INL/MIS-22-65989-Revision-1

NRIC 2022 Program Review Session 3

March 2022

Ashley E Finan, Trina M Davis, Alison M Conner, Jason P Andrus, Stephanie G Weir, Evans Damenortey Kitcher, Christine Marie Williams

Changing the World's Energy Future

Idaho National Laboratory

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NRIC Program Review

February 15, 2022
NRIC Program Review, Session 3

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Stakeholder Engagement

River Bennett & Wendolyn Holland, Stakeholder Engagement PMs
Dr. Ashley Finan, WP Manager

Stakeholder Engagement (SE) Team Overview

Team Member	Roles & Responsibilities	Affiliation
River Bennett	SE Strategy, Maritime Sector Engagement	University of Michigan (UM), Fastest Path to Zero (FPTZ)
Wendolyn Holland	SE Strategy, Tribal Education for NRIC	Local & Regional
Emily Nichols	Web/social/communications support	INL
UM, FPTZ, ANL, ORNL	Siting Tool for Advanced Nuclear Development	

Milestones:
M2RC-22IN0202014-Launch NRIC Siting Tool for Advanced Nuclear Deployment and provide access to users – Completed on time in January 2022
M2RC-22IN0202012-Complete annual report on FY21 NRIC stakeholder engagement activities to support advanced reactor demonstration efforts: Expected 09/15/2022

*Other work scopes not covered herein

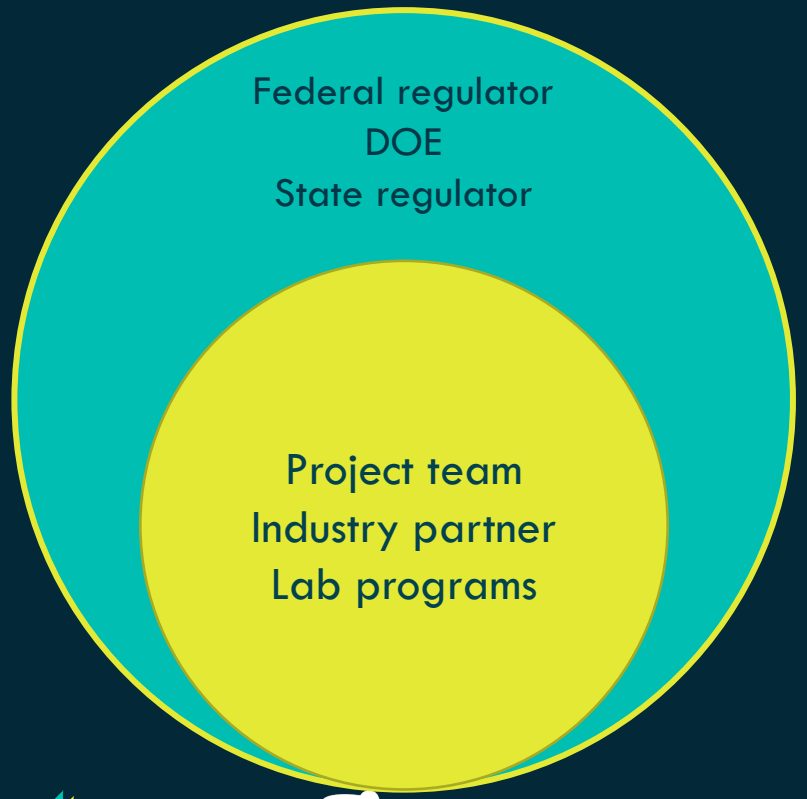
Budget Summary

- FY-22 total funding: $801,209 ($0 in new BA and $801,209 in carryover from FY-21)
  - FY-22 budget: $801,209
  - Labor: $244,053 (1.5 FTEs)
  - Non-labor cost 1: $49,445 for meetings and engagement
  - Additional Labor (SMEs for NRIC Resource Team as needed): $200,000
  - Travel: $10,000
  - Subcontract: $247,711 for work with University of Michigan on Siting Tool for Advanced Nuclear Development
  - Subcontract: $50,000 for communications strategy and execution support.
- FY-22 planned carryover: $0.

Defining "Stakeholder"

NRIC SE Team's definition is more expansive than conventional definitions by considering a longer list of entities that each have some combination of interest in and influence on advanced nuclear projects

Traditional Stakeholder Map



External stakeholders

Internal stakeholders

NRIC SE Map

Modernizing Stakeholder Engagement Strategies for Advanced Nuclear

Stakeholder Engagement, Why does it matter?

