INL/MIS-24-76625-Revision-0

IAEA ACTI Presentation

February 2024

Luke Mikel Voss

Changing the World's Energy Future

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Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Advanced Construction Technology Initiative Program

February 26, 2024

Luke Voss, Program Manager

MIS-24-76625

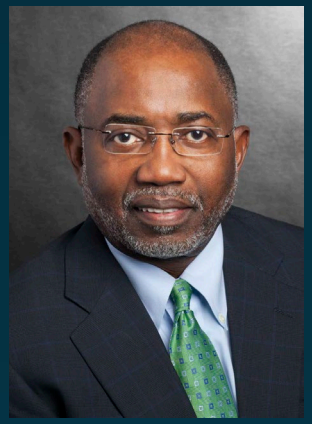
ACTI Scope

- Demonstrate Technologies to Significantly Reduce the Cost and Schedule for Construction of Advanced Reactors.
- Make these technologies available to reactor developers by the 2030s, to improve the economics of deploying Advanced Reactors.
- Selected technologies will not require major R&D efforts. Technologies are ready for demonstration for use in the nuclear environment.
- Cost-shared public-private partnership 70% DOE-NE / 30% GEH & TVA
- Phase 1: Duration 14 months;
  - Vertical Shaft Excavation
  - Steel Bricks™ - Modular Walling Systems Holdings Limited
  - Advanced Monitoring and Digital Twins
  - Learn By Doing!

NRIC INL

NRC Collaboration

- Congress recognized the importance of agency coordination in the Nuclear Energy Innovation Capabilities Act
- DOE/NRC MOU to "coordinate DOE and NRC technical readiness and sharing of technical expertise and knowledge on advanced nuclear reactor technologies and nuclear energy innovation, including reactor concepts demonstrations, through the [NRIC]."
- Monthly Coordination Calls – DOE/NRC/NRIC
- NRIC Rotations



Fred Sock
Office of Nuclear Regulatory Research

Allen Fetter
Office of Nuclear Reactor Regulation

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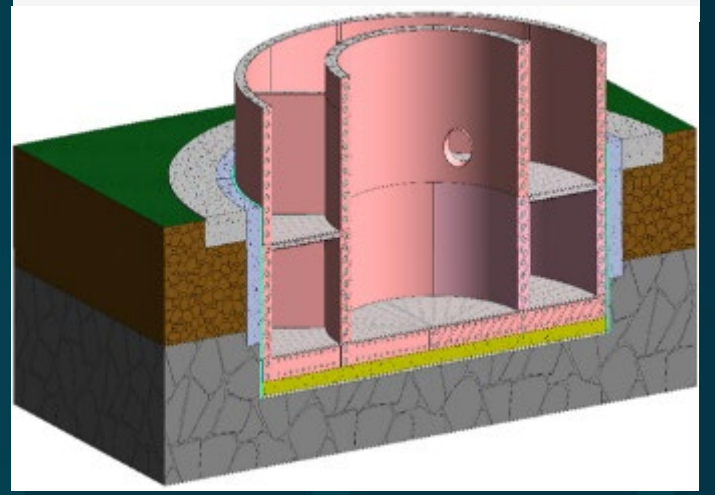
Advanced Construction Technology

- Cost Shared Project Awarded – January 2022
- Team - General Electric Hitachi
  - EPRI, Black & Veatch, Purdue, UNCC, Nuclear Advanced Manufacturing Research Centre, Caunton Engineering w/Modular Walling Systems Ltd and Tennessee Valley Authority
- Purpose - demonstrate technologies to:
  - Reduce the cost of new nuclear builds by >10 percent
  - Speed the pace of advanced nuclear deployment
- Two phase cost-shared project w/demo in FY2025
  - Vertical shaft excavation techniques
  - Steel Bricks™
  - Advanced monitoring & digital twin technology



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Steel Bricks is a trademark of Modular Walling Systems Holdings Limited

Steel Brick™ Concept

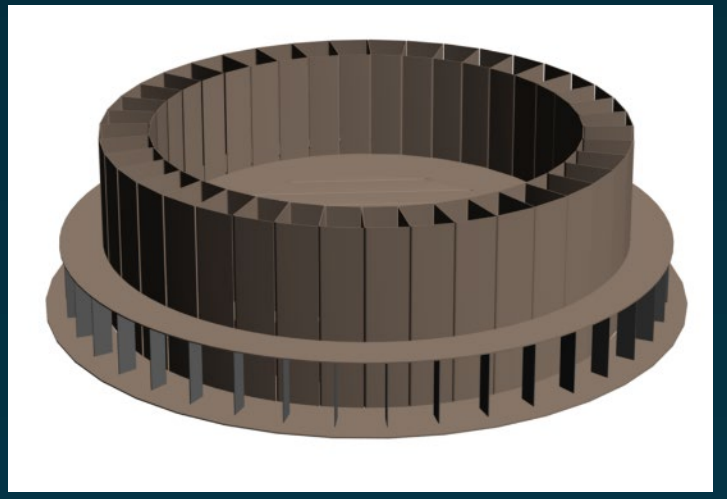
Next generation Steel Concrete Composite modules, for Seismic Category 1 structures installed in a radial configuration

