Progress and Lessons Learned on Advanced Construction Technologies for New Small Modular Reactor projects

RIC2023 - Session TH23

Juswald Vedovi, Ph.D.

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GE Hitachi Nuclear Energy

Overview of the DOE|NRIC ACT project and Status

Purpose:

Develop and demonstrate advanced construction technologies and processes that can transform the economics and schedule duration of new nuclear build projects, especially GEH's BWRX-300 and others SMRs

At the end of this project, the technical readiness level of the demonstrated technology shall be **TRL-6 or above**

Project Structure:

Phase 1: Detailed Design – Phase 1 of the project will detail and optimize the design of the scaled structure to be constructed, tested, monitored, commissioned in Phase 2. Phase 1 will also select the site for Phase 2 construction

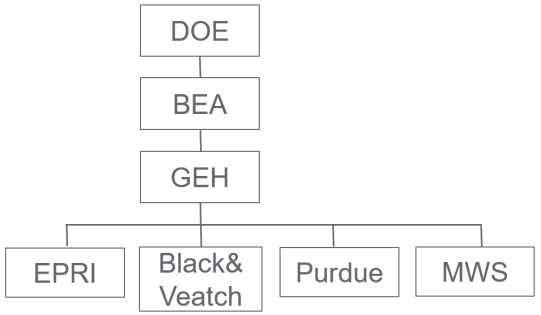
Phase 2: Construction – Phase 2 of the project will fabricate the Steel Brick™ panels, sink the shaft, construct the scaled structure, deploy the sensors and Digital Twin, test the structure, collect data, document TRL final assessment and lessons learned

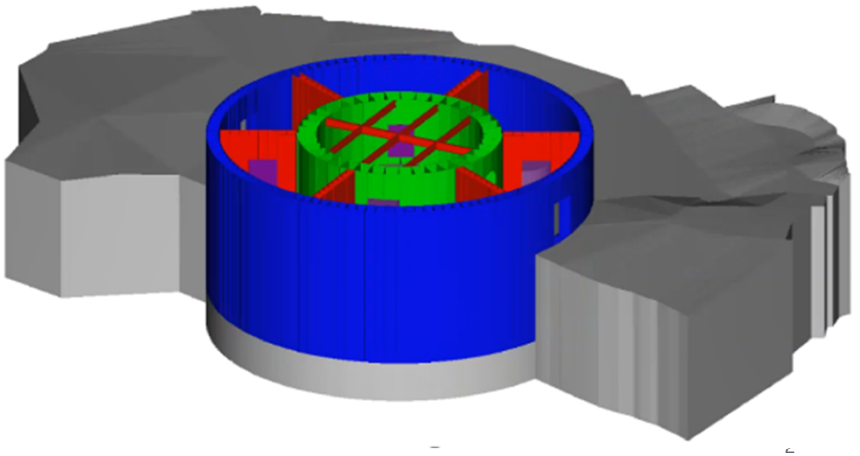
Project Duration:

Phase 1: ~14 Months – Start date Jan 27, 2022; End date Q2-2023

Phase 2: ~ 2-3 years

Phase 1 Agreement Structure





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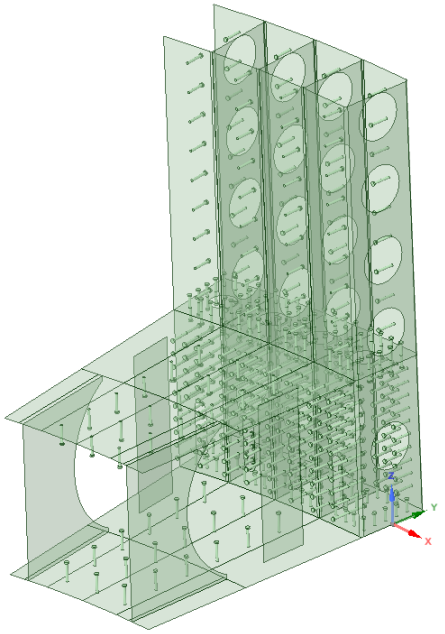
NRIC ACT Project Objectives

The NRIC project will focus on demonstrating the following technologies|aspects:

1. Steel Bricks™ system, next generation SC modules, for Seismic Category 1 structures including containments and novel techniques to integrate the modules into the basemat to avoid conventional structural attachment problems. This includes multiple aspects including the excavation technique to be used, construction sequence, prototyping and testing, etc. needed to mature the technology to the required TRL
2. State-of-the-art Digital Twin replica of the structure to integrate sensor data, support the construction, provide as-built FE models of the structures, create a databases of the utilized SteelBricks™ and enable advanced monitoring and data analytics
3. Advanced condition and performance monitoring techniques for implementing construction and in-service surveillance programs to address 10 CFR 50.65 Regulatory Inspection and Monitoring requirements as part of the Reliability Integrity Management (RIM) plan



