAL

The purpose of this section is to outline a standard set of data specifications and data transmittal procedures for the multinational reflood program that will minimize confusion in data transfer and maximize accessibility for interpretation and analysis of the experiments conducted. Since the program involves several facilities in three countries, three languages, and many different data acquisition systems, conformance to a common data transmittal format is extremely important to ensure a smooth exchange of information. Therefore, the data tape format was formulated according to the following guidelines:

1. completeness of data transferred for each experimental test (i.e., the data tape should be a self-contained document),
2. minimization of facility effort in transferring engineering data to the data tapes,
3. standard SI engineering units for all data, and
4. standard tape format specifications.

A. Data Specifications

This section describes the necessary information which must accompany the experimental data to facilitate adequate assessment and analysis of the experiments.

1. Instrumentation Output Identification

Every data output channel in each experiment shall have a unique label. The facility assigned label should contain at least the following information: component monitored, variable measured, instrument type, and location(s) of sensor(s). Labeling of instrumentation is the prerogative of the facility conducting the experiment; however, it is recommended that an alphanumeric label of less than 15 characters be adopted (see following section on tape format).

2. Measured/Computed Variables and Units

All data transmitted shall be in standard international (SI) engineering units. Since most modern data acquisition is in the form of electrical signals, processing is required to convert these to useful engineering units. In some cases, sophisticated interpretation of several simultaneous signals is necessary to infer a value. However, for purposes of data transmittal, only the final, untempered, output value is desired. All software-related functions in data reduction are the responsibility of the facility and/or instrumentation contractor (see Program Description Document,[1] App. III.C.3&4). The ASTM guide to SI units[2] is recommended as the standard for all data transmitted in this program .

3. Instrumentation Range, Accuracy, and Response

Evaluation of data requires knowledge of the range, accuracy, and response of the instrumentation used. Therefore, it is necessary that information on the performance features of the instrument/software system used in producing the data accompany it. While details on the physical sensor are of use, the range, accuracy, and response reported should correspond to that of the entire system used in converting the initial signal to the final output value. The reported range should indicate the lower and upper output value limits of the instrument system (it is assumed that the actual sensor range is greater than, or equal to the data acquisition system range) and error bands should be assigned over the range of the instrument system. The response time and sampling rate of the instrument system are also required. Finally, because of possible system malfunction, the status of each instrument channel should be indicated. In event of an instrument malfunction or reading out of range during a test, a value of 0.0 (zero) should be entered in the data field for each time-value pair, from the time of failure until recovery, or end of test.

B. Data Transmittal Tape Format

The format for entering data on the tape and the physical tape specifications are outlined in this section. In order for a data tape to be a self-contained document for each test, a standard format has been formulated which provides for the information described in the preceding sections. The tape will be composed of three sections:

1. a complete facility instrumentation listing, with appropriate references,
2. an instrumentation accuracy section, grouped according to instrument type, and
3. a set of individual instrumentation data blocks in a time-value format.

The general character format shall be A20 for Hollerith strings, I10 for integers, and 1PE10.3 for real numbers. A header shall be appended to the beginning and end of the tape naming the facility, the experimental test number, the date on which the test was conducted, the tape number, and the total number of tapes for this test.

a. Facility Instrumentation Description

This information should be grouped by components, and then subgrouped according to the variable measured. It should at least include the following:

1. instrumentation identification label,
2. sensor location,
3. data acquisition system range,
4. instrument type label for error bands,
5. reference documents for figure showing sensor location or software for data reduction, and
6. status during test or other comments.

b. Instrumentation Accuracy Section

Since many sensors are of a similar type and share the same data acquisition system, the accuracy for a given type may be catalogued once for many sensors. Therefore, a unique label should be assigned to each type of instrument channel recorded which will refer to a set of error bands tabulated in this section. The information shall include the following:

1. instrumentation type label,
2. generic description,
3. data acquisition system range,
4. error type (percent or absolute), and
5. a table of error bands (value, error) (if only a fixed error is known over the entire range, read in 0.0 and the error value).