Steel Brick™ Fabricated at Shop

Concurrent wall fab and excavation
Reduced schedule duration

Steel Brick™ Modules
Shipped to site

Reduced onsite work
Improved quality
Less rework



Assembled in field, outside of pit, lowered into pit

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Steel Brick™ Prototype Testing @ Purdue

- 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
  - Confirm equations used for analysis and design of Seismic Category 1 SB™ containment structures
- Results of Testing:
  - All the prototype tests completed successfully and outperformed expectations. In all testing scenarios and loading conditions, specimens met or exceeded design criteria
  - All the tests confirmed behavior and met acceptance criteria
  - Test results confirm the conservatism and applicability of the design equations being used for various parts of the structure
  - Simulated basemat, cylindrical shaft-to-basemat connections, containment vessel, vessel-to-basemat connection, reactor building walls

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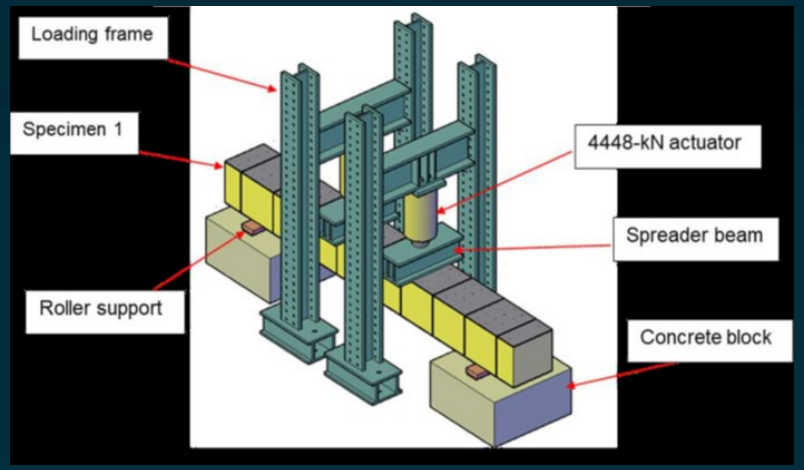
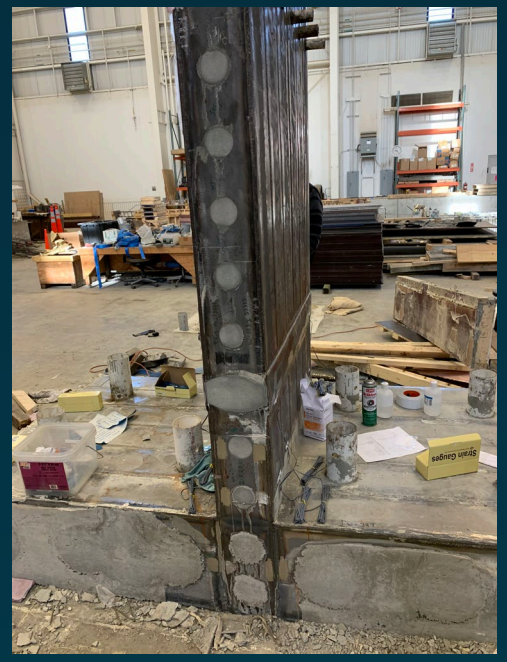
Steel Brick™ Prototype Testing @ Purdue





Digital Twin – Advanced Construction

- State of the art replica of the structure to integrate sensor data, artificial intelligence, machine learning, and data analytics. Cradle to grave monitoring
- EPRI, University of North Carolina Charlotte
- Organizes all project data by component and by life-stage
  - Each module with its own rich information, models and sensors
    - Flow of information through the modules - Back and Forth
    - Ability to query, investigate, assess conditions of individual Steel Bricks™ in the structure.
  - Semi-automated procedures to update Building Information Modeling & Finite Element Analysis models from field measurements
  - Long-term monitoring combining structural models with:
    - Earth pressure sensors (lateral stress)
    - LiDAR scans of base, shaft walls and ground surface
    - Procedures to stream data from the field for real-time decision-making via wireless transmission of sensor data

