BWX Technologies, Inc.

BWXT Advanced Nuclear Reactor (BANR) Regulatory Update

Mike Haggerty, ARDP Project Manager
Abbey J. Donahue, P.E., Technical Integrator
Dr. Jeffrey Powers, Fuel Performance Engineer
Alex Shrier, Nuclear Engineer
Don Statile, Licensing Manager

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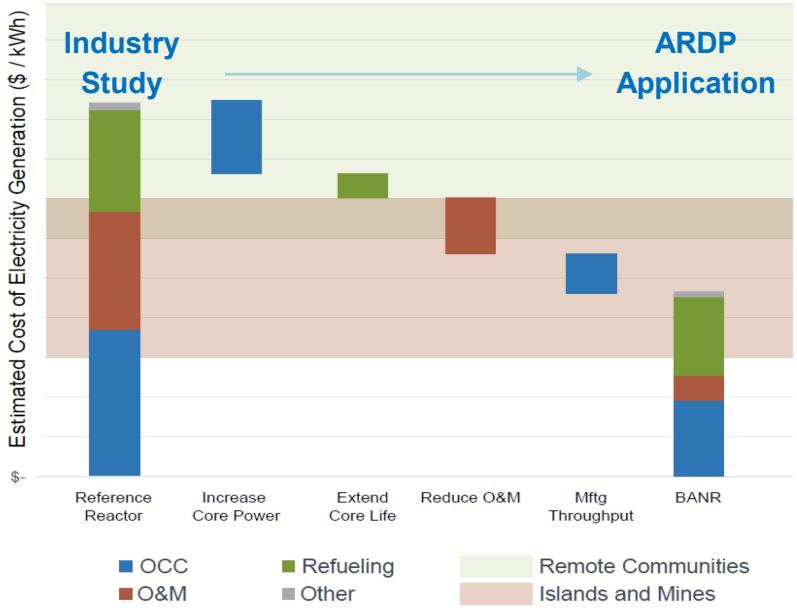
Agenda

- Introductions/Opening Remarks
- Review of BWXT ARDP Program Scope and Technology
- Review of Past and Upcoming Regulatory Submittals
- Review of Fuel Qualification Approach
- Proposed Content of Fuel Qualification White Paper
- Questions

BANR ARDP Program Scope

ARDP is a 7-year cost share program to facilitate development of U.S. private industry advanced nuclear demonstrations for designs that are reliable, cost effective, licensable, and commercially viable.



