

OECD/NEA NSC Activities
in 3D
Coupled Neutronics/Thermal-hydraulics
and
Coupled Core-plant Transients

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Introduction

OECD/NEA Committees (CSNI & NSC) sponsor and organise

- Benchmark activities in order to drive the development of coupled 3D neutronics / thermal-hydraulics codes
- Development of best-estimate (3D) methods and codes to be used both for reactor operation and safety analysis as investment in efforts needed for obtaining good results with simplified methods may be larger than for best-estimate methods
- Also it appears that “conservative methods” are not necessarily conservative for all problems
- Objective: comprehensive feedback testing and examination of the capability of coupled codes to analyze complex transients with coupled core/plant interactions by comparison with actual experimental data, and validating advanced system best-estimate analysis codes.

Past Topics (completed)

- Rod Ejection (**PWR**) – (Finnemann)
- Rod Withdrawal at Zero Power (**PWR**) – (Fraikin)
- Cold Water Injection / Pressurisation (**BWR**) - (Galati)
- **BWR** Stability - Ringhals1– (Lefvert)
- Time Series (**BWR**) Forsmark 1 & 2 – (Verdu)
- MSLB **PWR** TMI-1 - (Ivanov)

Present Topics (in progress)

- BWR-TT Peach-Bottom-2 benchmark: reports being finalised (workshops completed)
- CRISSUE-S: 3 final reports being published
- V1000CT-1 Specification published
- V1000CT-2 Specification being finalised
- PWR-MOX Rod Ejection: -> WPRS
- BFBT – 1st workshop 4 October 2004

MSLB PWR TMI-1 benchmark

Completed: 4 Volumes published

1. Benchmark Specification
2. Point kinetics plant simulation
3. Coupled neutronics/core thermal-hydraulics evaluation of core response from a multi-dimensional (3-D) perspective
4. Best-estimate coupled core – plant transient modelling

Full documentation and specification available on CD-ROM

BWR-Turbine Trip

Peach-Bottom-2 Benchmark

Workshops completed / reports being finalised

1. Benchmark Specification published
2. Power vs. Time Plant System Simulation with Fixed Axial Power Profile Table (Obtained from Experimental Data) – final review
3. Coupled 3-D Kinetics/Core Thermal-Hydraulic Boundary Condition Model and 1-D Kinetics Plant System Simulation – 2nd draft
4. Best-Estimate Coupled 3-D Core/Thermal-Hydraulic System Modelling – 1st draft

CD-ROM with workshop presentation and detailed data from the specification available

VVER-1000 (Kozloduy-6) Coolant Transient Benchmark (2 phases)

- V1000CT-1: Main Coolant Pump (MCP) Switching On
- V1000CT-2: Coolant Mixing Tests and Main Steam-Line Break (MSLB)
- 2 workshops held
- Benchmark Specification V1000CT-1 published
- Benchmark Specification V1000CT-2 drafted
- CD-ROM with results and presentation at workshops
- 3rd workshop: GRS Garching 2005
- 4th workshop: University of Pisa 2006

CRISSUE-S: Critical Issues in Nuclear Reactor Technology: State of The Art Report

FP5 with OECD/NEA participation (3 Volumes)

- Data Requirements and Databases Needed for Transient Simulations and Qualification (2004)
- State of the Art Report (2004).
- Achievements and Recommendations (2004) (final editing- published this autumn)

OECD/NEA AND U.S. NRC PWR MOX/UO₂ CORE TRANSIENT BENCHMARK

Carried out within WPRS

- PWR-MOX Rod Ejection
- The current problem compared to the previous (Finnemann benchmark) adds the complexity of modeling a rod ejection in a core fueled partially with weapons grade MOX. The core chosen for the simulation is based on four-loop Westinghouse PWR power plant similar to the reactor chosen for Plutonium disposition in the U.S. The problem is designed primarily to assess core simulators, and therefore few group constants are specified at the level of homogenized pin cells
- Specification distributed
- Results collected
- Publication end 2004/beginning 2005

NUPEC BWR Full-Size Fine-Mesh Bundle Tests (BFBT)

- The benchmark includes both macroscopic and microscopic measurement data.
- The benchmark specifications are designed to systematically assess and compare the participants' numerical models using the predictions of detailed void distributions and critical powers (details with a resolution of 0.3 mm)
- Objective: advancement in the insufficiently developed field of the two-phase flow theory
- Final Specification is in preparation
- 1st workshop at Nara, Japan in conjunction with NUTHOS-6 conference

Meetings / Conferences

- 1st BFBT workshop, 4 October 2004
- 6th International Topical Meeting on Nuclear Reactor Thermal Hydraulics, Operation and Safety, Nara, 4-8 October 2004 (NUTHOS-6)
- Third V1000CT Workshop, Garching, 4-5 April 2005
- AER-WGD meeting Garching, 6-7 April 2005
- Mathematics and Computation-2005, 12-15 September 2005, Avignon (M&C-2005)
- Nuclear Reactors Thermal-Hydraulics, 2-6 October 2005 Avignon (NURETH-11)
- Second BFBT workshop, 2005, PSU, USA
- Fourth V1000CT Workshop, Pisa, April 2006
- AER-WGD meeting, Pisa, April 2006

Conclusions

- Large interest in the development and validation of 3D coupled neutronics / thermal-hydraulics methods
- Endorsement in devoting increased efforts to refined two-phase thermal-hydraulics modelling
- Plan to assess sensitivity uncertainty analysis methods
- Activities in co-operation with the **CSNI** (Committee on the Safety of Nuclear Installations)