April 12, 2001

Dr. George E. Apostolakis
Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: ISSUES ASSOCIATED WITH INDUSTRY-DEVELOPED THERMAL-HYDRAULIC CODES

Dear Dr. Apostolakis:

The staff has reviewed the ACRS letter to the Commission, dated January 11, 2001, on Industry-Developed Thermal-Hydraulic Codes. The staff has been aware of the issues highlighted by the ACRS and has implemented steps to address the challenges identified by the committee. The issues raised in the letter will continue to be discussed with the ACRS during future industry code reviews and NRC code development meetings.

The ACRS provided 10 recommendations. This letter directly addresses these recommendations while taking into account the specific issues in the Appendix of the ACRS letter that relate to the recommendations. The recommendations and resolution paths follow.

1. The staff should make clear that standards to be applied to documentation of proprietary codes are the same as for codes generally accessible to public scrutiny.

The staff agrees that it is desirable to improve the documentation of proprietary codes. As a result of the Maine Yankee independent safety assessment in 1991, the staff is developing a regulatory guide (DG-1096, "Transient and Accident Analysis Methods") that will provide guidance on code development, application, and documentation. DG-1096 is out for public comment and the staff anticipates it will be issued as a final regulatory guide in Fall 2001.

2. The staff must continue to require that vendors and licensees supply working versions of the codes for internal NRC use and evaluation.

The staff agrees that it is desirable for vendors and licensees to supply working versions of their codes for internal NRC use and evaluation; however, current regulations (with the exception of the code required by Appendix K) do not require that working versions be submitted. The staff began requesting working versions of the vendor codes in 1998, beginning with the review of RETRAN-3D. The staff will continue to request that codes be submitted as part of the code review process, as outlined in the draft SRP Section 15.0.2, “Review of Analytical Computer Codes,” dated December 2000.

3. The staff should recommend how improvements can be more readily incorporated into codes.

The staff agrees that it is desirable that industry improves their codes and does not believe that the regulatory process is generally inhibiting industry code improvements. Industry codes are developed and improved when an economic incentive exists due to the extensive resources required to improve a code. However, as individual plants begin to request changes to their licensing basis (e.g., for power uprate or to support risk-informed decisions) that require improved analysis techniques, licensees and vendors will likely provide the resources necessary to improve the codes.

4. The staff should continue developing its own thermal-hydraulic code, making it more reliable, flexible, and easy to use.

The staff agrees with this recommendation. Maintaining an NRC-developed code is vital to building and maintaining in-house expertise necessary to understand the complexities of thermal-hydraulic code development and assessment. In addition, NRC thermal-hydraulic codes are publicly available and provide the staff with the ability to perform independent analyses. At its inception, the NRC code consolidation program considered modular code architecture as an important outcome to ensure that the code is easy to maintain and extend. Since this has been achieved, the NRC code can be used to determine the effects of different assumptions and models used in industry codes. Alternative constitutive packages can be easily substituted into a test version of the NRC code and their effect on the figures of merit analyzed. The graphical user interface has enhanced the code's ease of use, facilitating the staff's development of an independent model to verify industry code results. Decreased runtime and increased robustness also increase the efficiency of the review process.

The staff is also looking to the future and is beginning to incorporate alternative working fluids into the code, such as helium for the Pebble Bed Modular Reactor, and has focused on making the code easier to extend. Test programs and model development efforts are underway to improve the models in the code that dominate uncertainty. NRC is therefore planning its code development effort to maintain readiness and to respond in a timely fashion to industry initiatives; they will continue to do so.

5. The staff should examine ways in which the process of evaluation and assessment of proprietary codes can be made more publicly accessible and scrutable.

The process by which information can be exempted from public disclosure governed by 10 CFR 2.790, "Public inspections, exemptions, requests for withholding." This process requires that the licensee submit a request for a proprietary determination and a statement addressing why the information should be withheld from public disclosure. If the request is approved, the licensee submits a proprietary and non-proprietary version of the document. The non-proprietary version of the document is released so that the public is able to understand the nature of the licensing request. Draft DG-1096 and Draft SRP Section 15.0.2 are being developed to provide the public with information on the process used by the staff during code evaluation and assessment. Providing these documents for public comment allows the public to participate in developing the regulatory positions.

The safety evaluation reports written by the staff approving any code are publicly available and contain information about the review process used by the staff for that specific code evaluation, including the licensees' assessment process. This information will continue to be provided to the public as well as the information in the open public meetings held during the code review process, since the information is generally non-proprietary.

6. The staff, perhaps in cooperation with an industry-supported entity such as the Nuclear Energy Institute (NEI), should undertake an authoritative study assessing when, how, and why codes produce reasonable results despite numerous assumptions and simplifications. This study should include measures of code strengths and weaknesses and include an assessment of circumstances under which the shortcomings of the codes may have significant influence on regulatory outcomes.