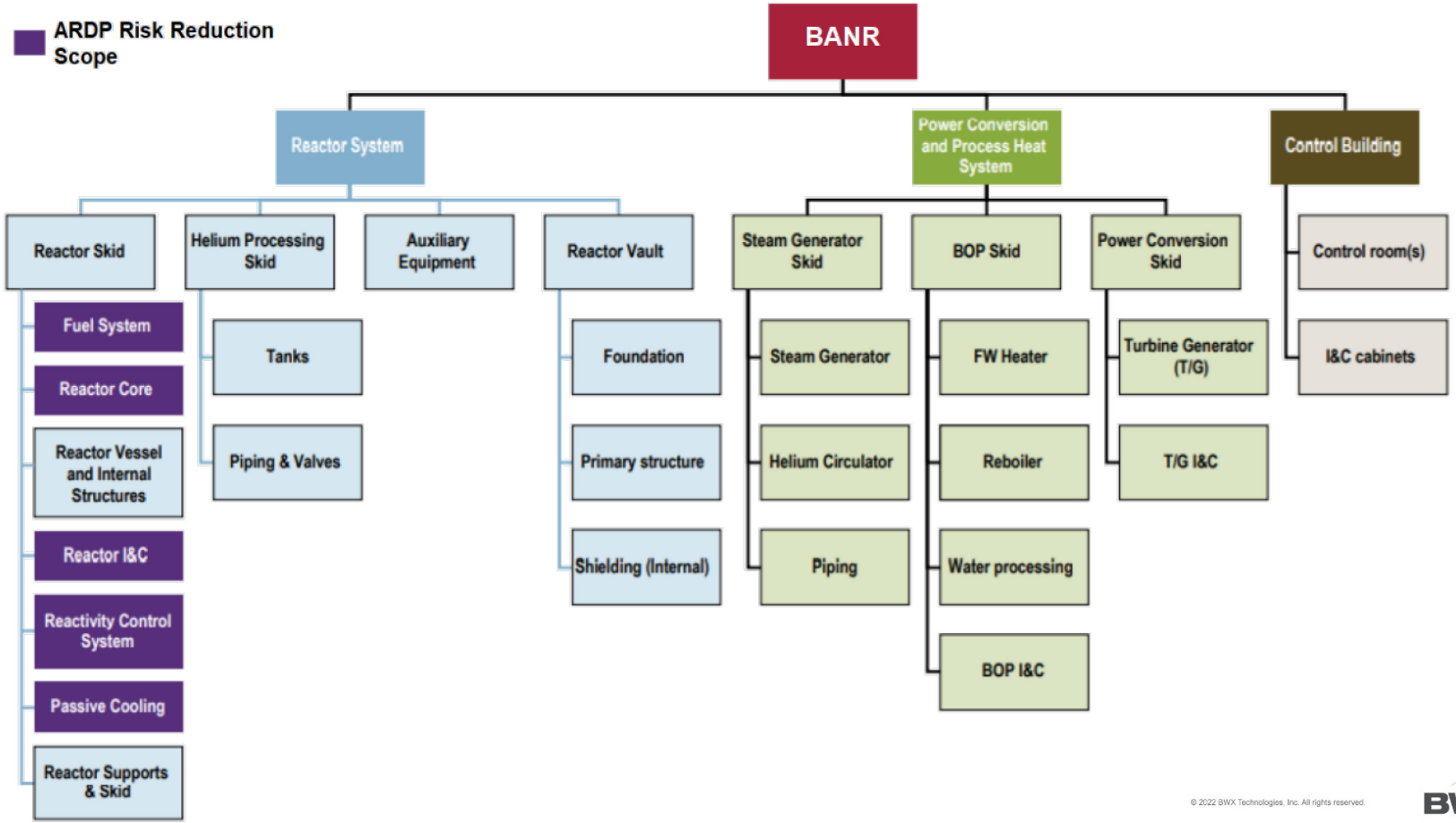
Cost Reductions Improve Market Penetration

- Increasing core power reduces the number of reactors required
- Extending core life reduces life time refueling costs
- Reducing operations and maintain cost directly reduces cost per kWhr
- Improving manufacturing through-put reduces initial capital cost and refueling cost

Target Markets:

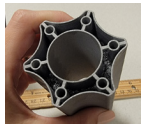
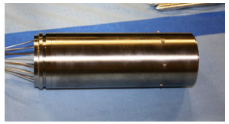
- Mining / Oil sands
- Remote communities
- Industrial process heat
- Secure off-grid power sources

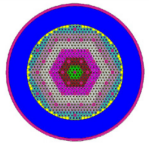
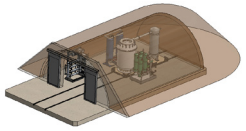
BANR ARDP Program Scope



BANR ARDP Program Scope



2021-2022	2023 - 2026	2026 - 2028	2028+
Fuel Development	**Demonstration**	**Fuel Qualification**	**Production**
○ Reactor design and manufacturing of fuel test specimens	○ Irradiation testing and in-process analysis of fuel integrity	○ Post irradiation examination ○ Development of licensing basis	○ Demonstration decision ○ Commercial implementation