Risk Reduction

Nuclear energy carries special needs for stakeholder engagement because of the broken social contract, established over many decades and from which advanced technologies cannot escape.

Multiple industries today use stakeholder and community engagement strategies to actively solicit feedback during project design and implementation phases. These industries include renewable energy, toxic waste siting, oil and gas, mining, public health, and urban planning.

SE Scope: The Importance of Risk Reduction

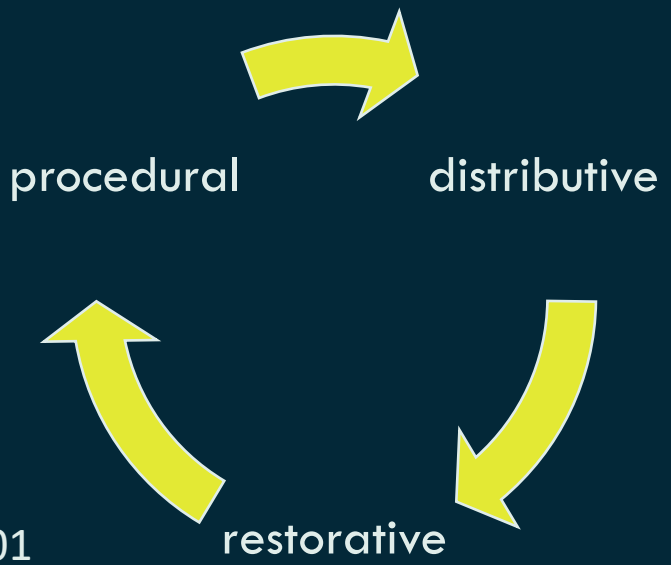
Due in part to both community and state opposition, advanced nuclear energy projects are not immune to scheduling delays and increased costs

- Here in Idaho, the 1995 Settlement Agreement is a key policy element
- Past and Present examples
  - TX Gov. Abbot signs law banning HLW storage
  - DOE's failed Dakota boreholes project
- All amid the Administration's return to <Consent-Based Siting> for waste

Stakeholder Engagement for Addressing Environmental Justice

- Environmental justice can be framed in terms of:
  1. Procedural justice: access to decision-making.
  2. Distributive justice: imbalanced costs and benefits.
  3. Restorative justice: addressing legacy impacts.
- When unaddressed, these issues can create a vicious cycle
- **This is preventable through soliciting active involvement from impacted communities from the start.**

Well-designed stakeholder engagement programs have the potential to help prevent this cycle from restarting within the context of the buildout of clean energy infrastructure in the 21st century.



SE Project Overview: Current Activities

- Stakeholder Engagement Strategy drafting & implementation plans
- Introducing NRIC and advanced reactors to key regional stakeholders
- Analysis of regional issues that have developed since 1st wave of nuclear innovation
- Avail ourselves to vendors as well as to other states & communities seeking to adopt advanced reactors
- Supporting early “road mapping” exercises with Alaska stakeholders
- Engagement and DOE-funded research with Maritime sector
- Tribal education for NRIC team and partners.

SE Strategy – Alignment with NRIC milestones

NRIC Milestone		Stakeholder Strategy
2021	Coordination: Establish resource team and multi-lab cooperation modes.	Phase 1: • Historical research and stakeholder mapping. • Early engagement and relationship building with key stakeholders in Idaho and neighboring states via meetings with Dr. Finan and INL leadership. • Addressing early stakeholder questions and concerns.
2022	MARVEL: Demonstrate MARVEL	
2023	Test Bed Construction: Complete design and begin construction of demonstration test beds. MSTEC: Completion and commissioning of MSTEC. Siting: Prepare and support sites for advanced reactor demonstrations.	
2024	Advanced Construction: Demonstrate advanced construction technology in partnership with industry.	Phase 2: • Expanded community and regional engagement at each of NRIC's. demonstration locations. • Partnership development and public engagement campaigns.
2025	Two by 2025: Two advanced reactor demonstrations up and running by the end of 2025.	
2025 - 2030	Commercialization: Multiple advanced reactors operating commercially.	Phase 3: • Broader engagement with energy and climate industries looking to see and interact with advanced reactors (in real life).

SE Alignment with NRIC Technical Mission & Goals

Supporting the technological innovations taking place in industry, at the national labs, and in U.S. universities requires innovation beyond the scope as well.

