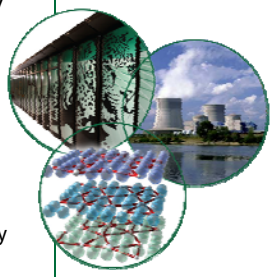
RIC 2010

Regulatory and Policy Issues for Small Modular Reactors

"Key Technical Issues Associated with SMR Policy Issues"

Gary T. Mays
Donald L. Williams, Jr.
Advanced Reactor Systems & Safety
Oak Ridge National Laboratory

March 10, 2010



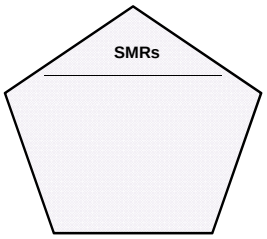
Objective—Frame Linkage Between Policy and Technology Issues for SMRs

- Examine key parameters of linkage
- Provide a model/approach for categorizing these parameters
- Use model to identify challenges to be addressed in deploying SMRs
- Develop basis for examining regulatory framework and approach to develop, license, and deploy SMRs

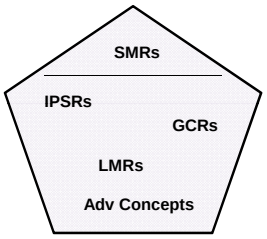
Where to Start—What Are Top Level Links?

Policy Issues	Technical Issues
• Safety and security—ensure same level of safety as current LWRs • Licensing Approach – Part 50, 52, 53, 5X, 100 – Risk informed/performance based – Applicability of prior non-LWR licensing reviews/actions • Experience base—large LWRs – Revised guidance • RG 1.206 COL • NUREG-0800 SRP • Siting—emergency planning • Confirmatory R&D and tools	• Passive safety—highly reliable reactor shutdown and heat removal • Demonstration of new safety features and technologies – Testing, demo, prototype – Simulation • Develop codes & standards • Develop analytical tools & codes for assessing safety • Use of digital I&C and diagnostics and prognostics • Multiple designs

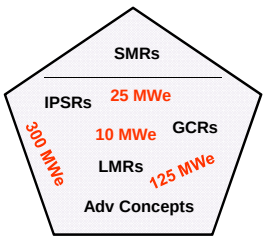
Key Parameters Provide Bases for Relating Policy and Technical Issues for SMRs



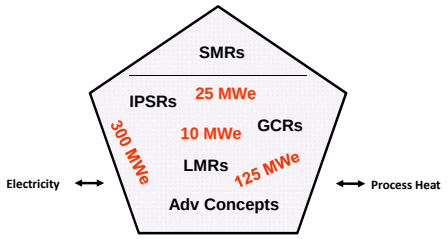
Key Parameters Provide Bases for Relating Policy and Technical Issues for SMRs



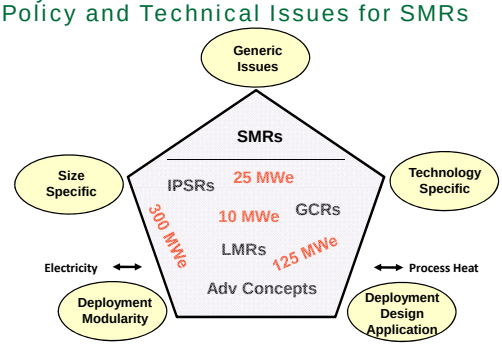
Key Parameters Provide Bases for Relating Policy and Technical Issues for SMRs



Key Parameters Provide Bases for Relating Policy and Technical Issues for SMRs



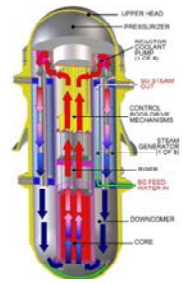
Key Parameters Provide Bases for Relating Policy and Technical Issues for SMRs