The project will demonstrate improvement of costs and schedule of new nuclear build projects as well as significant mitigation of risk during construction to prevent cost overruns and schedule delays experienced by many new nuclear builds. This will be accomplished by leveraging the application of patented Steel Bricks™ system innovation

One goal of the project will be engaging the US NRC, CNSC and potentially other global regulators to review the techniques, evaluate inspection and acceptance criteria, and update the NRC Inspection Manuals and Inspection Procedures.

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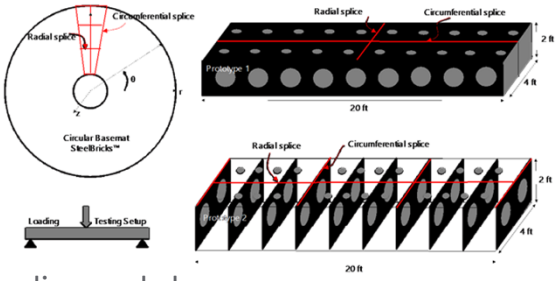
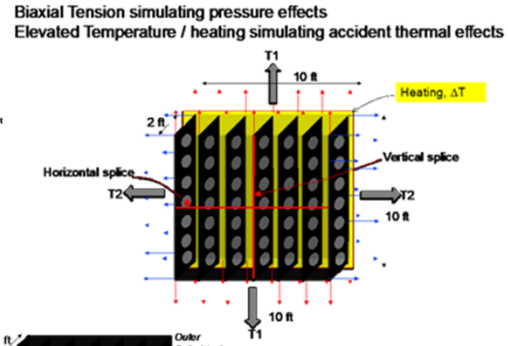
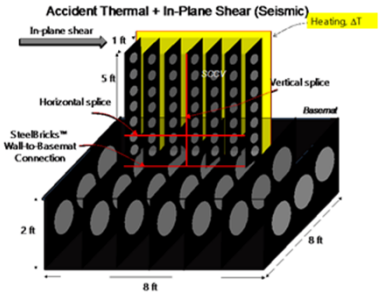
Test Matrix and objective for Phase 1 Testing Program

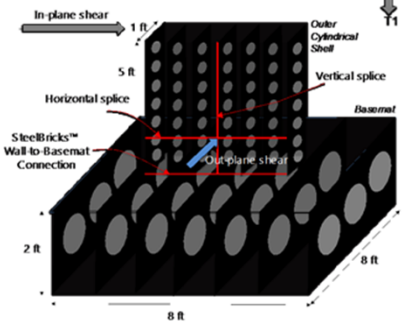
- **15 prototypes of the Steel Bricks™ components and connections of the below grade structure of the BWRX-300 including:**
  - Basemat
  - Outer cylindrical shaft and its connection to the basemat
  - Steel-concrete containment vessel and its connection to the basemat

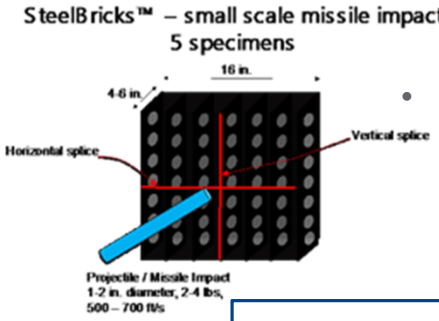




- **Test Plan includes:**
  - Out-Of-Plane bending and shear
  - Biaxial tension
  - In-Plane Shear and Thermal Loading
  - In-Plan Shear + Out-Of-Plane Shear Loading
  - Missile Impact
  - Accelerated Corrosion







- **Test Objectives:**
  - Structural Performance Assessment for Normal and Accident Condition Loads of SMRs
  - Validation of SB™ FE Models for structural analysis and design of SB™ structures
  - Verify equations used for analysis and design of seismic Category 1 SB™ containment structures

Supports GEH NEDC-33926 LTR on SB™ SCCV Structural Design to be submitted to NRC and CNSC in 202023

