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U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Spent Fuel and Waste Science and Technology

Review of Ongoing Thermal-Hydraulic Testing and Model Validation Efforts

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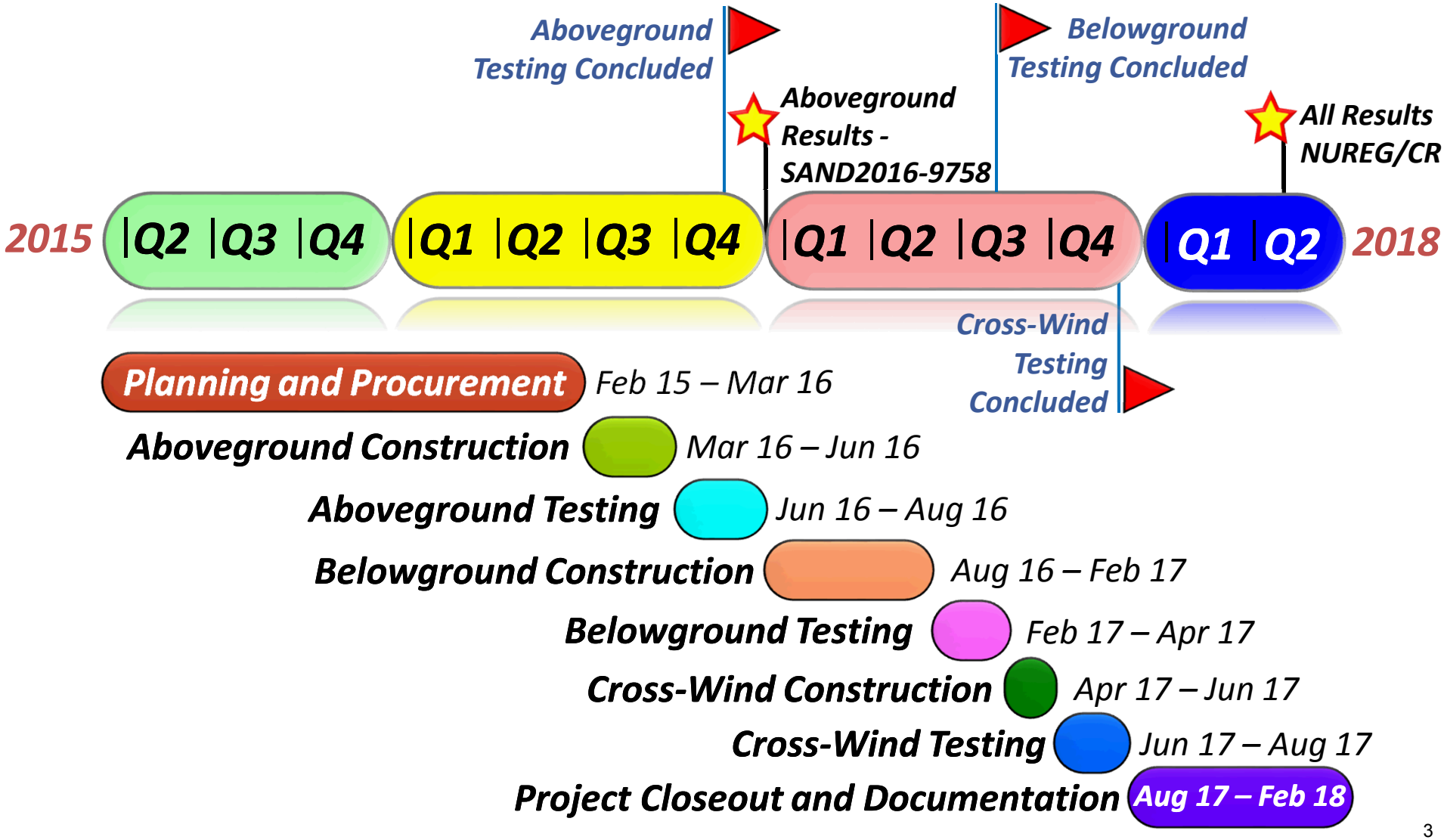
Current Research Roadmap

- **Phase 1: BWR Dry Cask Simulator (DCS)**
  - Aboveground configuration
  - Belowground configuration
    - *Cross-wind testing*
- **Phase 2: High Burnup Spent Fuel Data Project**
  - 2a: Calculations of the decay heat for the assemblies using different methods
  - 2b: Thermal analyses of the Research Project Cask using ***best estimates and proprietary information***
  - 2c: Sensitivity studies with a focus on mesh size variability and Grid Convergence Index (GCI)
  - 2d: Thermal analyses of a ***generic cask***
    - *No proprietary information*
- **Phase 3 Potential experiments and validation exercises to extend thermal-hydraulic understanding of dry storage**

