ADVANCED REACTOR, FUEL CYCLE, AND ENERGY PRODUCTS WORKSHOP FOR UNIVERSITIES

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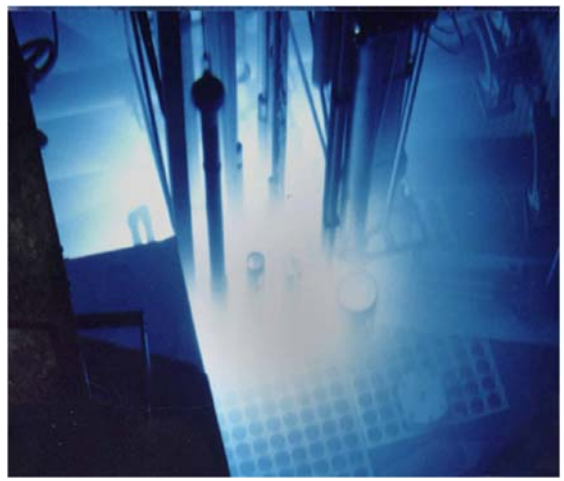
THIS RESEARCH AREA INCLUDES

- **Selection, development, and qualification of structural materials needed to design and build the advanced reactors being developed within the Gen IV Reactor Program**
- **These activities are part of the Gen IV Reactor Program and are closely coordinated with similar structural materials research for the AFCI, NHI, and GNEP ABR Programs**
- **Materials needs will be addressed for the NGNP and SFR reactor systems, as well as for their energy conversion systems, through R&D on their specific issues combined with crosscutting tasks**

Advanced Materials Development and Qualification Essential for All Gen IV Reactors

- **Materials Will Be Exposed to High Temperatures, Neutron Exposures, and Corrosive Environments**
- **60-Year Operating Lives for Gen IV Reactors Will Require Very Long-Term Materials Stability**

- **Process-Heat Use for Large-Scale Hydrogen Generation Will Also Require Materials Compatibility with Heat-Transfer Media and Reactants**
- **Research Will Build upon Extensive Previous Materials Development for Other Reactor Systems and Related Domestic and Foreign Programs**



FY06 ACCOMPLISHMENTS

- Completed Assessments of Materials Needs, R&D Plans, and Technology Status for Gen IV Reactors
  - Generation IV Reactors Integrated Materials Program Plan
  - Next Generation Nuclear Plant Materials Research and Development Program Plan
  - Materials Testing Requirements and Initial Test Program for Intermediate Heat Transfer Loops
- Completed Preliminary Comparison of Reaction Rate Theory and Object Kinetic Monte Carlo Simulations of Defect Cluster Dynamics under Irradiation
- Completed Initial Development of Gen IV Materials Handbook
  - Web-accessible, hyperlinked data repository for structural data
  - Incorporated trial creep data on 617 and 230

FY06 ACCOMPLISHMENTS (cont)

- Initiated creep and creep-fatigue testing and development of improved constitutive models for 617 in support of ASME code case development
- Developed and evaluated controlled-chemistry variant of 617
- Completed interim development of simplified high-temperature design methods
  - Load- and deformation-controlled loading
  - Primary and secondary stresses, including cycling, relaxation, and racheting
  - Current status and needed improvements for analytical methods plus required experiment validation
- Evaluated existing rules for negligible creep evaluation for 9Cr-1Mo steel and implemented program for improvements

FY06 ACCOMPLISHMENTS (cont)

- Completed scoping irradiations of high-temperature structural materials
  - 1.3-1.6 dpa at 550°C to 750°C
  - 800H, 617, 14WT, 14YWT & 9Cr-1Mo
- Performed initial evaluation of alternate joining methods for advanced materials
  - Diffusion bonding, transient liquid-phase joining, friction-stir welding
  - 617 and ODS materials
- Developed environmental systems for evaluation of aging effects and creep testing of high-temperature alloys in VHTR helium and initiated aging studies
- Investigated stability of dynamic equilibrium of impurity content in VHTR helium environments

FY06 ACCOMPLISHMENTS (cont)

- Developed draft ASTM specification for nuclear grade graphite and ASME rules for graphite use in core and core support structures
- Developed draft ASTM standards for graphite oxidation and fracture testing
- Evaluated status, deficiencies, and improvements needed for ASME Sec III Subsec NH rules on elevated temperature design
- Developed candidate methods for standardization of ceramic composite testing
- Completed initial comparative irradiations of C-C vs SiC-SiC composites for control rod applications

FY06 ACCOMPLISHMENTS (cont)

- Completed scoping high-dose irradiations and PIE on NGNP candidate graphites in HFIR
  - PCEA and NBG-10 compared to H-451
- Completed initial procurement and characterization of NGNP graphite billots
  - NBG-17, NBG-18, IG-43 and PCEA
- Completed capsule design & fabrication and specimen preparation for initial graphite irradiation-creep experiment in ATR
- Completed initial design for very high-temperature graphite irradiation experiments in HFIR
- Completed initial development of irradiation performance modeling of graphite

FY07 Work in Progress

- **Complete supplemental PIE on scoping irradiations of high-temperature structural materials**
- **Complete comparison of reaction rate theory and Monte Carlo Methods for simulating cluster-dynamics-derived point defect distributions**
- **Complete review and modification of *Gen IV Materials Handbook* based on beta-version evaluation**
- **Continue development of simplified high-temp design methods**
- **Continue development of ASTM standards and ASME Code for nuclear-grade graphites & composites and rules for elevated temperature design**
- **Complete capsule preparations and pre-irradiation characterization of graphites for creep-irradiation experiment**
- **Develop graphite procurement and qualification plans for NGNP**
- **Complete C-C & SiC-SiC comparisons for control rod materials**

High-Priority Materials R&D Will Focus on NGNP Needs in FY08-FY09

- Selection and qualification of graphite
- Selection and qualification of high-temperature metallic materials and development of improved high-temperature design methodology
- Assessment of irradiation effects and fabrication methods of reactor pressure vessels
- Assessment of environmental and thermal aging effects
- Development of supporting ASME and ASTM codes and standards
- Development and population of materials database