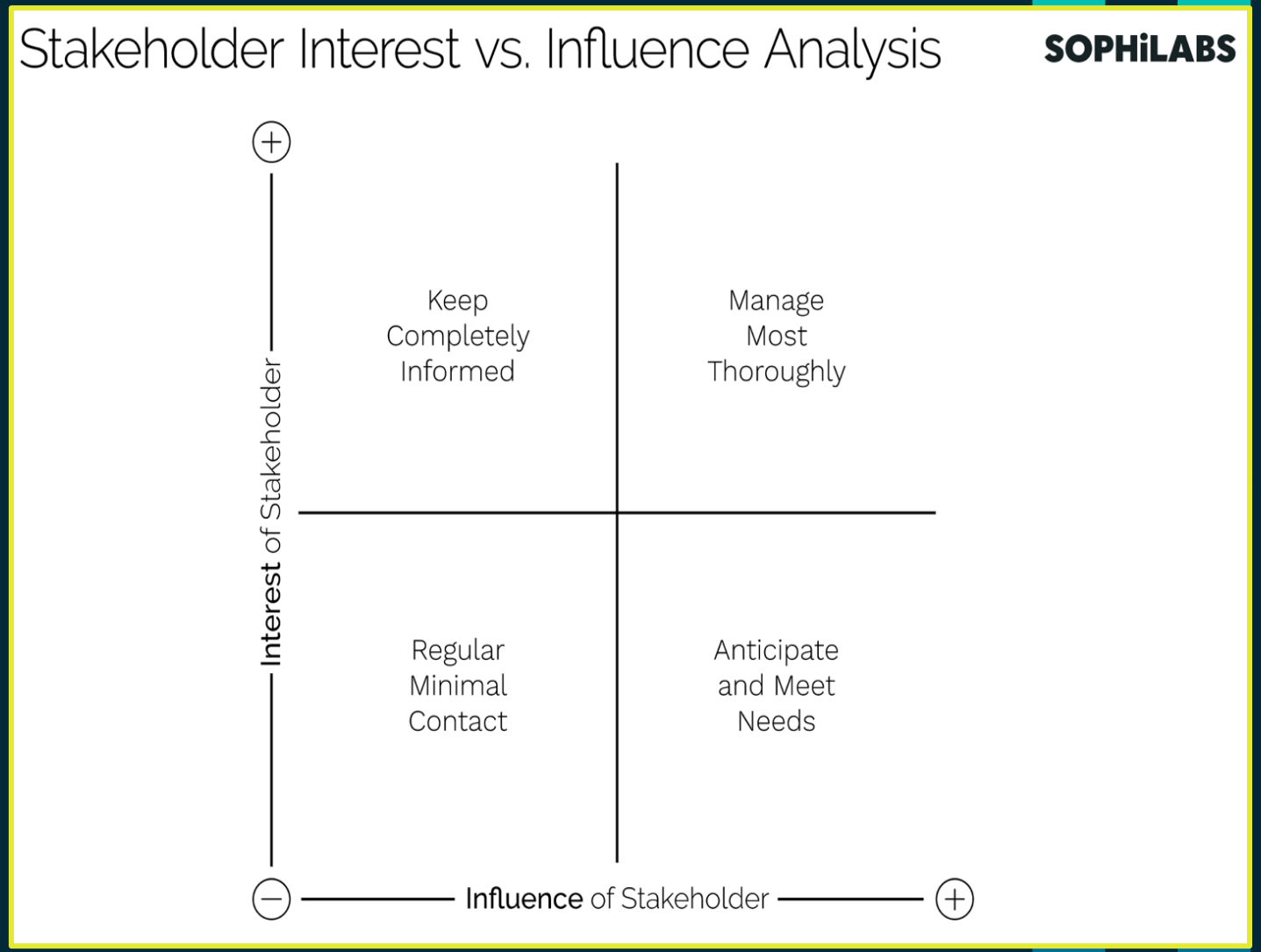
Departing from "Decide-Announce-Defend" (DAD) strategies and mentalities in favor of a more involved community and stakeholder engagement strategies helps to build relationships where previously there may have been conflict. This applies largely to the overarching siting and construction phases for advanced reactors.

Addressing Public Acceptance: We can't get everyone on board, but we aim to increase acceptance by learning from stakeholders who have been historically neglected.

