U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Basic Research on High Temperature Gas Reactor Thermal Hydraulics and Reactor Physics

Cooperative Program Review Meeting

February 24-25, 2009

College Station, Texas

Cooperative Program Review Meeting

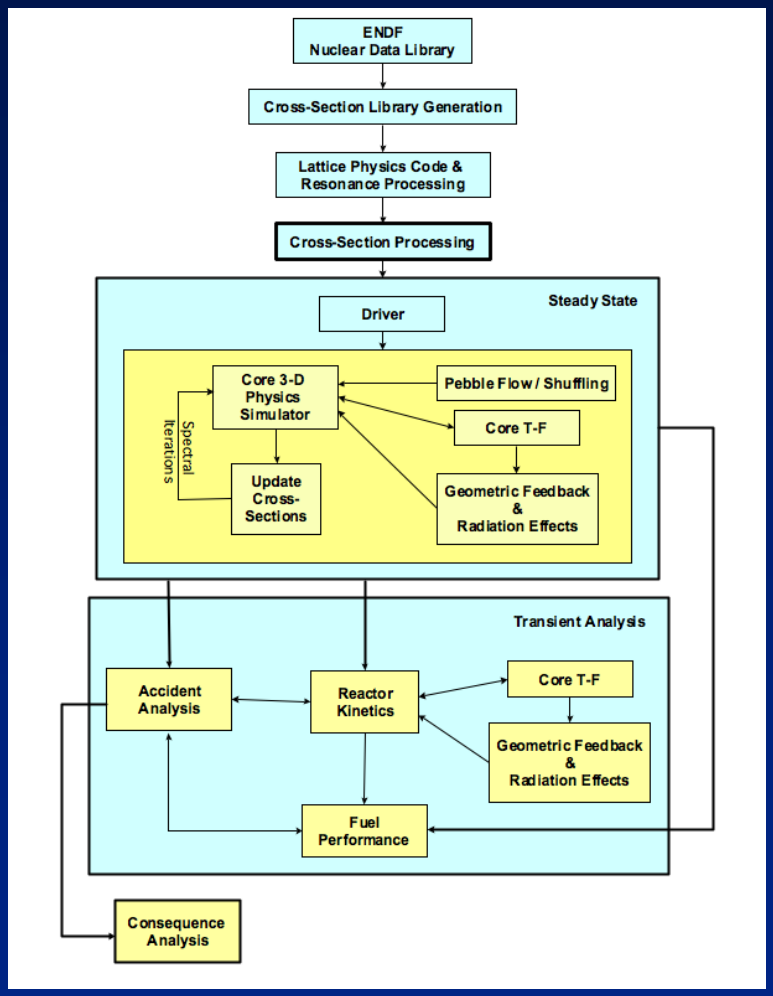
- Background
  - For first of a kind plants, NRC has performed confirmatory research in an integral test facility.
    - Focus on passive system in B-DBA events looking for "cliffs" in behavior to ensure margin exists. Examples:
      - AP-600/1000: ROSA-IV and OSU/APEX
      - ESBWR: PUMA facility at Purdue
  - Cooperative Agreement
    - Provides an opportunity to conduct this research for the NGNP in both a cost effective and timely manner.
    - Also provides aid in the development and validation of the NRC's NGNP evaluation model.