The information up to this point would have to be encoded only once (excepting changes in accuracy due to revised calibration) and except for comments regarding status for a particular test, it could be read to each experimental test tape from a facility stored file.

c. Instrumentation Data Blocks

The data blocks will contain the actual time-value pairs of output data from the experiment. The sequence of these blocks should, for clarity, follow the order used in the facility instrumentation description, but this requirement is not mandatory. For each data block, the following information shall be provided:

1. instrumentation identification label (identical to that used in facility instrumentation description),
2. instrumentation type label (identical to that used in instrumentation accuracy section),
3. units, and
4. a time-value data table.

Table I lists the information and format for the data tape for each of the above sections. Note that there are several key words used to delineate information sections. These keywords are mandatory (otherwise processing the tape will be extremely difficult). Figure 1 illustrates schematically the structure of the information on the t.pe.

d. Tape Physical Specifications

The procedures for recording the information described in preceding sections on tape in a standardized manner are delineated in this section. Data shall be in written characters in standard EBCDIC code*, and recorded on standard nine-track tape at 1600 bpi (bytes per inch phase encoded) in fixed block sizes of 3360 bytes. Table II lists the tape specifications. Following the above guidelines, it is estimated that the data for 1000 instrument channels, at an average sampling rate of 100 Hz for a 100-second transient could be recorded on less than five tapes. Each tape reel shall be identified externally with the following information:

1. facility - test number - test data,
2. tape number - total number of tapes for this test, and
3. recording code - tape speed - block size.

Accompanying each set of tapes should be a letter with the above label information and the name, address and phone number of the person(s) responsible for recording the tapes.

*EBCDIC - Extended Binary Coded Decimal Interchange Code.[3]

TABLE I

DATA FORMAT SPECIFICATION

Section	Information*	Format
	START-TAPE	A20
	BEGIN-HEADER	A20
Header	facility name, test number, test date, tape number, total number of tapes	3A20, 2I10
	END-HEADER	A20
Facility	BEGIN-DESCRIPTION	A20
Instrumentation Description	CDID - instrumentation identfication label, sensor location, data acquisition system range, instrument type label for error bands, reference document label, status during test, comments (repeat for each channel)	A20, plus A20 as needed
	END-DESCRIPTION	A20
	BEGIN-REFERENCE	A20
	CDRF reference document label, document description (repeat for each document)	A20, plus A20 as needed
	END-REFERENCE	A20
Instrumentation	BEGIN-ACCURACY	A20
Accuracy	CDAC instrumentation type label, data	A20, 2(1PE10.3)
	acquisition system range, error type (PERCENT or ABSOLUTE), generic description	A20, plus A20 as needed
	BEGIN-TABLE	A20
	value - error pairs (repeat as needed)	2(1PE10.3)
END-TABLE	A20	
	(repeat CDAC through END-TABLE for each instrumentation type)	
	END-ACCURACY	A20

TABLE I (Cont)

Section	Information	Format
Data block	BEGIN-DATA	A20
	CDIN-instrumentation identification label, instrumentation type label, units	3A20
	BEGIN-TABLE	A20
	time - value pairs (repeat as needed)	2(1PE10.3)
END-TABLE	A20	
	(repeat CDIN through END-TABLE for each instrument channel)	
	END-DATA	A20
	BEGIN-HEADER	A20
Header	facility name, test number, test date, tape number, total number of tapes	3A20,2I10
	END-HEADER	A20
	STOP-TAPE	A20

*Underlined key words shall be entered precisely as given in table (no spaces around hyphen). The labels shall follow the key immediately following the hyphen and fit within an A20 format, including the key (e.g., "CDIN-" plus label is less than, or equal to, 20 characters).

