Systems Analysis of VHTR, Deep Burn, AHTR Systems

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From Yesterday (Petti)

- The VHTR is a helium-cooled, graphite moderated reactor with a core outlet temperature between 750 and 850°C with a long-term goal of achieving an outlet temperature of 950°C.
- The reactor is well suited for the co-generation of process heat and electricity and for the production of hydrogen from water for industrial applications in the chemical and petrochemical sectors.

- Large R&D program planned to qualify fuel, graphite, high temperature materials and methods for NGNP which also supports many of the longer range high temperature reactor concepts.
- Smaller programs in Deep Burn, AHTR, SFR and SMR also have needs (often complementary)

Reactor Analysis Methods

- **In the area of *core simulation*, proposals are sought that address:**
  - Modeling and simulation of core phenomena such as:
    - Reactivity transient effects on fuel considering coupled fuel performance, neutronic, and thermal fluid simulation and simulation of transient fuel performance experiments
    - Mechanical-neutronic-thermal fluid interactions such as fully coupled simulations of graphite dimensional changes under irradiation with thermal and neutronic feedback
    - Fuel Management techniques that enable fuel cycle optimization in prismatic HTRs for enhanced performance and deep burn reduction of spent fuel heavy metal inventory
    - Core temperature and flux measurement/reconstruction techniques for VHTR/HTGRs
    - Nuclear data including cross section measurement and validation in high burnup fuel (experimental)

Plant Simulation and Safety Analysis

- **In the area of plant simulation, safety analysis, uncertainty and sensitivity analysis in VHTR Core calculations, proposals are sought that address issues of:**
  - Plant modeling and uncertainty
  - Licensing approaches
  - Dynamic and economic analyses of reactor-process heat plant coupling
  - Source term
    - Including dust and fission product transport in VHTRs
    - Special emphasis on experimental validation and uncertainty and sensitivity analysis in coupled core calculations

VHTR Heat Transport, Energy Conversion, Hydrogen and Nuclear Heat Needs

- **Approaches that can greatly improve the ease of coupling, the operability of the combined system, and the ultimate economics**
- **Address modeling of basic energy transfer and conversion of the energy in VHTR outlet coolant streams including:**
  - Dynamic simulation of reactor-driven process heat plants focusing on system investigations related to the coupling of high temperature reactors with process heat plants considering load matching and rejection and the influence of multiple modules
  - Economic analysis and optimization of VHTR-process heat plant coupling
  - Analysis of alternative coolants
- **Hydrogen generation using high temperature steam electrolysis,**
  - Development of advanced material sets for solid oxide electrolysis cells to produce hydrogen that maximize long term cell performance
  - Equivalent circuit modeling of solid oxide electrolysis cells using AC Impedance Spectroscopy data for various cell designs