SE Tools: Stakeholder Identification and Mapping

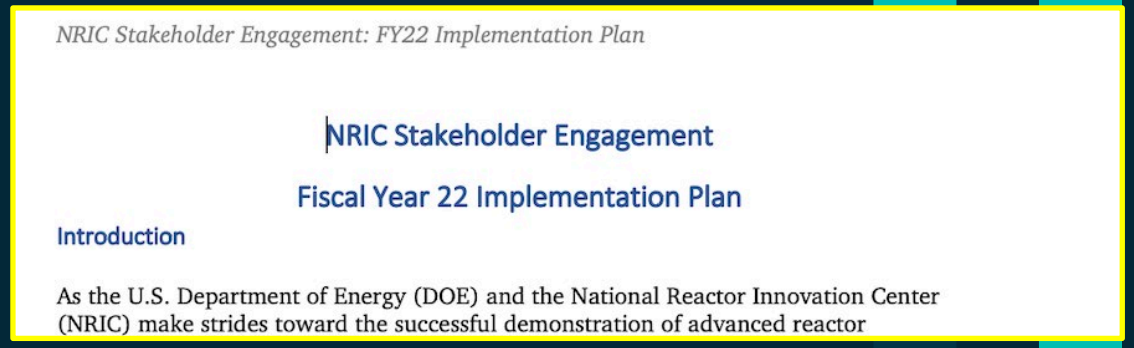
Initial stakeholder mapping completed with INL's Government Relations Team in Boise. Focused on identifying high-priority stakeholders to begin building relationships with. Details contained in:

- **FY-22 Strategy document:** overarching approach and strategy for NRIC stakeholder engagement
- **FY-22 Implementation Plan:** actions to take during FY-22 to begin accomplishing Phase 1 goals.



SE Accomplishments

- Strategy and FY-22 Implementation Plan
- Dynamic Stakeholder list
  - ~45 priority individuals and orgs.
- Maritime Engagement
- Tribal Education, in line with DOE Order 144.1
- FY-21 SE + Comms Report.



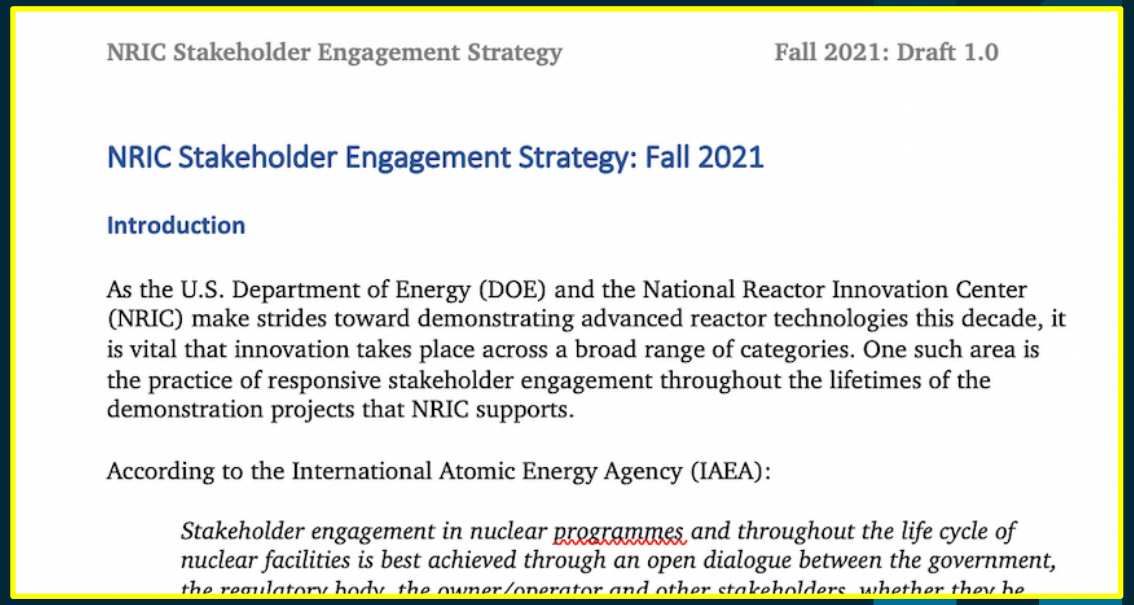
NRIC Stakeholder Engagement: FY22 Implementation Plan

