UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAY 15 1979

MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

William J. Dircks, Director
Office of Nuclear Material Safety and Safeguards

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER #54, THE SET EQUATION TRANSFORMATION SYSTEM

This memorandum describes work performed to improve the Set Equation Transformation System (SETS computer code) for fault tree evaluations of nuclear safety systems. The present version of the SETS code, developed by Sandia Laboratories, represents a major advance over the fault tree codes used in the Reactor Safety Study (RSS), particularly for large and complex trees. Whereas the codes used in the RSS could only efficiently compute minimal cut sets (the basic combination of components which cause the system to fail) up to double or perhaps triple component failures, the SETS code can usually process the same size trees with no such limitations on the size of minimal cut sets produced. For example, the code has been successfully used to process a tree containing approximately 300 gates, 300 primary events, and over 64 million minimal cut sets. The ability to process large trees with no strict limitations on minimal cut set size is of particular importance when SETS is used for common cause searches of large cut sets having a common cause failure potential. In addition to serving as an efficient analysis tool, SETS has another important benefit in that its input and output are a standardized form of documentation for the analysis. The analysis can be repeated or modified for sensitivity studies, and a given analysis of a fault tree can be combined with other related analyses as future needs arise. SETS has been well tested and is an accepted code which is currently in use at Lawrence Livermore Laboratories, Los Alamos Scientific Laboratories, and Sandia Laboratories.

As a result of the work performed in the SETS computer code project, an improved version of the SETS code has been documented and made available for use by NRC contractors and personnel for projects requiring an efficient tool for the analysis of complex systems.

The major results of the SETS program have been:

1. Development of an automatic tree decomposition algorithm (documented in the SETS user's manual, Attachment 1) which will further increase the speed and efficiency of SETS for processing large trees, and which is currently being incorporated into the standard version of SETS.

2. Development, in preliminary form, of basic minimal cut set quantification procedures. These procedures, which are currently being incorporated into the standard version of SETS, form the beginnings of a comprehensive quantification capability.

3. Development of a standardized version of the SETS code for the CDC 6600 computer, and installation of this version of the code at the Brookhaven National Laboratory Computer Center for use by NRC personnel. (All future updates, and enhancements to the standard version of SETS will also be made available to NRC.)

4. Preparation of a SETS users' manual oriented specifically for the fault tree analyst (see Attachment 1).

5. Presentation of two courses for NRC personnel and contractors on the use of SETS for fault tree analysis.

If you require further information or have any questions regarding the SETS code, please contact Francine F. Goldberg (492-8388).

Saul Levine

Saul Levine, Director
Office of Nuclear Regulatory Research

Attachment:
1. A SETS User's Manual for
   the Fault Tree Analyst

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