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INDEPENDENT PEER REVIEW OF NUCLEAR SAFETY COMPUTER CODES

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Introduction

A structured process of independent computer code peer review has been developed to assist the US Nuclear Regulatory Commission (NRC) and the US Department of Energy in their nuclear safety missions. This paper focuses on the process that evolved during recent reviews of NRC codes.

The NRC adheres to the principle that safety of plant design, construction, and operation are the responsibility of the licensee. Nevertheless, NRC staff must have the ability to independently assess plant designs and safety analyses submitted by license applicants. According to Ref. 1, "this requires that a sound understanding be obtained of the important physical phenomena that may occur during transients in operating power plants." The NRC concluded that computer codes are the principal products to "understand and predict plant response to deviations from normal operating conditions" and has developed several codes for that purpose.

However, codes cannot be used blindly; they must be assessed and found adequate for the purposes for which they are intended. A key part of the qualification process can be accomplished through code peer reviews, an approach has been adopted by the NRC. This paper describes a structured process of independent code peer review, benefits associated with an independent code peer review, as well as the authors' recent experience with this type of review activity.

Structured Process Of Independent Code Peer Review

As a prologue to the code review process, the owner of the code specifies (a) design objectives and (b) targeted applications for the code. For NRC codes MELCOR, SCDAP/RELAP5, and CONTAIN, the NRC has prepared this information. By defining code objectives, targeted

applications, and associated success criteria, the code owner is effectively providing a yardstick against which the peer review committee can measure overall technical adequacy of the code.

As a supporting part of the review of code targeted applications, it is important to identify plant characteristics, key processes, and the phenomena expected, so that increased attention can be given to the associated code models. This is a large effort, because several scenarios are examined and a phenomena identification and ranking table (PIRT) is developed. PIRT's have been developed for several light water reactor applications (e.g., Ref. 2), a Savannah River reactor (Ref. 3), and the New Production Heavy Water Reactor (Ref. 4).

The complete code peer review proceeds from two perspectives. First, the code is reviewed from the "bottom-up" by looking at individual closure models and correlations and assessing the (a) pedigree, (b) applicability, and (c) fidelity of each code model where the third item is the comparison between model and data. The review effort assigned to individual models and correlations is related to the importance of the processes and phenomena being modeled. After the bottom-up review is completed, a "top-down" review is undertaken to examine the integral features of the code. The basic governing equations and numerical schemes are reviewed. Applicability of the code for the targeted analysis applications is also examined.

The review results are documented in a summary report within the framework discussed above and, hence, are scrutable. The peer review committees typically have 5 to 7 experts, depending upon the complexity and variety of phenomena in the reactor the code is designed to simulate.

Benefits Of The Independent Code Peer Review

1. The process ensures a structured review of the important features of the code and ensures that deficiencies are not overlooked.

2. The process is scrutable and can be reviewed and defended (even though expert opinion may be involved).

3. The process defines needs for code improvement by identifying (a) acceptable models and correlations and integrated code performance features, (b) deficient models and correlations and integrated code performance features, and (c) missing models and correlations and integrated code performance features.

4. The process defines assessment needs for the code.

5. The process identifies any deficiencies in the experimental database needed to demonstrate code adequacy

Experience With Independent Code Peer Reviews

The MELCOR Peer Review was completed in April 1992 and provided NRC with a report on the technical adequacy of the MELCOR code (Ref. 5). Most of the procedures for code review were developed during the peer review of MELCOR. The SCDAP/RELAP5 Peer Review (Ref. 6) was completed in December 1992 and used the same process employed for review of MELCOR. Enhancements to the process were developed including development of a "technical adequacy matrix," the ranking of important code deficiencies by accident intervals ("Hierarchy-by-Interval" approach), and development of a "user survey." A code adequacy assessment of TRAC-PF1/MOD3 for NP-HWR thermal-hydraulic applications (Ref. 4) was completed in 1992 using portions of the peer-review process identified in this summary. A CONTAIN Peer Review has just begun and will employ the same procedures used for MELCOR and SCDAP/RELAP5, capitalizing on the lessons learned to enhance the process further.

Conclusion

The process of performing an independent code peer review has been described, and the benefits given. Experience with the code peer review process has demonstrated the effectiveness of a structured and independent code peer review, and the value obtained by providing a measure of code technical adequacy. The periodic measurement of code technical adequacy assures the code owner that development is progressing in a consistent manner towards clearly defined design objectives and targeted applications.

References

1. Nuclear Power Plant Thermal-Hydraulic Performance Research Program Plan, US Nuclear Regulatory Commission document NUREG-1252 (July 1988).

2. R. A. Shaw, S. Z. Rouhani, T. K. Larson, R. A. Dimenna, "Development of a Phenomena Identification and Ranking Table (PIRT) for Thermal-Hydraulic Phenomena During a PWR LBLOCA," EG&G Idaho, Inc. document NUREG/CR-5074 (August 1988).

3. R. G. Hanson, M. G. Ortiz, and G. E. Wilson, "Development of a Phenomena Identification and Ranking Table (PIRT) for Thermal-Hydraulic Phenomena During a Double Ended Guillotine Break (DEGB) LOCA in an SRS Production Reactor," EG&G Idaho, Inc. Draft document (June 1989).

4. B. E. Boyack and J. S. Elson, "Assessment of TRAC-PF1/MOD3 Code Adequacy for NP-HWR Thermal-Hydraulic Analyses," Los Alamos National Laboratory document LA-NPR-TN-010 (September 10, 1992).

5. B. E. Boyack, V. K. Dhir, J. A. Gieseke, T. J. Haste, M. A. Kenton, M. Khatib-Rahbar, M. T. Leonard, and R. Viskanta, "MELCOR Peer Review," Los Alamos National Laboratory report LA-12240 (March 1992).

6. M. L. Corradini, V. K. Dhir, T. J. Haste, T. J. Heames, R. P. Jenks, J. E. Kelly, M. Khatib-Rahbar, and R. Viskanta, "SCDAP/RELAP5 Independent Peer Review," Los Alamos National Laboratory report LA-12481 (January 1993).