NRIC Stakeholder Engagement

Fiscal Year 22 Implementation Plan

Introduction

As the U.S. Department of Energy (DOE) and the National Reactor Innovation Center (NRIC) make strides toward the successful demonstration of advanced reactor



NRIC Stakeholder Engagement Strategy Fall 2021: Draft 1.0

NRIC Stakeholder Engagement Strategy: Fall 2021

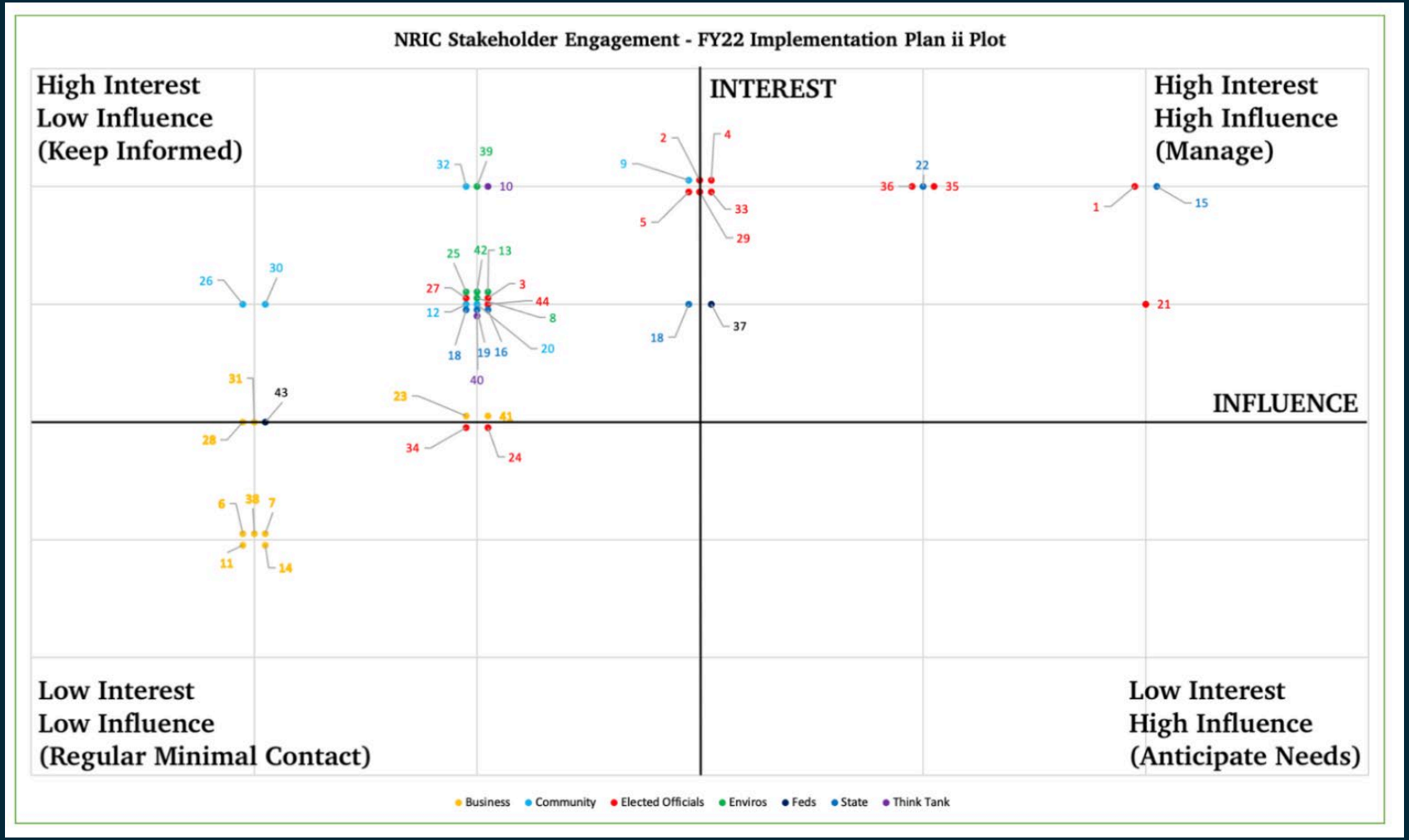
Introduction

As the U.S. Department of Energy (DOE) and the National Reactor Innovation Center (NRIC) make strides toward demonstrating advanced reactor technologies this decade, it is vital that innovation takes place across a broad range of categories. One such area is the practice of responsive stakeholder engagement throughout the lifetimes of the demonstration projects that NRIC supports.

