

FST-51200.50.18.01: Addressing Known Gaps in our Knowledge of Severe Accidents

- Project Lead: J. Buell
- Technical Leads: J. Spencer, L. Gardner, L. Lebel, K. Stoll, R. Dickson, E. Lessard, H. Zahlan, K. Podila

Objectives

- Improve the understanding and predictive capabilities of severe accident progression to aid in the diagnosis and prognosis of a nuclear accident
- Knowledge gained will contribute to tools used within the CNSC's Emergency Operation Centre (computer models, input parameters, fission product source term)

Stakeholder (Primary)

- CNSC

Corium Penetration Experiments

- Corium flow through calandria vessel (CV) penetrations can threaten in-vessel retention (IVR)

Experiments with Corium Ingress into a Pipe

- Horizontal and vertical orientated pipe
- Thermite chemical reaction melts prototypic corium (2500°C), which flows through penetration (pipe externally cooled with water) and forms a plug
- 25 kg of thermite

Finite Element Analysis

- Help compare the reactor case (end-fitting) to the experimental setup (pipe); pre-test predictions

Status and Future Work

- Apparatus currently being procured/constructed
- Experiments planned for late this fiscal year

Computational Fluid Dynamics (CFD) Modelling

- Modelling of corium ingress into a CANDU end-fitting
- Help establish in-vessel retention (IVR)

Status and Future Work

- Simulations are currently being performed
- CANDU-6 end fitting geometry simulated for the first-time using CFD

PARs Experiments with Hydrogen, CO and Steam

- In addition to hydrogen, a significant amount of CO can be produced from molten core concrete interaction – CO is flammable
- Develop PARs recombination rate expression(s) incorporating CO oxidation

Status and Future Work

- New facility has been commissioned to maintain hydrogen recombiner and combustion experimental capability (scaled version of the Whiteshell Laboratories Containment Test Facility)
- Safety vent line to be installed
- Hydrogen, CO, and steam experiments with PARs to be performed

Filtered Containment Venting

- Venting of containment gases necessary to reduce pressure and prevent containment failure
- Filtered containment venting systems are used to capture radionuclides and limit release to the environment (7 to 30 times reduction)
- Timing of venting will affect releases to environment, potential for secondary releases of radionuclides
- Develop improved strategies and methodologies for the operation of filtered containment venting systems

Simulations

- Range of severe accident scenarios to be investigated
- Generic CANDU 6 and multi-unit reactors

Status and Future Work

- Review of filtered venting systems currently used in Canada completed. Developed database of severe accident scenarios, meteorological conditions, etc.
- Simulations currently being performed
- Propose and explore different prototype venting strategies

Fuel Bay Model Development

- Develop model of CANDU irradiated fuel bay

Experiments

- 9 simulated fuel bundles in a vessel
- Experiments to be performed in an air, steam, and air-steam environment

Status and Future Work

- Apparatus currently near completion
- Commissioning in air planned for 2019 October

- Steam and air-steam tests planned later in fiscal year
- Development of fuel-temperature correlations

Calandria Tube Pullout

- Sagged and disassembled channels rest on topmost row of cooled calandria tubes (CT)
- Intact CTs will support the weight of disassembled channels – when will the CT rolled joints fail?

Experiments

- Experiments will determine the failure strength of the CT rolled joints
- Actual CT and rolled joints will be tested

Status and Future Work

- Apparatus currently being designed
- Commissioning at end of current fiscal year
- Experiments planned for next fiscal year

Moderator Expulsion

- Moderator level has large effect on severe accident progression (timing of loss of moderator inventory)
- Help establish in-vessel retention (IVR)
- Experimental results to be applied to MAAP-CANDU moderator model for best-estimate simulations

Status

- Scaling of experimental apparatus complete
- Apparatus design and procurement/construction ongoing

Future Work

- Experiments planned for late in fiscal year: varying parameters like temperature; pressure; channel configuration; number of relief ducts that open