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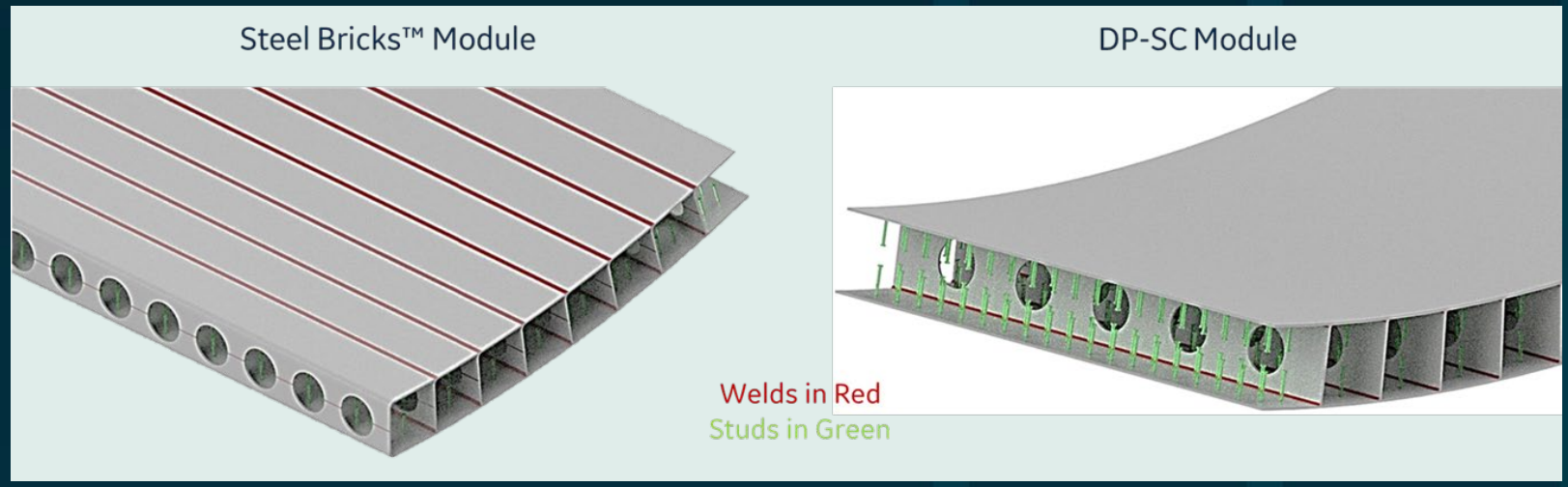
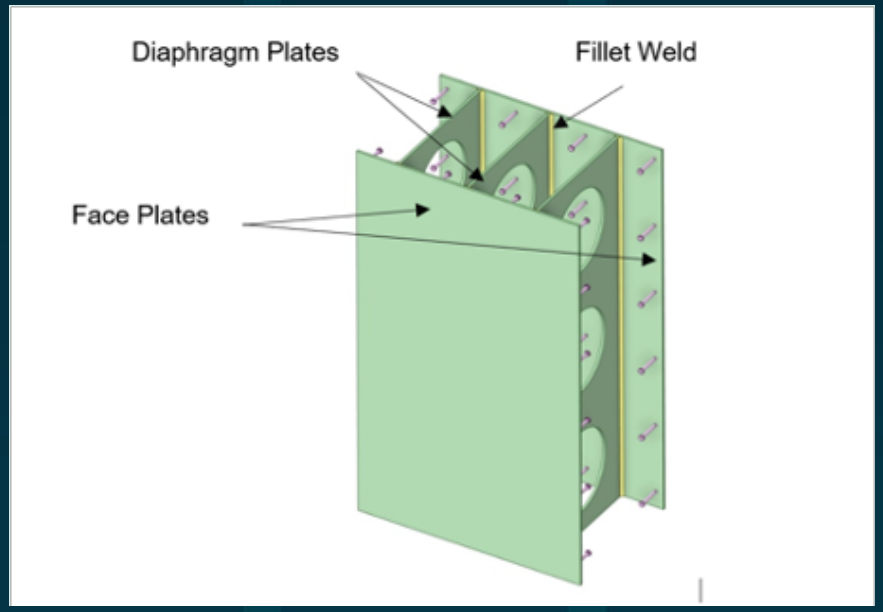
Diaphragm Plate Steel Composite (DPSC)



- From lessons learned in Phase I, GEH determined that DPSC are a better solution than Steel Bricks™ for Phase II of the ACTI Project
- Benefits over Steel Bricks™
  - Major reduction in weld volume and inspection
  - Faster to fabricate
  - Does not require post-forming heat treatment
  - Simplified fit-up
  - More cost effective