According to the International Atomic Energy Agency (IAEA):

Stakeholder engagement in nuclear programmes and throughout the life cycle of nuclear facilities is best achieved through an open dialogue between the government, the regulatory body, the owner/operator and other stakeholders, whether they be

SE Tools: Stakeholder Identification and Mapping



Two Types of Risk the SE Team Faces

Programmatic	Substantive
Team bandwidth	"Hide-out" Fail: we do not try hard enough (or lack sufficient resources). Result is the status quo. Or worse. • NRIC name is not associated with vendors' success • NRIC and vendors fail to meet 2025 goal b/c public perception impedes progress
Misalignment b/n our strategy and DOE	"Heroic" Fail: we bravely attempt big leaps that don't land gracefully. Result • Running afoul of INL or DOE • Missing the mark
Insufficient exposure (NRIC not "everywhere"): we need attention regionally and in Washington D.C., proportional to our technological accomplishments	Project delays
1995 Settlement Agreement	Potential project impacts

SE Upcoming Projects

- Implementing FY-22 engagements
- Begin work on FY-23 Implementation Plan
- State-level engagement and road-mapping with Alaskan stakeholders
- Working with NRIC team on sci-comms: how to communicate our work and publications to the public
- Learning from the vendors about their SE plans, including their statements on waste
- US NIC April Sun Valley event: well-poised for spotlight
- Making Voices Count: NRIC's vendor-focused stakeholder engagement initiative to learn best practices in stakeholder and community engagement from neighboring industries
- Continued Maritime engagement and Tribal education work
- Building out network of SE specialists (within and outside the lab system).

Stakeholder Engagement Summary

The primary reason for NRIC's concerted effort on Stakeholder Engagement is

Risk Reduction

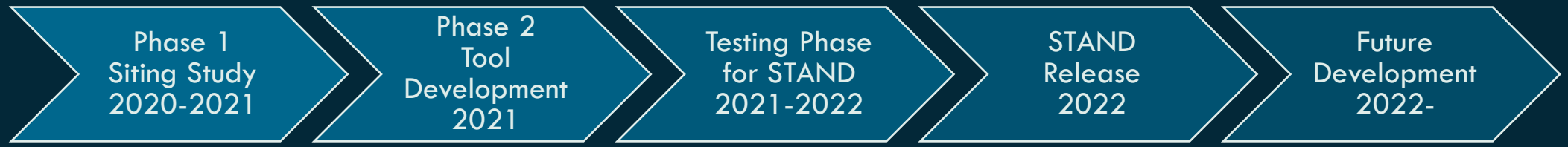
- Among the primary barriers to AR adoption is public acceptance
- "Walking the Talk" our innovations in SE mirror and support those on the tech side.

<u>Up Next</u>

- Significant Idaho and regional activity
- Deeper connection with vendors
- Expanding work with other states.

Siting Tool for Advanced Nuclear Development - STAND

Timeline



Timeline	Notes
Phase 1	• Individual tools from participating organizations were utilized for select sites for demonstration • Public report available on OSTI (https://publications.anl.gov/anlpubs/2021/04/167516.pdf)
Phase 2	• Integrated tool development • Meeting and input from social science academics and industry members
Testing Phase	• Internal and beta testing • Issues and bugs resolved
STAND Release	• Tech Talk • STAND training sessions
Future Development (possible)	• Expansion of the tool to include more areas • Updates and improvements based on user needs and input

02/14/2022 INL/MIS-22-65989-Rev001

NRIC INL FASTEST PATH TO ZERO UNIVERSITY OF MICHIGAN OAK RIDGE National Laboratory Argonne NATIONAL LABORATORY