Risk Reduction Program Scope

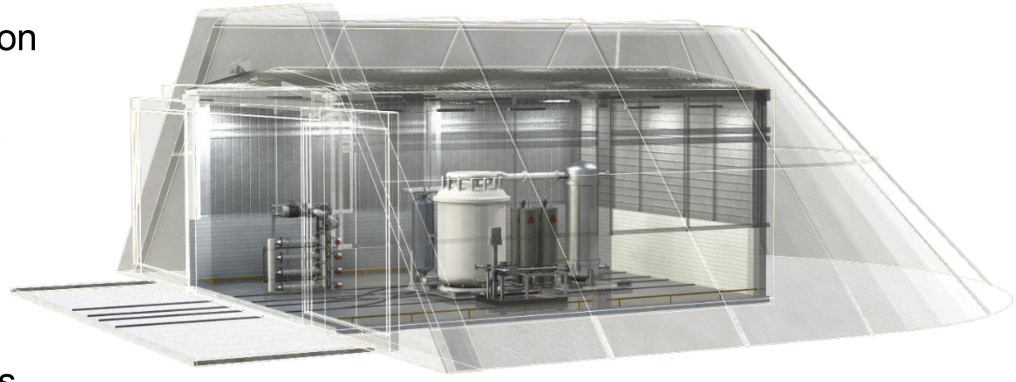
- Mature design and manufacturing technologies, improving commercial viability
- Demonstrate advanced technology applications to reduce manufacturing costs
- Develop and demonstrate high-power density TRISO fuel form for microreactors
- Focus on reactor skid: fuel system, core design, reactivity control, passive cooling, I&C

Fuel-Specific Scope

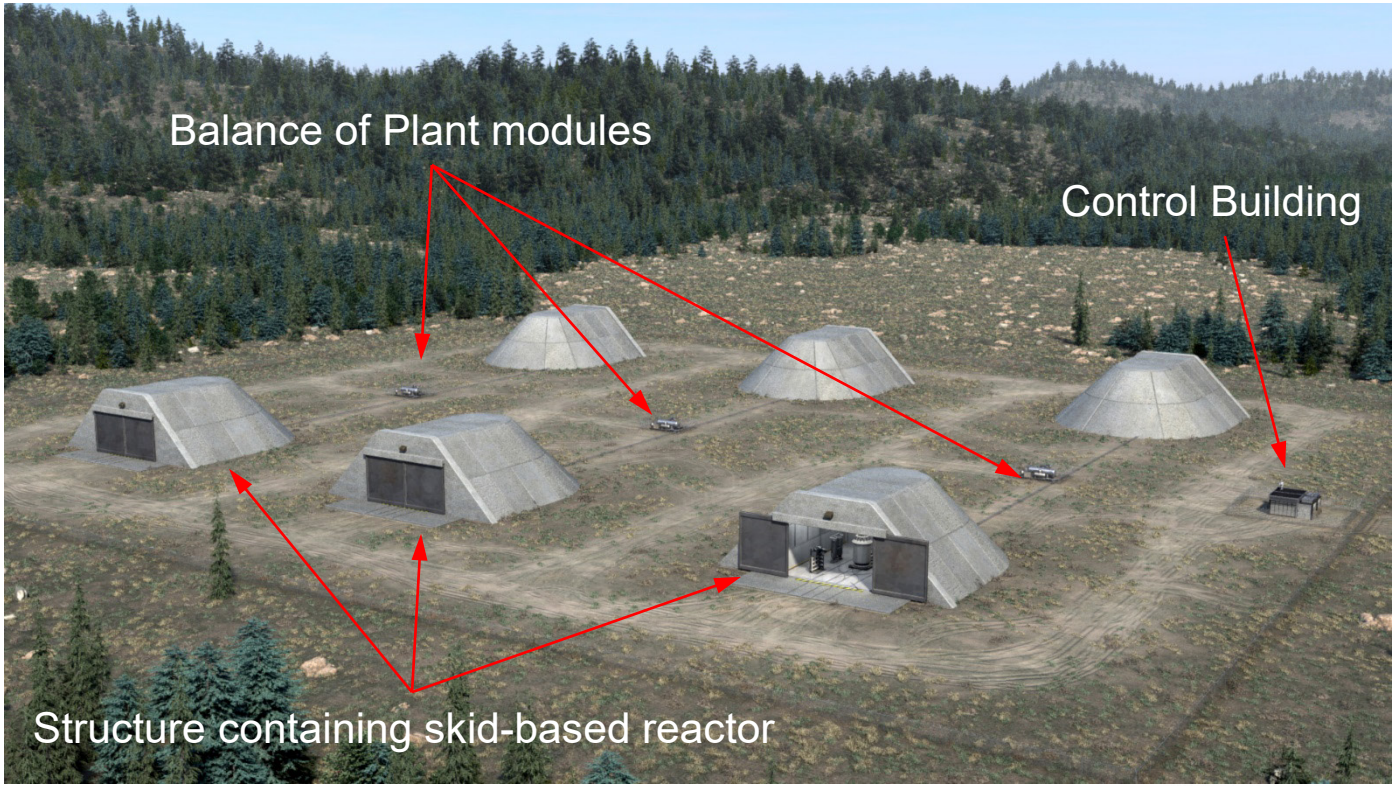
- HALEU fuel acquisition; TRISO fuel production
- Knowledge transfer from INL's AGR program and ORNL's TCR program
- Iterative manufacturing and testing of fuel elements, e.g. AM using CVI densification, element testing and characterization
- Irradiation (INL) and examination (ORNL) to advance UN fuel performance
- **Licensing activities to advance fuel form regulatory case**