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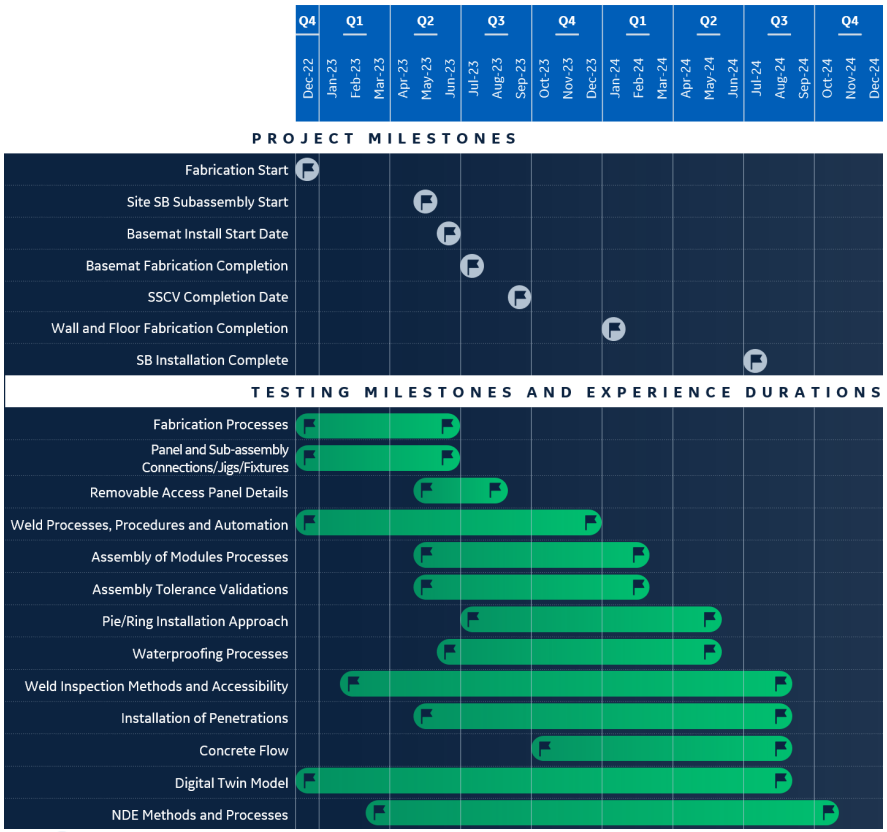
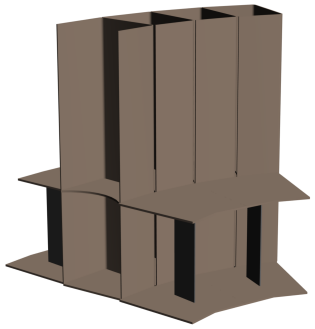
NRIC ACT Phase 2

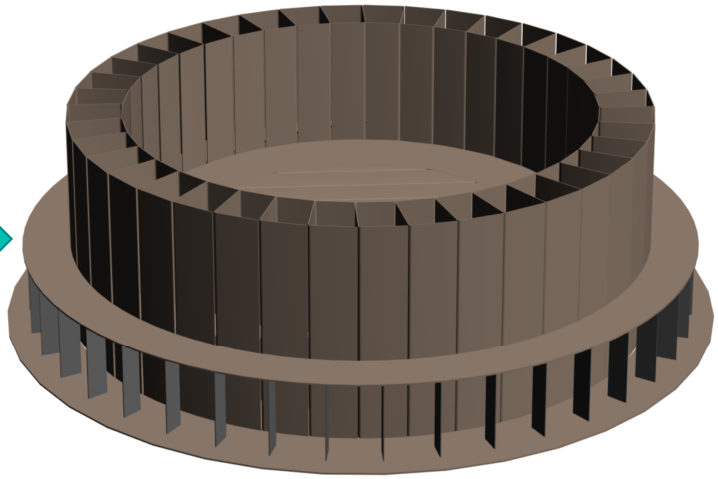
- Phase 2 needed to close the gap on identified low TRL items



- Lessons Learned gathered and shared at different stages on Phase 2 construction
- Lessons Learned to be applied for first BWRX-300 construction
- Phase 2 Key to mitigate several risks related to constructability issues of SMRs (e.g. BWRX-300)



Shipped to site



Assembled in field, outside of pit, lowered into pit

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Lessons Learned

- Initial results of SB™ for Out of Plane Shear test exceed test acceptance criteria:
  - **Significantly exceeded AISC N690 design capacity**
  - **Matched calculated capacity**
- Importance to develop a large US-based supply chain for SB™ fabricators – including qualification of welding procedures and welders
- Selection of proper welding technologies – effectiveness to improve timing and ensure consistent quality - importance to be tested prior construction
- Identify database and modularization – tremendous opportunity to reduce construction cost
- Establish a repair management program
- Consider impact of Metric vs US customary vs Imperial units for multi-country market and supply chain

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