

January 31, 2007

MEMORANDUM TO: Frank Gillespie, Executive Director
Advisory Committee on Reactor Safeguards

FROM: Farouk Eltawila, Director */RA/*
Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research

SUBJECT: TRACE V5.0 DOCUMENTATION AND SUPPORT

We have recently completed work on TRACE Version 5.0 and have made it available to the NRC staff to finalize assessment for this version and perform audit calculations. This is an important but not necessarily final step in the TRACE consolidation and development effort that has been ongoing for several years. The next steps in this development are to complete the documentation and provide the support necessary to make TRACE an efficient and effective tool for agency use.

The purpose of this memorandum is to

- a) summarize the current status of TRACE development,
- b) identify specific documentation and the expected completion dates,
- c) communicate our plans for a peer review
- d) list the activities to help integrate TRACE into the regulatory process

Current Status of TRACE Development

Although there are several code models that need to be updated, all model development and revisions have been halted, and TRACE has been “frozen” as Version 5.0, “Release Candidate 3” (V5.0RC3). This version has been released internally to the NRC staff and represents the official V5.0 code version. Prior to release of this version, all assessment cases were simulated and the overall results in comparison to experimental data judged to be reasonable. This assessment included simulations of large break and small break phenomena in conventional light-water reactors as well as assessment directly applicable to the ESBWR.

Currently, the NRC staff is making additional comparisons between the predicted and measured results, and updating the draft assessment manual. The ESBWR- related assessment will be included in a separate “Applicability Document” that will reference the TRACE Assessment Manual. The schedule for completion of these documents is discussed in the next section.

Plans for Completing the Documentation

With the release of TRACE 5.0, the main focus of our efforts is being redirected toward completion of the documentation. The TRACE documentation most useful for application of the code consists of the Theory Manual, the Assessment Manual, and the User's Guide. The Theory Manual will document the models and correlations used in TRACE along with descriptions of the conservation equations and solution methods. The Assessment Manual will document TRACE simulations of numerous separate and integral effects test and provide a basis to demonstrate code accuracy. The User's Guide will describe the input and methods for successful application of TRACE. These documents will be accompanied by the Theory Manual Supplement, which will provide extra details on models in the code, and the ESBWR Applicability Report, which will discuss application of TRACE to ESBWR design basis accidents. Additional details on these documents follow:

Theory Manual and Theory Manual Supplement

Because of the large volume of information, there will be two separate volumes documenting the models and correlations in TRACE. The Theory Manual will be a self-contained reference that identifies the underlying theory, empirical models, and special features contained within TRACE. This volume will document exactly what models are used by TRACE, how those models are applied, and summarize their limitations. The "Theory Manual Supplement" will go into greater levels of detail behind certain mathematical derivations and document the development of, and basis behind, each physical model as well as any coding details relevant to the model. We believe that the Theory Manual is sufficient for the vast majority of TRACE users. The Theory Manual Supplement will be of more interest to thermal-hydraulic code and model developers.

Based on the Thermal-Hydraulic subcommittee's comments and recommendations, we have decided to improve the description of the two-phase field equations and the approximations and assumptions that are made in their application in TRACE. The Theory Manual will contain a section that discusses limitations due to these approximations and assumptions to help prevent the code from being applied outside of its intended range of application.

Our estimated date of completion for the Theory Manual is the end of June 2007, and the estimated date of completion for the Theory Manual Supplement is the end of September 2007. Assuming two months to complete the peer review and incorporate any comments, the Theory Manual and its supplement will be ready for ACRS review in August and November 2007, respectively.

Assessment Manual

The Assessment Manual will document the results of a large number of TRACE simulations and compare those results to experimental data. The main body of the report will summarize the performance of the code and characterize code accuracy where feasible with a bias and uncertainty. The main body will also discuss problems and potential limitations associated with TRACE. Individual assessment cases will be documented in Appendices to the main report. We are finalizing the individual assessment sections to ensure they are all performed with the strictly "frozen" V5.0RC3 code version. Our estimated date of completion for the Assessment

Manual is the end of April 2007. Part of the Assessment Manual will be included in the Peer Review, which will be completed in November 2007. We will provide the Assessment Manual for ACRS review at that time.

In Addition, a report is being prepared to qualify TRACE for its application to ESBWR design basis accidents. This report will document assessments specific to passively cooled boiling water reactor systems involving experimental tests in facilities such as PUMA and PANDA. The ESBWR Applicability Report will discuss scaling of these facilities for ESBWR and provide recommendations on modeling ESBWR with TRACE. The Applicability Report will be ready for ACRS review in November 2007.

User's Guide

This manual has been divided into two separate volumes. Volume 1 is the first document a new user will use. It is designed to get a new user familiar with TRACE input and the mechanics required in actually running the code. This document is currently up-to-date and requires no additional preparation. Volume 2 presents the process of preparing a new model and associated calculation notebook, detailed modeling information for each available component type, and overall user guidelines. This document will require some additional preparation time in terms of updating the user guidelines and the component descriptions to reflect the addition of new BWR component types or modification of existing components or features.

Our estimated date of completion for Volume 2 is the end of May 2007. We will provide the User Guide for ACRS review at that time.

Plans for Conducting an Independent Peer Review

We intend to initiate an independent peer-review of the TRACE code in the latter half of calendar year 2007. We envision a 6-9 month effort by 3-5 individuals not involved in the TRACE code development program. We will ask the peer review team to review and provide comments on the following:

- a) field equations, finite volume methods, solution methods,
- b) constitutive models, flow process models, and special component models,
- c) developmental assessment matrix, its applicability to the code's intended uses, and conclusions regarding ability of the code to model those scenarios, and
- d) our ability to clearly and concisely document the modeling limitations imposed by the mathematical model or other simplifying assumptions made during the development of the various constitutive models.

We expect that any comments from the peer review will be incorporated into future revisions of the documentation, assessment matrix, or code models and correlations as appropriate.

Incorporation of TRACE into the NRC's Regulatory Process

The ACRS expressed its concern regarding the rate at which TRACE is being introduced into the agency's regulatory framework. To ensure that code users adopt TRACE, the following items must be addressed:

- 1) availability of plant models
- 2) robust code performance and reasonable calculation run times
- 3) availability of training for staff
- 4) accurate documentation
- 5) defensibility (the code must have been assessed for the targeted applications)
- 6) demonstration of code analysis capabilities that are equal to or better than the capabilities of RELAP5

We either have addressed, or are currently addressing all these and have started the process of creating a TRACE plant model library. The first four models are expected to be completed by October 2007. We expect to provide an additional nine plant models in 2008. In terms of providing accurate documentation, we are in the process of completing that task, as the above plan demonstrates. The remaining activities have been addressed and are not expected to hinder code users with respect to using TRACE.

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