Cooperative Program Review Meeting

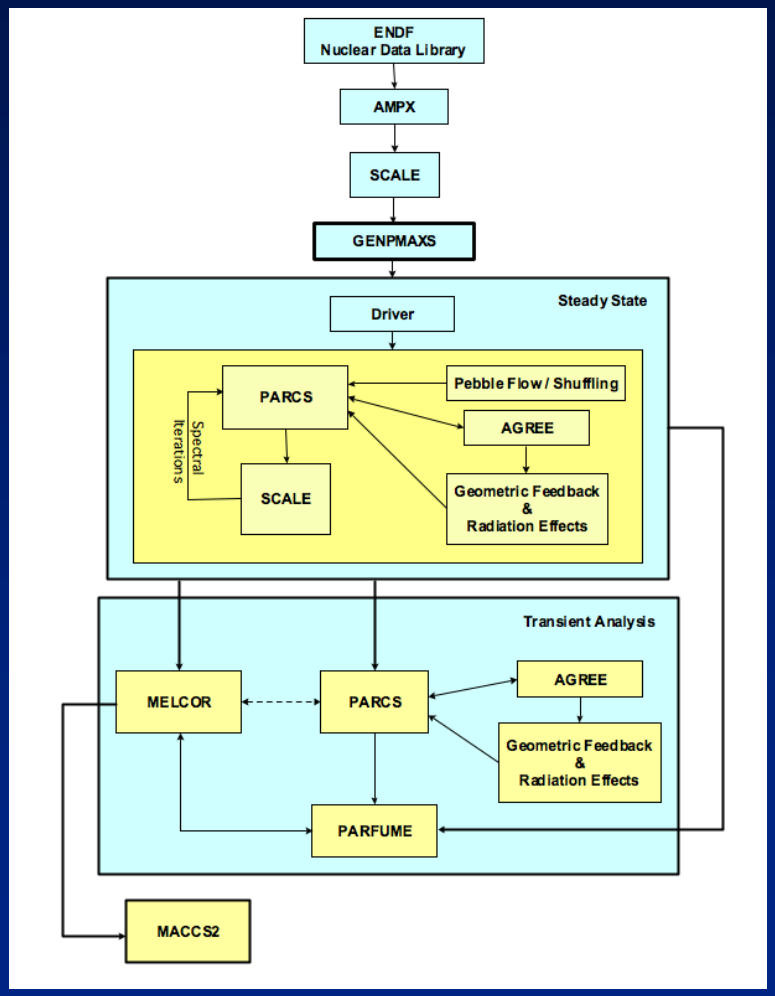
- Meeting Purpose:
  - Progress Review
    - Task 2: Coupled Rx Physics and T/H Modeling
    - Task 3: Small-Scale Separate Effects Tests
  - Integral Effects Test
    - Scaling & Design Review (total of 2-3 before construction)
  - Dialogue with NGNP Partners (DOE/INL)
    - Provide information on Coop program status/plans
    - Get feedback on how Coop experimental program can help to meet DOE/INL data needs in addition to those of the NRC.