TABLE II

TAPE SPECIFICATIONS

Data:	Written characters
Format:	Hollerith - A20
	Integer - I10
	Real - 1PE10.3
Code:	EBCDIC
Tape:	9 track
Recording speed:	1600 bytes/inch (phase-encoded)
Block size:	3360 bytes/block

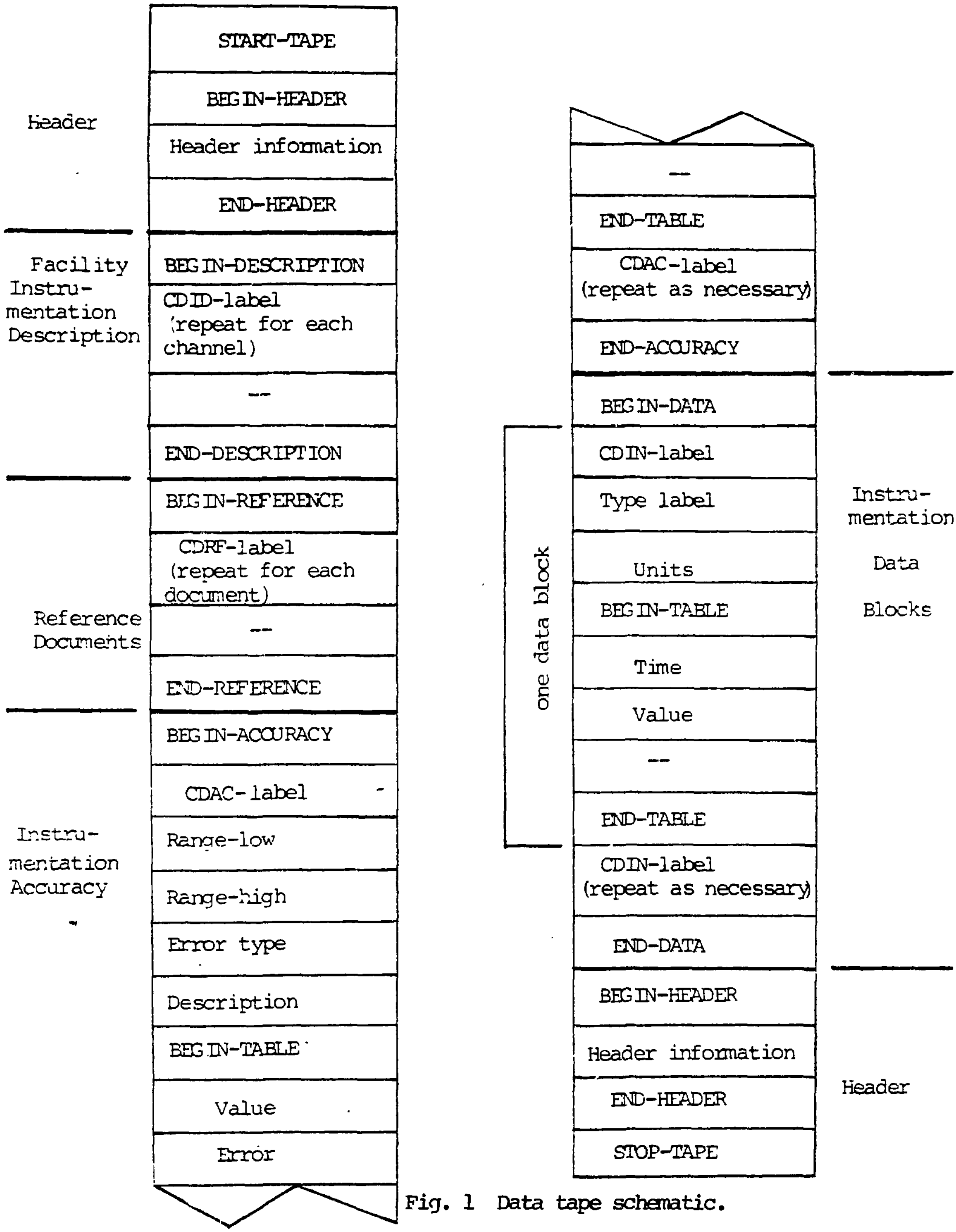


Fig. 1 Data tape schematic.

II. REPORTING OF TRAC ANALYSIS AND RESULTS

This section describes the sequence of TRAC calculations which will be performed for each test analyzed and discusses the type of report to be issued for each calculation in the test series. Estimates of the time involved in preparing the reports and calculations for each test are included. We envision that the following procedure will be followed for each test analyzed:

1. a <u>pretest simulation</u> to assist the experimentalists,
2. a <u>blind posttest prediction</u> using the measured boundary and initial conditions,
3. comparison of the results of the <u>blind posttest prediction</u> with experimental data, and
4. <u>posttest analyses</u> if needed to investigate significant discrepancies.