BANR ARDP Program Technology

- High temperature gas (HTGR) technology proven since the 1950's
- 50 MW_{th} per reactor provides scalable solution to meet site specific power needs
- High power density fuel fabricated by BWXT enables 5+ year refueling cycles
- Five modules, each meets road and rail shipping requirements
- Flexible power conversion to provide process heat, electricity, or co-generation
- Passive cooling, inherent safety features
- Rapid modular installation and refueling

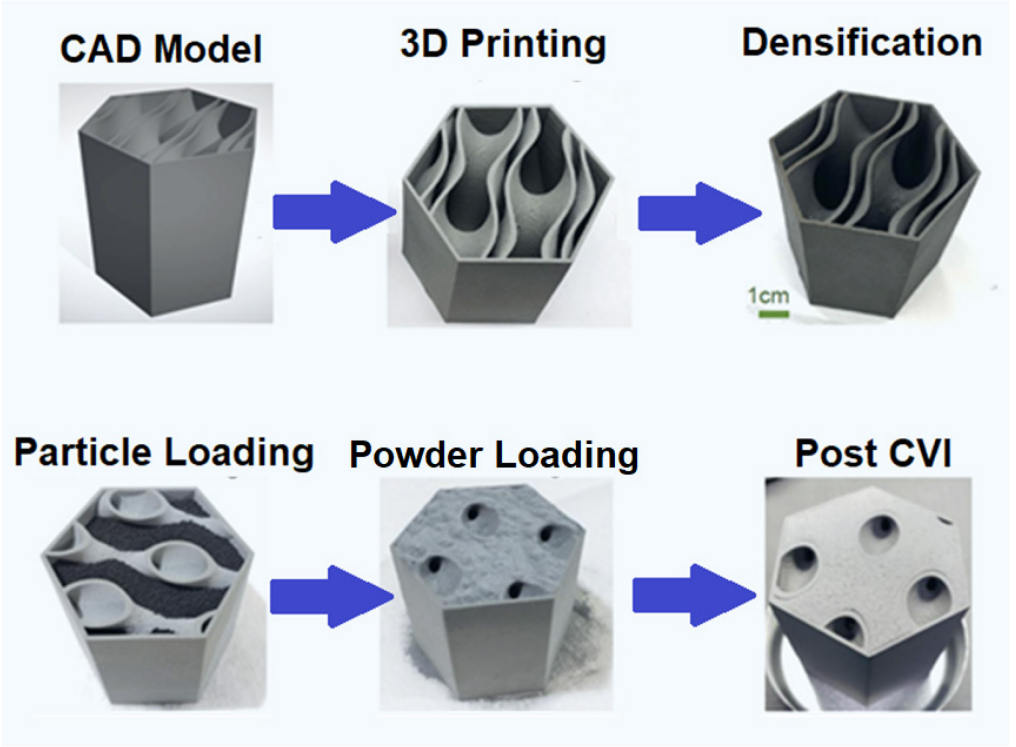


Separate modules/skids allow for factory assembly, shipping and flexible configuration for a multitude of applications



BANR ARDP Program Technology

1. CAD Model: A fuel element geometry is created in modeling software.
2. 3D Printing: Using a 3D binder jet printer, the fuel shell is built with an industrial printhead selectively depositing a liquid binding agent onto a thin layer of powder particles. This is repeated layer by layer until the fuel element shell is complete.
3. Densification: This pre-fuel loading densification step provides strength to the fuel element shell so that fuel can be loaded.
4. Particle Loading: UN TRISO fuel particles are placed into the empty fuel element shell
5. Powder Loading: A powder is packed into the fuel element filling the spaces around the UN TRISO particles.
6. Post CVI: Through chemical vapor infiltration, the interior structure is densified into a solid matrix.