NGNP Evaluation Model

- By Function



- Code Specific



NGNP EM: Codes

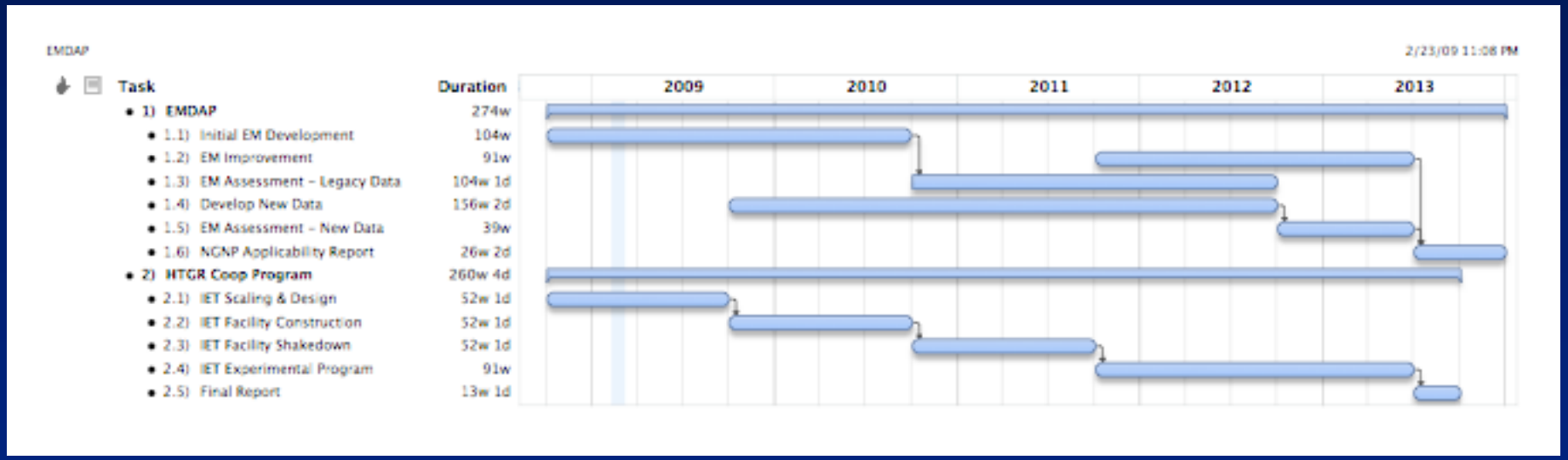
- **MELCOR** - U.S. NRC Severe Accident Code
  - Solves 2D flow, heat transfer & fission product transport.
    - Core heat transfer & flow models: PBR & PMR
    - Graphite oxidation models
    - Extend aerosol models to graphite dust transport
    - Fission product release models for coated fuel particles
- **SCALE/AMPX** - U.S. NRC Nuclear Analysis Code Suite
  - AMPX processes ENDF nuclear data into code usable libraries
  - SCALE provides lattice physics and depletion capabilities to generate few-group cross-sections, decay heat and FP inventory.
- **PARFUME/TMAP4** - INL Mechanistic CFP Performance Codes
  - CFP failure rate vs. fuel temperature and BU from NGNP-specific CFP failure rate test data & PARFUME sensitivity studies
  - FP transport in a CFP, fuel matrix, and prismatic fuel block (TMAP4)
- **MACCS2** - U.S. NRC Accident Consequences Code
  - Estimates off-site consequences
  - Input source term, health, and site parameters

NGNP EM: Codes

- **PARCS** - U.S. NRC Advanced Reactor Core Neutronics Simulator
  - Solves 3D, Time Dependent Core Flux/Power Equations
  - Solves 3D Flux in both Cylindrical (PBR) and Hexagonal (PMR)
  - Benchmarked for PBR with OECD PBMR-400 Benchmark
- **AGREE** - **A**dvanced **G**as **RE**actor **E**valuation
  - 3D, two-temperature porous medium (PBR) approach based on the legacy THERMIX/DIREKT codes.
  - Coupled to PARCS to provide coupled time-dependent neutronics-thermo-fluid solution for gas reactors
  - Benchmarked with Julich SANA Test Experimental Data and OECD PBMR-400 Benchmark
  - Will be extended to model prismatic core.
- **GENPMAXS** - **GEN**erates **PMAXS** cross section files for PARCS
  - Reads SCALE/TRITON output at all burnup and temperature/fluid conditions and provides cross section library for PARCS

