Working Group 2

New Reactor Designs With Higher Efficiency, Lower Cost & Improved Safety

Bill Kastenberg
University of California, Berkeley
April 24, 1998

Objective

- Conduct research that supports new nuclear plant concepts with enhanced cost-effectiveness, safety, and reliability in order to improve future potential for nuclear energy deployment

- Topical examples are identified and non-exclusive examples are provided to clarify intent but not to restrict innovative thinking

Computer, Software and Digital Technology Research

- Nuclear Plant "Virtual Model"- for economic & schedule simulation of design/construction/operation
- Advanced Modeling & Simulation
  - PRA, safety and performance models
  - Real time assessment of accident /risk management strategies
  - Advanced training aids and decision support tools
  - Advanced data processing/integration

Computer, Software and Digital Technology Research

- Instrumentation & Control Systems Innovation
  - Wireless data/information transmission technology
  - Advanced sensor development
  - Advanced computer/component integration e.g. smart equipment for self diagnostics and monitoring,, micro-machine
  - Real time inspection & diagnostic methods and technology
  - Imbedded Software technology
  - Automated Reactor Systems - inherently-safe operation, automated startup/shutdown, on-line diagnostics, Inferential measurements

Materials Science Research

- Fundamental Materials R&D
  - R&D that will enable material behavior to be predictive rather than reactive
  - Needed to gain a better basic understanding of all nuclear related materials phenomena: e.g. embrittlement, stress corrosion cracking, etc.
  - Explore innovative material concepts for advanced reactor concepts e.g. composites, new alloys, smart materials,
  - Radiation effects basic research, experimentation & modeling is required

Materials Science Research

- Applied Materials R&D - for advanced reactor concepts
  - R&D driven by issue, project or reactor type
  - Materials and material compatibility research for high temperature reactor concepts and high efficiency power conversion cycles e.g. ceramics
  - Advanced material applications that limit component damage e.g. replaceable reactor reflector to keep vessel fluence low
  - Improved material, design & component manufacturing & process technologies needed to reduce cost
  - Methods to evaluate, characterize and measure material properties/characteristics e.g. fatigue evaluation, structural
  - Isotopic materials & sample preparation - for materials dosimetry

Advanced Energy Conversion Research

- Basic thermal fluids research
  - First principle approach coupled with experimentation
- Innovative Reactor and Fuel Cycle Concepts
  - Advancements to existing reactor technologies
  - Combined cycle reactor system
  - Thermodynamic cycles with greater efficiency
  - Direct conversion technology
  - Concepts for non-electricity/co-generation technology e.g. isotope production, hydrogen fuel production, desalinization
  - New reactor & core designs concepts e.g. geometry & power density to preclude core melt, inherent control properties, total consumption of actinides, couple to modern energy conversion technology
  - Nuclear Data - compilation & evaluation

Institutional & Social Research

- Robust & reliable analysis/models to fairly evaluate all energy conversion systems
- Institutional/social demand type design criteria for new reactor systems: e.g. reactor design without core melt
- Need nuclear regulation evaluation/change as new technologies are developed
- Human reliability, organization/management research to improve safety, operation and economics
- Paths to Public Acceptance

Research Proposal Criteria

- Potential/prospects for improved economics, safety and efficiency of the proposed research need to be stressed in proposals
- International collaboration or partners is neutral other than technical merit, quality and value of the collaboration
- Research should take advantage of other industry breakthroughs

Research Proposal Criteria

- Innovation and relevance are important evaluation criteria
- Degree of preference will be given to proposals involving interdisciplinary or intercommunity collaboration
- Project involving students and post-doctoral appointments are especially encouraged

Process requirements

- Research to support deployment time-frames
  - Need near term accomplishments and technology spin-offs
  - Intermediate time-frame - 2010 to 2020 - Existing technology innovation
  - Long term time-frame - 2020-2050 - new reactor concepts

Grant/Contract Size

- Small projects grants/contracts
  - Small single investigator
  - $100K-$300k for 2-3 years
  - At least 50% of available funds
- Large projects grants/contracts
  - Consortia recommended
  - Remainder of available funds

Peer Review Process

- Pre-proposal stage- 2-5 pages commensurate with size of project
  - Reviewed for technical quality and relevance
- Full Proposal - 15-25 pages commensurate with size of project
  - Use 2 page NSF resume format

Peer Review Process

- Peer Review Panels
  - Convene panel based on reviewers comments
  - DOE compile list of potential panel members from university department chairs, lab depart. heads and industry
  - Use retirees as well as active researchers
- High level panel for final selection with DOE