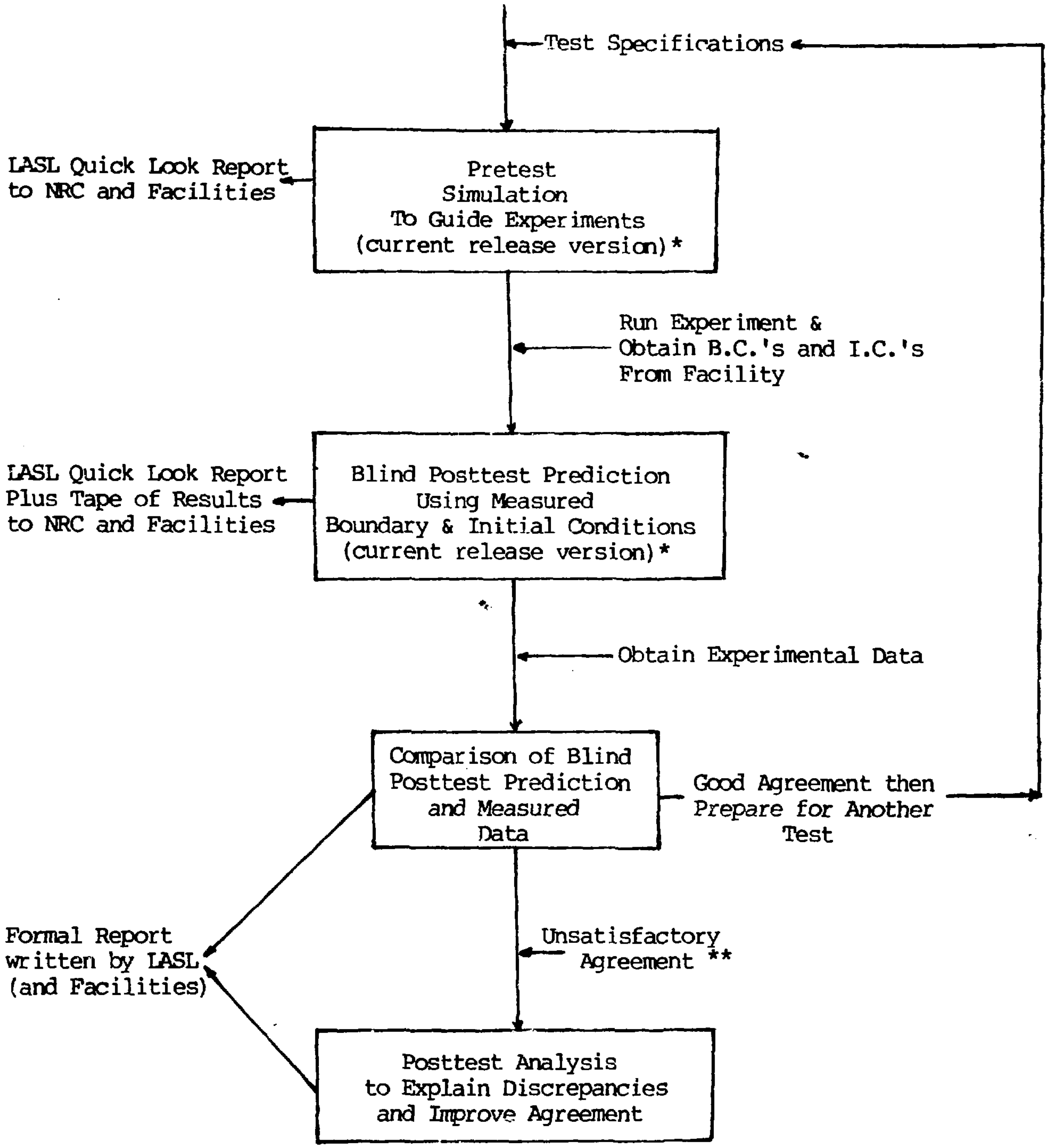
As stated above, the pretest simulation is a TRAC calculation to guide the experimentalists. It is expected that such a calculation will be performed for each experiment, or series of experiments, using only available design information and the results of any previous calculations on the same facility and on full-scale PWR. We believe that such pretest simulations will be of use to the experimentalists to help define the ranges of conditions which might be expected during an actual test. This simulation is not a pretest prediction in the conventional meaning of the phrase, since the actual measured boundary and initial conditions will not be available when this calculation is performed. Such calculations would probably take one week to perform. The results, in a "Quick Look" format, will be sent to NRC and the experimental facilities from two weeks to a month before the tests. The format of this report will include a brief introduction describing the TRAC models of the system and a series of TRAC output graphs of variables specified by the facilities and LASL. Also included will be a brief section to assist the experimenters in interpreting the results of the TRAC calculations.

