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New Advanced Reactor Development Challenges

Implementation of Codes and Standards

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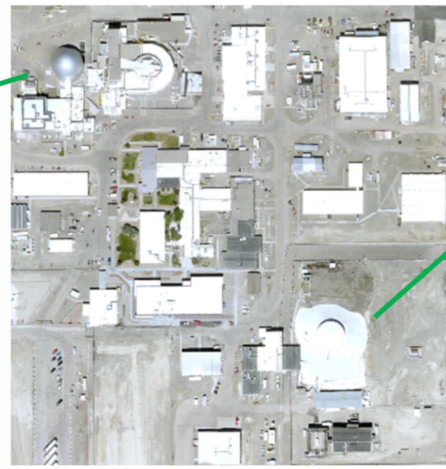
NRIC Testbed Strategy

NRIC-DOME Testbed

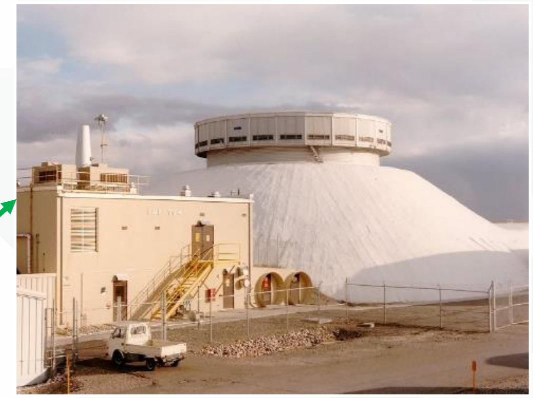
- EBR-II Operated from 1964 to 1994
  - 62.5 MW thermal
- Reestablish EBR-II as NRIC-DOME

- FEEED – 3 HTGR Microreactor developers
  - Westinghouse (eVinci)
  - Radiant (Kaleidos)
  - USNC (Pylon)
  - > 10 candidates

Materials & Fuels Complex at INL



NRIC-LOTUS Testbed



- ZPPR Operated from 1969 to 1990
  - Used for transuranic and enriched-uraniu material inspection/repackaging and experiments
- Establish ZPPR as NRIC-LOTUS Testbed

- Southern/TerraPower
  - MCRE

DOME – Demonstration of Microreactor Experiments
LOTUS – Laboratory for Operations and Testing in the US

ASME Section III Division 5 Challenges

ASME code presents constraints for advanced reactors:

- Typical reactor types impacted: HTGR, Molten Salt

- Constraints for Material Selection
  - Selection of metallic material limited
    - Materials being used by reactor developers are not all addressed by the code
  - Design constraints for metallics
    - Temperature Allowable:
      - Certain reactor applications necessitate operational and transient temperatures above those allowable in the Code

ASME Section III Div 5 Challenges (cont'd)

Supply Chain Challenges Impact all Developers

- Metallics:
  - Industry still coming up to speed on Div. 5 - limited supply chain able to fabricate IAW the code (supply chain exists for metallics)
    - Tailoring of procurement specs to align with code requirements to address high temperature services could bridge the gap
  - Creep and fatigue issues related to new reactors do not have operational experience from existing code / fleet
  - Approving existing materials to operate at higher temps via testing and analytical methods in process, but not complete
  - Limited number of metallics available for use in current code
    - Code cases require development for materials not currently accounted for in the code
    - Approval of new materials for the code currently anticipated to take longer than development cycle of the planned reactors.
    - Explore possibility of external funding to support for these types of expedited material updates.
- Non-Metallics (e.g., graphite)
  - Lack of qualified graphite suppliers Graphite Certificate (GC) or Materials Organization (MO)
  - Uncertainty of application of Div 5 to Graphite – limited uses in industry to date(e.g., QA program required for G, 3rd party oversight (ANI responsibilities)MO activities requiring code data reports)
  - Fabricability of approved materials is uncertain. Anticipated materials used by commercial industry may not meet current code requirements
  - Commercial Grade Dedication (CGD) explicitly disallowed. Critical characteristics prescribed by the code.

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Path Forward to Commercial Deployment

Leave Design Constraints:

- Limit new nuclear design to existing materials and temperatures - Staying in code design space is possible for some projects; anticipate all projects will experience issues with supply chain and manufacturer qualifications

Address Design Constraints (NRC):

- Develop the necessary data to expand the code materials and temperatures (Potential for external funding of expedited testing for code compliance)
  - i. Testing programs
  - ii. Shorten the time for Code Cases
  - iii. Leverage other portions of ASME code (Section VIII and utilization of code cases being developed by ASME task group for use of alternative treatment)
    1. Investigate the feasibility to use 10 CFR50.69 to allow use of commercial codes for graded / tailored approach for design of components (additional barriers to be addressed to use this approach)

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Path Forward (cont'd)

NRIC pursues multiple options with developers.

Leverage DOE Capabilities:

a. The DOE System has the ability to use equivalencies under 10 CFR 851 and others to meet the requirements due to the research nature of our work
   i. Can evaluate equivalent level of safety for the application being proposed for a reactor experiment under DOE authorization (through analysis and testing)
   ii. Flexibility to review and approve new materials or materials beyond listed temperature allowable based on material test programs tailored to the application
   iii. Can augment the quality systems/programs of the supply chain informed by the code requirements for ANI, AI, MO, etc. with project specific plan

b. Able to build to ASME code w/ equivalencies documented, but not stamped to extend industry ability to meet the requirements of advanced reactor developers (equivalent to what the international community does)

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