The authoritative study proposed would be a large effort requiring substantial resources from both the NRC and the industry. The staff believes that a useful process exists already and is currently in use throughout the industry and academia. The Phenomena Identification Ranking Table (PIRT) process is used to identify the phenomena important to a specific scenario or class of scenarios; PIRT panel members rank the importance of the phenomena based on the impact they have on the results. The staff believes that continuing the use of PIRTs as described in DG-1096, for identifying the phenomena of greatest importance for the different scenarios, will provide insights into which phenomena are appropriately addressed by assumptions and simplifications. We have adopted this approach and developed a PIRT-based assessment matrix that is being used to assess the TRAC-M code. It should be noted that the staff has begun to synthesize the data used in the assessment matrices of its codes into relevant dimensionless parameters for the high-ranked phenomena. This approach will first be applied to the inverted annular flow regime during reflood using data from various facilities. The results will be presented to the ACRS at the Fall 2001 meeting with the Thermal-Hydraulics and Severe Accidents Subcommittee.

7. The staff should take steps to ensure that the existing data base for thermal-hydraulic code evaluation is preserved in accessible form.

The staff agrees with this recommendation. NRC maintains a database pertaining to thermal-hydraulic and severe accident phenomena. The staff is currently comparing its database to that compiled by CSNI to determine what, if any, data are missing from the NRC databank. If necessary, the staff will attempt to compile a complete set through international cooperation. A current practice on NRC contracts requires that the test data be delivered to NRC in a format that facilitates its inclusion in the databank. The synthesization study described in the response to question 6 will help identify missing information and will also ensure that appropriate evaluation routines are available for each facility to reduce the raw data into usable form.

8. The staff should consider how definite measures of code quality, such as bias and uncertainty in predicting significant phenomena and success criteria, can be more specifically required as outputs from the code assessment process.

9. The staff should investigate and recommend how uncertainties in code predictions can be best quantified to be suitable for incorporation into risk-informed regulation.

Recommendations 8 and 9 are addressed in a combined response.

The staff agrees that quantification of code uncertainties is important to the extent required by the intended usage of the analytical results. The staff believes that code quality should be commensurate with the code application and that methods of uncertainty analysis such as Code Scaling and Uncertainty (CSAU) methodology should be used accordingly. For certain applications, significant quantification of uncertainty is more important, while for other applications, it can be limited to a focused set of parameters. Much of the CSAU process is incorporated in DG-1096, however, other methods of uncertainty analysis can also be used and will be considered by the staff.

Users of realistic codes for LOCA analysis are required by 10 CFR 50.46 to address uncertainties although the method for this is not explicitly prescribed. Staff guidance on acceptable uncertainty approaches is outlined in DG-1096. The guidance calls for an evaluation of the uncertainties in the experimental data, as well as quantification of the uncertainties and bias in the difference between the calculated results and the experimental data. The staff believes this guidance provides the necessary flexibility in addressing uncertainty while ensuring a proper level of quality in the code. Codes that are intended to meet Appendix K requirements contain sufficient conservatisms in the analysis methodology so that the uncertainties introduced will be bounded by the safety margin created from these conservatisms. Best estimate plus uncertainty methods can be extended beyond LOCAs to other scenarios as circumstances and resources warrant.

Regulatory Guide 1.174 discusses in some detail the comparison of PRA results with the acceptance guidelines and the treatment of uncertainty. Regulatory Guide 1.174 recognizes that many sources of uncertainty are not readily quantifiable, and the focus is on identifying the sources of uncertainty in the evaluation and assessing whether they have an impact on the particular application. To this end, the staff acknowledges the importance of identifying the sources of uncertainty in the use of the codes, and in this way understanding their limitations and realms of applicability. If the NRC were to pursue a risk-based regulatory approach, treatment of uncertainty would be essential. However, the philosophy of risk-informed regulation is that the numerical risk results are but one of the inputs to decision-making. In this case, the role of uncertainty analysis is to provide insights for how much weight can be given to the numerical results.

10. The staff should reevaluate the design specifications for the outputs of codes and their relationship to present and anticipated regulatory requirements.

The staff believes that the current approach is sufficient to meet current and anticipated regulatory requirements, however, the staff agrees that code outputs and parameters should continue to be evaluated as new regulatory initiatives are undertaken. Assessment of the industry-developed codes is critical to ensure that codes are appropriate for the intended application. Guidance on appropriate methods for ensuring this is being developed in DG-1096 and SRP Section 15.0.2.

Currently, thermal-hydraulic codes are reviewed for their ability to meet the requirements for the intended licensing applications. For example, to ensure proper Peak Clad Temperature calculation, multiple parameters calculated by the code must be adequately predicted. Therefore, the staff evaluates many code parameters during code reviews, including pressure, flow, inventories, kinetic response, solver methodology, and other models that may have a substantive impact on the code results to verify that the code is producing consistent and reasonable predictions of reactor response.

Additionally, the codes are assessed against actual plant (when available) and experimental data that provide a level of confidence that the codes are predicting the phenomena acceptably for the proposed application. Analysis that quantifies uncertainty and incorporates it into the analysis results provides an additional measure of assurance that safety will be maintained. A similar approach will be employed when new licensing criteria are proposed.

We appreciate your views on the issues associated with industry-developed thermal-hydraulic codes and staff will continue to address these issues at future meetings with the ACRS members.

Sincerely,

/RA by William F. Kane Acting For/

William D. Travers
Executive Director
for Operations

cc: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

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We appreciate your views on the issues associated with industry-developed thermal-hydraulic codes and staff will continue to address these issues at future meetings with the ACRS members.

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