The next TRAC calculation in the sequence will be a blind posttest prediction. This calculation will be done after the actual test has been run so that the measured boundary and initial conditions (temperatures, flow rates, pressures, etc.) can be used as input. It is expected that the calculation will take from one to two weeks to complete after LASL receives the initial and boundary conditions. The initial and boundary conditions should be sent to LASL either in tape form (as specified in Section II) or in "Quick Look" report form as soon as possible after the test has been run. The results of the blind posttest prediction will be sent by LASL to the NRC and the facilities on tape or microfiche and in a LASL "Quick Look" report with a format similar to that described above.

After the blind posttest prediction has been completed and the results have been sent to NRC and the facilities, the next step in the analysis procedure will be to release the actual experimental data to LASL where comparison between results of the blind posttest prediction and the measured data will be made. A list of measured variables and locations, specified by a concensus of all parties, will be compared with the TRAC calculation. Based on how well the calculation compares with the data, two separate paths may be taken.

Optimistically, the blind posttest prediction and data will compare well. If this is the case, then no modeling or code improvements would be required and the analysis of the experiment would be essentially completed. The most likely path (at least for the initial tests) would occur if there are discrepancies between the calculation and the measured data. In this case, detailed study of the differences between the calculation and the measured data, which might be caused by such things as input errors, inadequate noding, bad experimental data, or modeling deficiencies, would point out appropriate changes to be incorporated in posttest calculations. In order to maintain the "independent" assessment nature of these calculations, all blind predictions will be performed with the currently available version of TRAC. However, extra calculations using improved versions of the code (based on the detailed posttest analyses) may also be performed for analysis purposes. If LASL and the NRC mutually agree that certain model changes are absolutely necessary, then the modified version of TRAC will also be used for the actual blind predictions. The results of the comparison between the blind posttest prediction, data, and the posttest analyses will be reported in a formal document. The document would include a detailed description of the comparison between the data and the predictions and a description of the code improvements that may have been made. This document would be written by LASL, aided by the facility in matters pertaining to data interpretation.

The analysis and reporting procedures are summarized in Fig. 2. The final analysis report for each test series will be written by LASL and the facilities. Such a document will summarize the tests in the series and the TRAC calculations performed, and will detail recommendations for subsequent tests. As we gain more experience in analyzing the tests, we expect the time required to perform the analyses described above to decrease. Initially, the analyses of the tests may overlap, but we expect the procedure to become smoother after several initial test analyses.



* Use current release version unless both LASL and NRC agree on needed code changes-possibly two calculations.
**May not require code changes - could be measurement, noding, etc. problems.

Fig. 2
TRAC analysis and reporting procedure.

REFERENCES

1. "A Coordinated Analytical and Experimental Study of the Thermohydraulic Behavior of Emergency Core Coolant During the Refill and Reflood Phase of a Loss-of-Coolant-Accident in a Pressurized Water Reactor," U.S. Nuclear Regulatory Commission draft Program Description Document (July 1978).

2. "Standard Metric Practice Guide (A Guide to the Use of SI - The International System of Units)," American Society for Testing and Materials report ASTM E 380-72 (1973).

3. "OS Assembler Manual, Appendix A: Character Codes," IBM Systems Reference Manual, File No. S36-29 (1972).