TCR Fuel Element Photos from ORNL

Past Regulatory Submittals

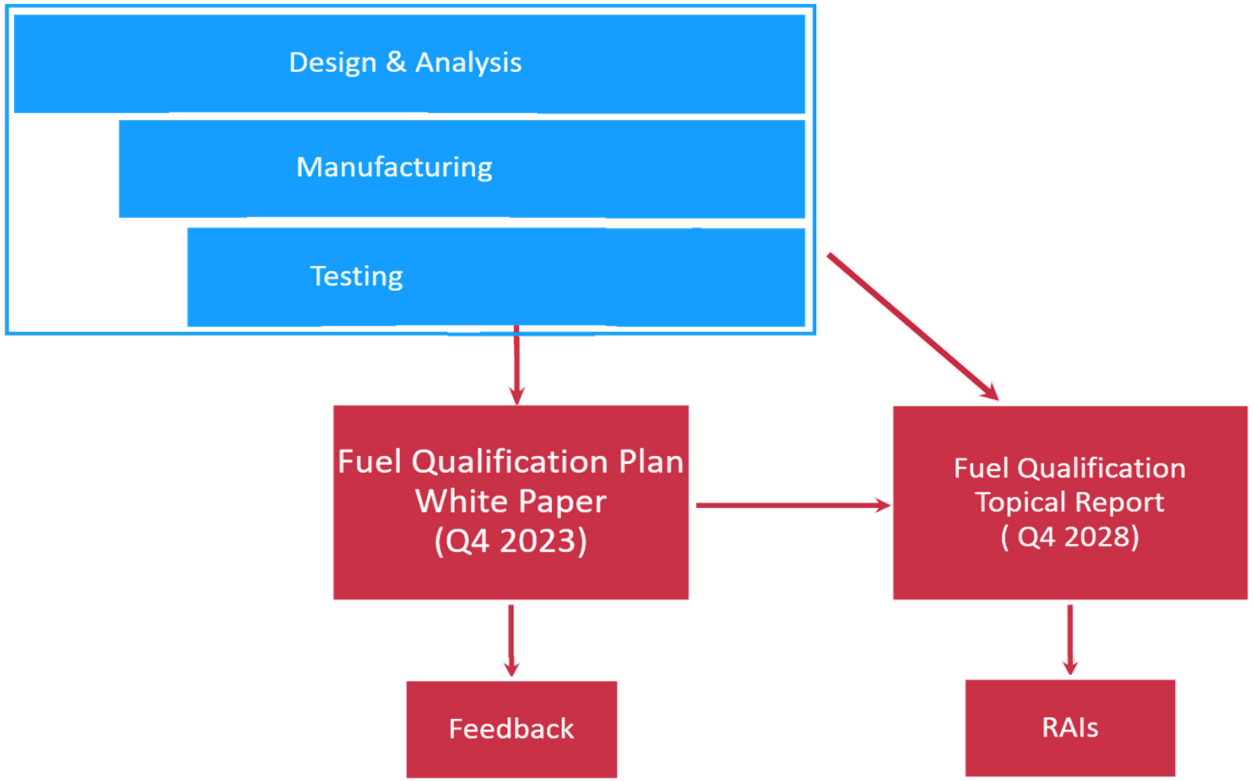
- Regulatory Engagement Plan
  - Submitted 8/31/2022; ML22243A112
  - Purpose: Establish and enhance communications between BWXT AT and NRC with the intent to increase regulatory certainty on topical and technical reports
  - Contents: Identifies the planned regulatory approach and tentative licensing submittal schedule, and defines interactions, roles and responsibilities to enhance communications.
- QA Topical Report
  - Submitted 11/30/2022; ML22335A417
  - Purpose: Establishes the quality assurance policy and assigns major functional responsibilities for BANR activities conducted by or for BWXT AT.
  - Contents: Applies to BANR activities affecting the quality and performance of safety-related structures, systems, and components including, but not limited to designing, procuring, fabricating, inspecting, handling, testing, and training.