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Phase 1 Accomplishments

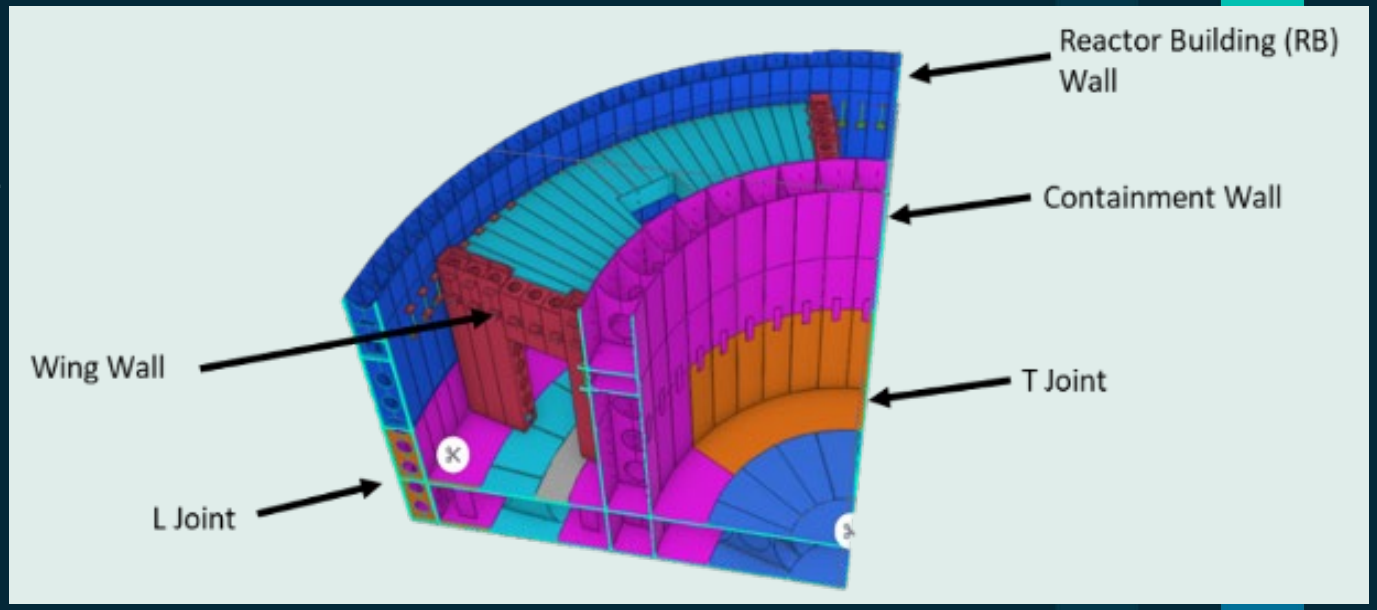
- Proved concept of fabricating Steel Bricks™ assemblies in factory setting demonstrating the ability to achieve tighter tolerances than conventional methods:
  - Demonstrated NDE methods to inspect the concrete for voids inside a steel encased brick
  - Developed welding methods using automatic devices to improve quality
  - Demonstrated the strength of Steel Bricks™ assemblies and steel composite structures in general exceed values calculated
- Determined vertical shaft construction readiness using secant piles and diaphragm walls

Phase 1 Accomplishments Continued

- Established digital twin and monitoring techniques:
  - Demonstrated digital image capture of fabricated walls; confirmed digital twin technology use to evaluate the tolerances of assembly
  - Selected technology to record and evaluate ground motion pressure and movement against reactor building
- Identified significant cost savings for this application by pivoting design from Steel Bricks™ to Diaphragm Plate Steel Composite (DPSC)
- Fully engaged NRC through the rotations of Fred Sock and Allen Fetter from NRC to NRIC

Next Steps

- Extended phase I to July 2024 (complete)
  - Design pivot to DPSC
  - Fabricate and test DPSC
  - Establish design for potential phase 2 demonstration
- Evaluate design/proposal for potential phase 2 demonstration
- Make decision on potential phase 2 demonstration
- Phase 2 scope includes:
  - Build and test structure
  - Disassemble and decommission



Benefits of Testing & Demonstration

- Bridge the gap between development and commercialization
  - Mature technology readiness and reduce risks to participants for first of a kind build
  - Facilitate partnership between technology developers, end users, national labs, universities, regulators, industrial participants
- Learn by doing reduces risks associated with first commercial build
  - Identify materials standardly available
  - Optimize design
  - Establish procedures
  - Sequencing of operations
- Builds confidence with regulators
- Develops supply chain

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Thank you!

Questions?