Phase 1: Dry Cask Simulator Testing



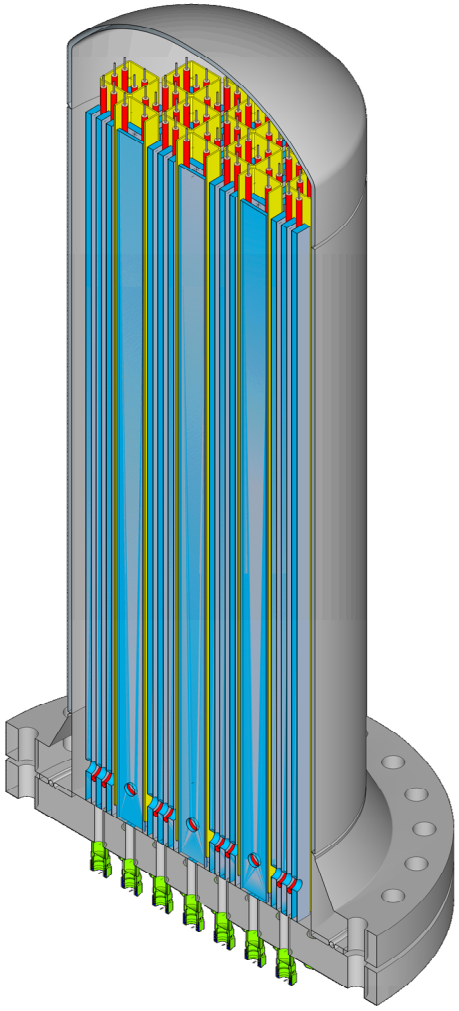
Phase 1: Modeling Comparisons

- **Dry Cask Simulator (DCS) Modeling Handbook in draft**
  - Contains geometry, material information, boundary conditions, and recommendations for DCS modeling activities
  - Only aboveground cask configuration currently considered
- **What is a reasonable timeline for modeling initiation, completion, and reporting?**
  - Limit decay heat and internal pressure to one (possibly two) cases
  - NRC to publish NUREG in 2018
  - PNNL to publish DOE report in September 2018
- **Which quantities should be used for comparison?**
  - Peak cladding temperature (PCT) and external air mass flow rate
  - Additional temperatures? Axial and transverse temperature comparisons throughout?

Phase 2: High Burnup Spent Fuel Data Project

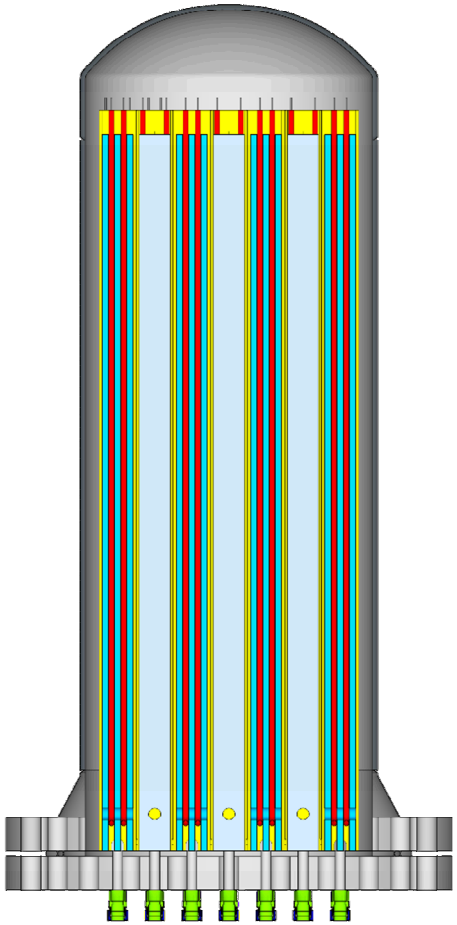
- **Cask loaded as of November 14, 2017**
- **Task 2b and 2c: Proprietary modeling completion date of March 2018**
  - Boundary and initial conditions (as loaded) due to participants by mid-December 2017
  - Participants: NRC, PNNL, and TN
  - DOE M3 (PNNL results) report due May 2018
  - EPRI report with compendium of limited-release test results and modeling in 2018
- **Path to generic modeling of TN-32 High Burnup Cask Demo (Task 2d) dependent on funding and interest**