Upcoming Regulatory Submittals

- Fuel Qualification Plan White Paper
  - Planned to be Submitted: 4Q 2023
  - Purpose: Describe the fuel qualification approach and the manufacturing and testing program
  - Contents: Includes the UN TRISO development, the Advanced Test Reactor test, the binder jet process, the CT scanner, CVI process, and data engineering plan
- Fuel Qualification Topical Report
  - Planned to be Submitted: 4Q 2028
  - Purpose: Present fuel qualification topical report
  - Contents: Fuel performance modeling, ATR test results, PIE, etc.

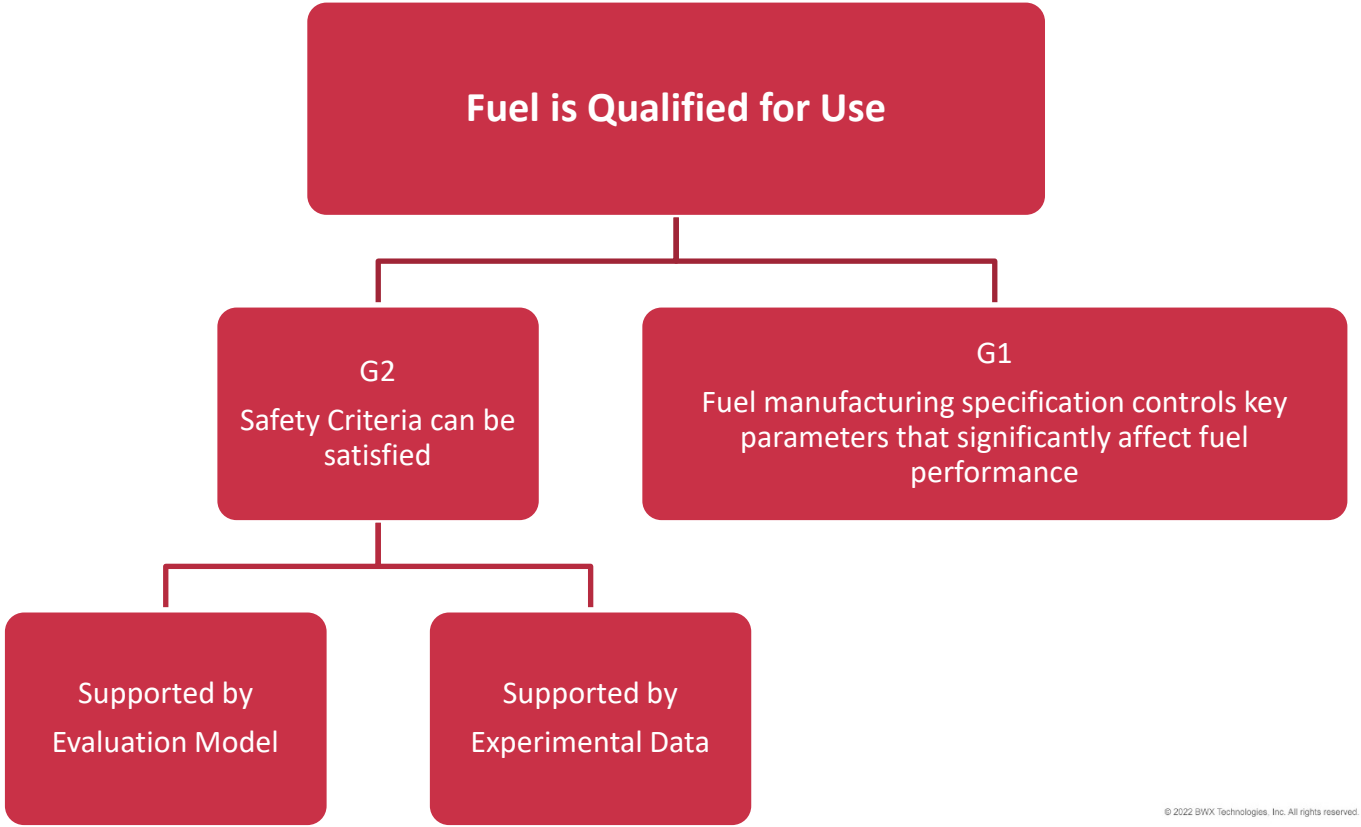
Fuel Qualification Approach

Following BWXT culture of "Design, Build, Test" to support fuel qualification