Technology Specific Issues Involve Non-LWRs

- **Generic non-LWR Issues**
  - **Available consensus standards/accident analysis codes**
  - **Leveraging international experience/previous licensing reviews**
  - **Available licensing infrastructure**
  - **Materials qualification (high temperature and rad effects)**
  - **Extended time frames for development and deployment**
- **GCRs**
  - **Qualification of TRISO fuel**
  - **Vented/filtered confinement vs containment**
  - **Graphite performance**
  - **NGNP Gap findings on R&D and data needs**
- **LMRs**
  - **Fuel qualification: metal and oxide fuels**
  - **Positive void coefficient**
  - **Steam generator leaks**

Size Specific Issues Suggest Re-examining Regulatory Approach



Functional arrangement of primary systems and components in an IPSR (IRIS design courtesy of Westinghouse)

- Simplifies design by eliminating loop piping & external components
- Enhances safety—eliminates major classes of accidents
  - No large pipes in primary circuit means no large break LOCAs
  - Increased water inventory means slower response to transients
  - Internal CRDMs means no rod-ejection accidents
- Reduced source term
- Improved decay heat removal
- Compact containment enhances siting and security

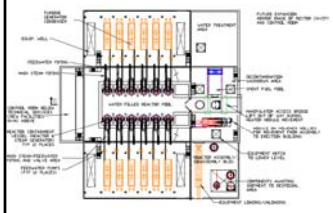
Size Specific Policy and Technical Issues To Address Early

- **Reduced source term impacts**
  - **Reduced EPZ**
  - **Emergency planning requirements**
  - **Smaller offsite dose consequences**
  - **Enhanced siting options**
- **Potential security/safeguards impacts**
  - **Underground siting key design feature for most SMRs**
  - **Safety systems underground**
  - **Reduced number of vital areas**
  - **Reduced staff size**
  - **Aircraft impact evaluations**

Size Specific Policy and Technical Issues To Address Early (cont'd)

- **Evaluate enhanced safety**
  - **Lower probability of severe accidents**
  - **Slower progression of accidents**
  - **Improved decay heat removal**
- **Operator requirements and staffing size impacts**
  - **Smaller size staff**
  - **Potential increased range of responsibilities**
    - **Online refueling**
    - **Maintenance**
  - **Extent of automated controls employed**
  - **Training/simulator requirements**

Deployment of SMRs With Multiple Modules Presents Unique Issues to be Evaluated



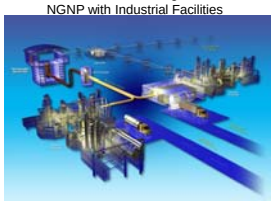
Multiple deployment options for modules

- Identification of shared systems
- How to employ PRA
- Implementation of control system architectures
- Reactor operator requirements
- Control room design/layout
- Licensing of construction and operation of subsequent modules with operating modules
- ITAAC
- Define Design Basis Threat with several small reactors operating at one site

Deployment Applications for SMRs Offer Additional Challenges

- Proximity to process heat plant
  - Siting options positive
  - Identification of mutual hazards
  - PRA
  - How plants interface—who regulates what?
- Reactor control system design
- Heat transport system interface
- Operational requirements
  - 100% reactor availability needed?
  - Impacts of unplanned shutdowns of either facility on the other

INL Illustration of Integration of NGNP with Industrial Facilities



Application design options
- Electricity only
- Process heat only
- Both

Other Generic Issues for SMRs

- **Extended fuel cycle operations**
  - **Develop enhanced condition-based monitoring and diagnostics/prognostics capabilities**
  - **Address inspection and maintenance approach (ISI and IST)**
- **Requirements and qualifications for**
  - **Fabrication facilities**
  - **Construction processes**
- **How to reconcile issuing manufacturing license for SMRs with site-specific safety features?**
- **Number of NRC Resident Inspectors needed?**
- **Operating experience assessments—develop new or modify existing Reactor Oversight Program (ROP)?**