KNOO
Keeping the Nuclear Option Open

KNOO WP4 Meeting

UNDERSTANDING FETCH IN THE KNOO-WP4 FRAMEWORK

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Background

- Development of Finite Element Transient Criticality Model – FETCH
- Consistent treatment of coupled spatial physics, including multi-phase fluids
- Based on dynamic coupling of two major computer codes:
  - FE Radiation Transport
  - FE Multiphase fluids
- Extensively validated: CRAC, SILENE and TRACY experiments
- Modelling JCO accident

Background

- The FETCH code has a range of applications including criticality safety assessment and is based on fundamental approaches
- It has been applied to
  - Solutions
  - Porous media
  - Granular materials (e.g. powders)
  - Nuclear reactors
  - Application to new issues, experimental data and beyond the scope of experiments

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FETCH MODEL

- Full neutron transport equation
- Multi-phase models of gas-liquid or particle flows. Including compressibility/ incompressibility of all phases, energy, volume fraction and momentum equations for each fluid phase.
- Movement of delayed neutron precursors within one or more of the phases

Coupled Neutron Transport and Multiphase Flow Models

- Models to address nuclear safety and operational issues.
- Numerical and Computational
- Radiation transport
- Reactor Physics
- Thermal/hydraulics (porous; granular; solution, lattices)
- CFD/adaptive parallel LES
- Criticality safety – including shock wave and structural impact
- Optimisation mathematics
- Uncertainty Methods

Single and Multiphase Thermal Hydraulics

- Developed high resolution, robust, FEM based multi-phase CFD methods FLUIDITY
- 3D unstructured adaptive mesh geometry conforming FEM based
- LES - Unstructured dynamic self-adaptive meshing in parallel
- Robust high resolution methods for multi-phase flows – modelling shock waves

Single and Multiphase Thermal Hydraulics

- Porous media; bubbly fissile solutions; granular materials in fluids; single and multi-phase reactor coolants
- Many-phase modelling of polydisperse powders, liquids and gases
- Modelled and helped optimise, operation of Sellafield TDN fluidised beds; accident scenarios modelling with JAEA, nuclear waste repository and modelled steam generating sludges.

Future work

- LES-based subgrid models for detailed dynamics
- Heat transfer submodels
- 1-D circuit coupling: MACE, RELAP, TRAC
- Dragon and Consort Reactors: Jason & Brendan
- Control rod and structural movement
- Burnup modelling for long term transients
- Virtual reactors and hierarchical models
- Multi-physics modelling (fluids/RT/structures)
- Coupling of next generation RT with fluids
- Modelling with uncertainty