NGNP EM: Schedule

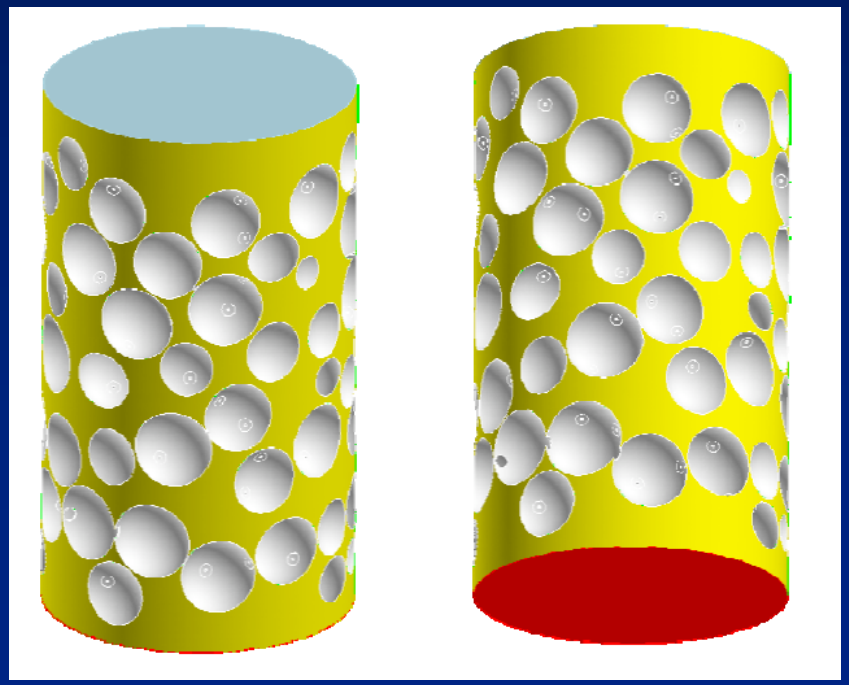
- Validated EM together with code applicability report due Dec. 2013.

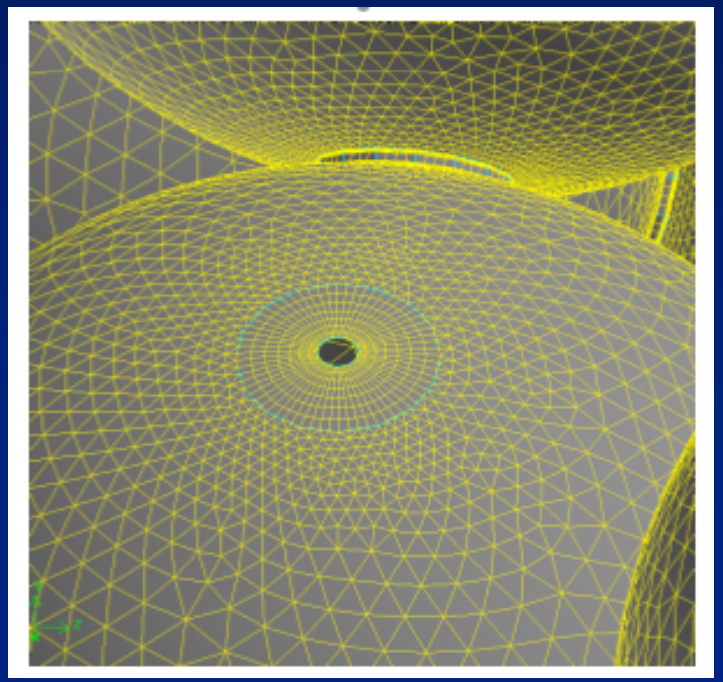


  - Cooperative agreement will permit NRC to fill some of its data needs in the thermo-fluids area.

Role of CFD: Examples of Ongoing Studies

- Sample Results
  - Meshing of a random packed pebble bed.
    - Remote from reflector wall (infinite medium)





Role of CFD: Examples of Ongoing Studies

- Sample Results: near reflector wall
  - Pressure Drop

Table 10.5.2: Pressure Drop Predictions – Reflector Model

Flow Rate	Pressure Drop (Pa/m)			
	KTA rules Correlation (Based on Reflector Values)			CFD Model
	Nominal	Lower Bound	Upper Bound	Reflector Model
15 kg/s	175	149	202	129
75 kg/s	3144	2673	3615	2391
150 kg/s	11448	9731	13165	9212

  - Pebble-Gas HTC.

Flow Rate	KTA rules correlation (Reference 10.23)	CFD Models & Thermal Solution	% Difference from KTA
15 kg/s	725	529	-27%
75 kg/s	1983	1144	-42%
150 kg/s	3239	1939	-40%