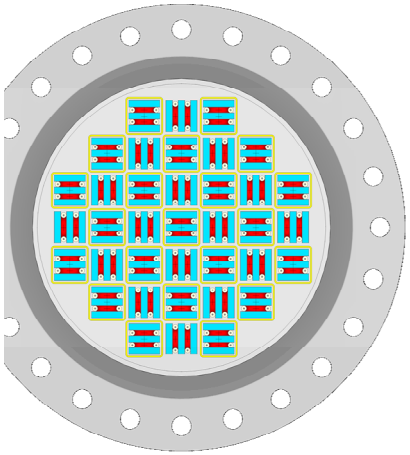
Phase 3: Potential Next Steps



- **Additional validation data warranted**
  - Historical testing not appropriate for modern cask designs
    - *Not pressurized*
    - *Internals not optimized for heat transfer*
    - *Fewer assemblies*
  - Recent DCS testing has known scaling distortions due to single assembly design
    - *Higher decay heats needed for prototypic PCT's*
    - *Higher coupling of fuel response to BC's*
- **Represent whole, modern cask?**
  - Use informed scaling arguments
    - *Reduce capital equipment costs and construction complexity*
    - *Multiple dimensionless group matching*
      - Reduce scaling distortions

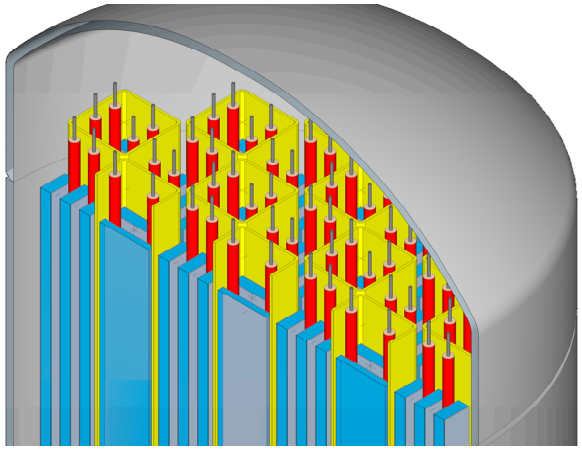
Phase 3: Configurability

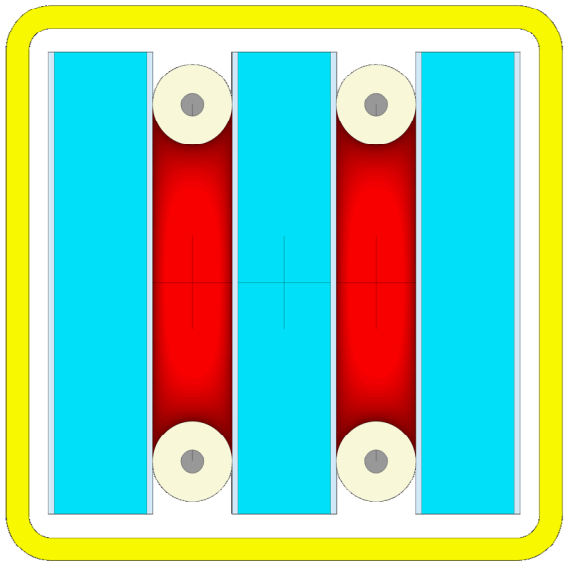


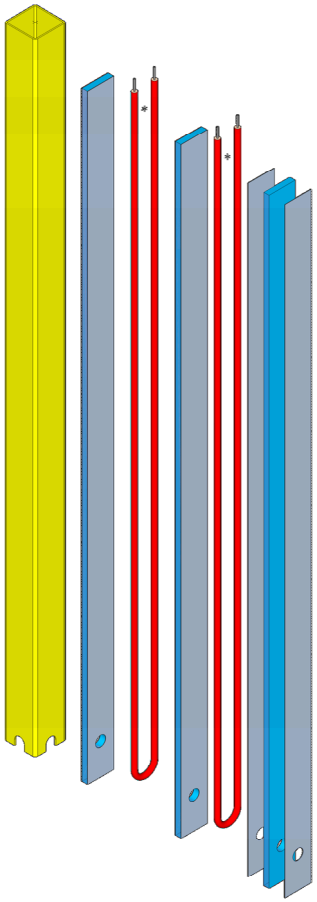


- **Accommodate wide parameter space and variable boundary conditions**
  - Modern basket designs
  - Convective and conductive systems?
  - Different fuel loading patterns
    - *Unique decay heats*
  - Different overpacks
  - Vertical and horizontal?
- **Drying operations?**
  - Compatible with water
  - Heated vacuum
  - Forced drying

Phase 3: Potential Tradeoffs







- **Conceivably exchange fuel assembly simplification for whole cask representation**
- **Match key fuel parameters**
  - Scaled hydraulic diameter
  - Effective axial conductivity
  - Pressure drop
- **Interchangeable baskets**
  - Stainless steel
  - Aluminum