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#### **Review of TRACE manual with emphasis on the Physical Models sections**

#### Final report, May 10, 2008 by

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#### Background

The U. S. Nuclear Regulatory Commission (USNRC) Office of Nuclear Regulatory Research (RES) has organized a panel to provide an independent review of the TRACE Version 5.0 computer code (referred to as the "TRACE code" in this report) and the associated theoretical and test assessment documentation. The author of this report is one of the four members of this review panel and his report will be incorporated in the final panel report.

#### **Objective**

The objective of the work of the peer review panel was to review the TRACE manuals that include the Theory Manual, the Assessment Manual and the User's Guide and produce a report that summarizes the strengths and deficiencies of the code as documented, and provides recommendations for code changes and improvements. These findings are to be presented to the Advisory Committee on Reactor Safeguards Thermal-Hydraulic (ACRS T/H) subcommittee.

#### Scope and conduct of the work

Each peer review panel member reviewed primarily certain sections of the TRACE manuals. The review was not intended to be a line-by-line review of the coding; however, the source code was made available, although the panel members were not expected to run the code. The author of this report was asked to provide specific comments regarding the application of the conservation equations, and the thermal-hydraulic closure relations and physical models. Given the resource and time limitations, the following evaluation is mainly based on the Theory Manual, and to a lesser extent on the Assessment Manual. The User's Guide was not reviewed and running the code was not feasible within the time constraints of the project.

Two very helpful meetings were conducted where the code developers and members of the NRC staff provided information on the code and answered questions from the review panel. Interim reports written by the review panel members were provided to the developers before the second meeting. Some of the issues raised in the interim reports were discussed during the second meeting. Written replies to all the comments made were returned to the panel members in April 2008. Practically all the replies acknowledged the comments made one by one and promised actions, for the vast majority of the comments made, within two years, as "mid-priority issues." Therefore, the comments, conclusions, and recommendations of the present final report are not that different from those of the interim report of 22 February 2008 of this author. (The present report does not repeat the minor typographical-error and editorial remarks made earlier as these were given "high-priority" for immediate correction).

The numbering of the comments is kept the same as in the interim report for ease of reference. The early remarks made on 21 October 2007 are incorporated now in the main set of comments without altering, however, the numbering, to provide continuity and hopefully facilitate the review process.

Comments are made in this report only when there is something special to remark, and in particular regarding perceived deficiencies and needs for improvement. Clearly the qualities

of the manual and its positive aspects are taken for granted and not further mentioned for the sake of efficiency of the review process.

### **Review of the Theory Manual**

This reviewer's work concentrated primarily on the following closure-law sections:

Drag ModelsInterfacial Heat Transfer Models

- Wall Heat Transfer Models

and considered also Appendix A: Quasi-Steady Assumption and Averaging Operators

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