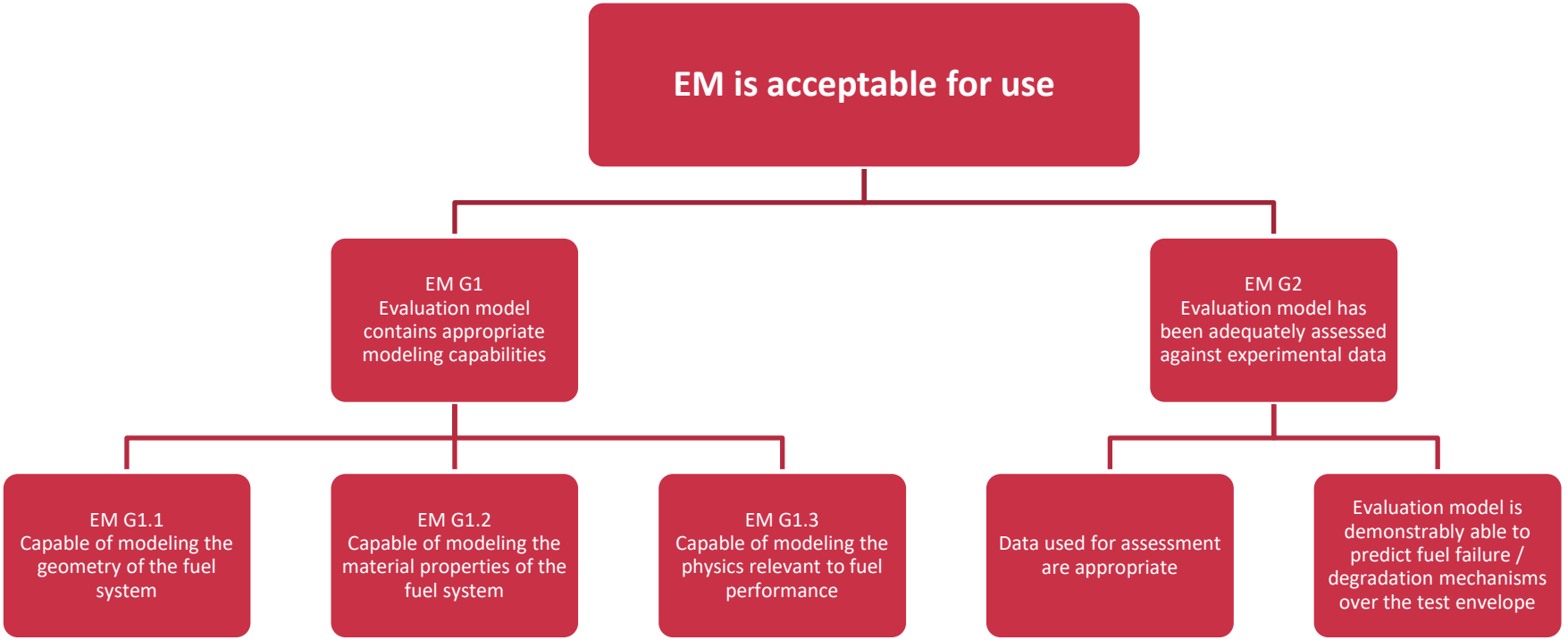


Discussion of proprietary information related to the above topics will occur during the closed session.

Fuel Qualification Assessment Framework



Evaluation Model (EM) Assessment Framework



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Proposed Content of Fuel Qualification White Paper

Fuel Qualification White Paper will provide framework for Fuel Qualification Topical Report

- TRISO particle discussion
- PIRT for Fuel Qualification
- Fuel design criteria
- Fuel performance modeling
  - Defined analytical approach
- Fuel fabrication specifications
- Test plans
- Fuel Performance

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Questions

and

Open Discussion