NEUP Nuclear Energy University Programs

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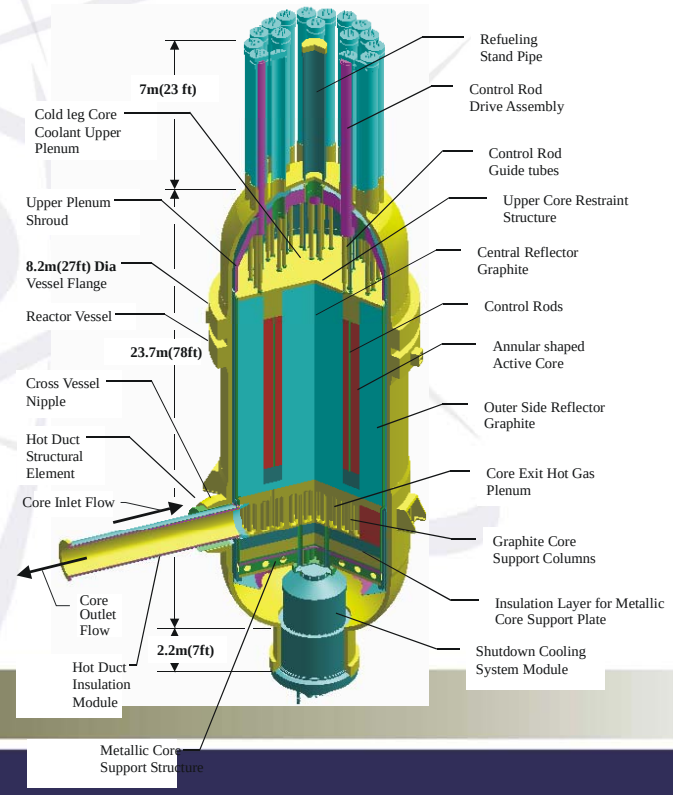
FY2011 NEUP Workshop High Temperature Materials Breakout Session

Rockville, Maryland

NGNP Design Drivers

- The NGNP is BIG: reference pressure vessel design is on the order of 8m diameter by 23m tall and up to 200mm thick
- 750°C outlet with steam generator with follow-up with IHX at up to 950°C
- 90% of the core is graphite
- Prismatic design graphite may receive 7 dpa; pebble bed may receive 20 dpa
- The first plant is a technology and licensing demonstration
- The desired license period is 60 years (500,000 hours)
- Built soon



Heat Exchanger and Steam Generator Alloys Needs

- Mechanisms of creep cavity formation, dynamic strain aging, and stress relaxation
- Phenomenological models of creep-fatigue interaction
- Characterization and phenomenological models of environmentally assisted crack growth in relevant environments

Pressure Vessel Steels

- Address impact of potential in service conditions on elevated temperature properties including:
  - Methods for accelerated aging and extrapolation to long times from laboratory experiments
  - Characterization and constitutive models for influence of cyclic loading on mechanical properties and negligible creep

Experiment Planning And Decomposition

- Scaling, experimental design, fundamental phenomena identification, costing and PIRT review for one or more of the following:
  - High temperature test facility
  - Natural circulation in the core (plenum-to-plenum)
  - Steam ingress flow and chemistry
  - Core and boundary heat transfer experiment and multi-scale modeling
  - Ex-core cooling (reactor cavity cooling)
  - Lower plenum and bypass flow (esp. non-isothermal)

Graphite Research

- Improved non-destructive examination techniques for detecting small flaws (≤ 100 microns) in large graphite components (> 400mm^3)
  - Advanced data analysis techniques and long penetrating techniques achieving high resolution are required (no interest in analysis of small samples and flaws at small microstructure level)

Graphite Recycling

- Novel graphite recycling techniques
  - Specifically related to new graphite formulations effect on behavior (i.e. binder-filler ratio)
  - Effects of using previously irradiated graphite on material performance

- Annealing studies on irradiated graphite properties
  - High temperature (secondary) Wigner energy release mechanisms.
  - What are the possible defect structures for this issue?

Graphite - Oxidation

- Long-term oxidation studies of nuclear graphite
  - Oxidation rate, affects, and mechanisms on material of graphite within the kinetic and diffusion controlled oxidation regimes

- Fundamental mechanisms for irradiation induced property changes
  - Specific areas of interest include irradiation induced creep, the relationship between irradiation induced dimensional changes and irradiation creep, dislocation movement within graphite, and irradiation induced pore structure morphology

Composites research

- Development of non-destructive examination techniques
  - Can be used for predicting component lifetimes for CFC, SiC/SiC
- Composites for ceramic components (such as insulation blocks, insulating blankets/weaves, tiles and columns)
- Both pre-IE and in-situ techniques