Siting Tool for Advanced Nuclear Development - STAND

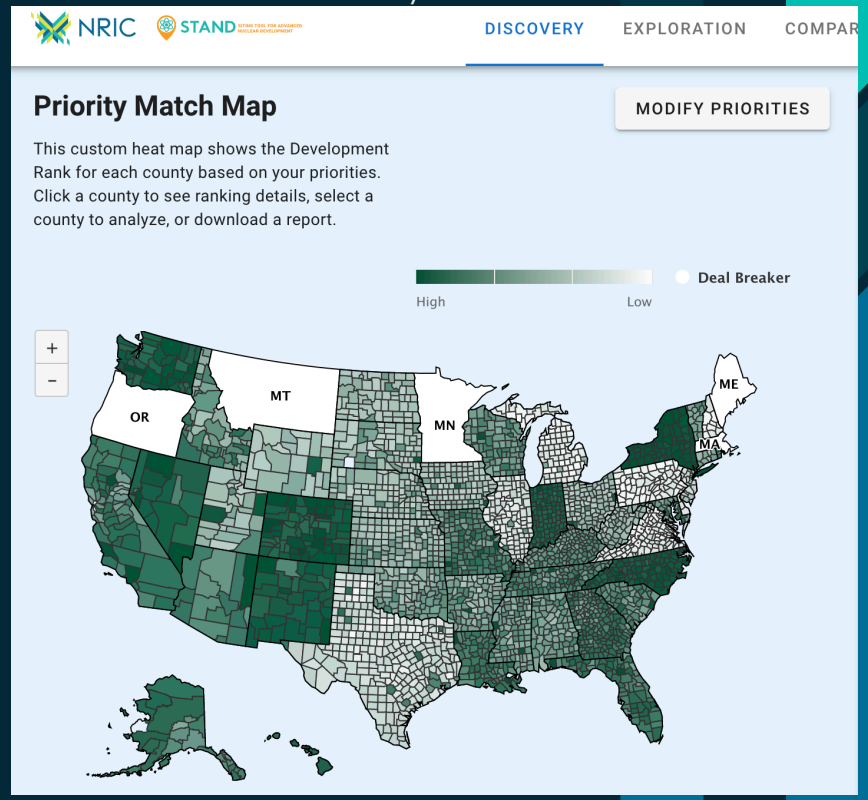
Provides a systematic way based on user siting preferences and priorities to:

Discover areas that may be a good fit

Explore areas to identify specific sites

Compare sites to identify an optimal option

Launched at January 26th Tech Talk https://nric.inl.gov/nric-tech-talks-stand-tool/



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NRIC INL FASTEST PATH TO ZERO UNIVERSITY OF MICHIGAN OAK RIDGE National Laboratory Argonne NATIONAL LABORATORY

Thank you!

Questions?
Time Permitting

Contact: holland@wendolynholland.com

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NRIC Resource Team

Trina Davis

NRIC Resource Team Program Overview

In support of NRIC's mission to accelerate the commercialization of new reactor concepts and technologies, effectively advancing the U.S. in nuclear leadership, the NRIC Resource Team Program was developed in 2020. This program provides a quick, efficient route for qualified nuclear demonstration projects to receive 200 hours of support from national laboratory subject matter experts (SMEs) in areas such as, but not limited to: siting, fuel qualification, NEPA guidance, system modeling and analysis, regulatory consultation, and Phenomenon Identification and Ranking Table (PIRT) review.

- National Labs providing SME Support: Idaho National Laboratory (INL), Argonne National Laboratory (ANL), Oakridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL).
- Resource team program manager: Trina Davis (INL). National laboratory leads: Chris Grandy (ANL), Mark Nutt (PNNL), and Andrew Worrell (ORNL).

NRIC Resource Team Program Progress

FY21 Resource Teams

>Kairos KP-FHR
>Radiant ARDD-6 Kaleidos
>MicroNuclear Molten Salt Nuclear Battery
>Westinghouse Lead Fast Reactor
>GERA Ace Engine Demonstration

Some areas supported:
-Oxidation and strength testing
-Tritium management
-Graphite materials and qualification
-System analysis
-Simulation setup
-Consultation on fuel handling
-Consultation on licensing and design
-Simulation analysis.

FY22 Resource Teams as of 1/31/22

>USNC Micro Modular Reactor
>Radiant ARDD-6 Kaleidos Reactor
>Westinghouse Lead Fast Reactor
>MicroNuclear Molten Salt Nuclear Battery
>ARC Clean Energy Disposal Justification

Scope requested:
-TRISO fuel qualification
-Irradiation test design evaluation
-NEPA guidance –Emergency Preparedness
-Hydride and cladding system development,
-Graphite and fuel regulatory consultation thermal hydraulic SAM development
-PIRT review.

- NRIC program leads currently working with 3 new candidates for resource teams.
- Upcoming Milestones: September 2022- Annual report. Teams will provide feedback report or memo in August 2022 which will be utilized to draft the report.

NRIC Resource Team Program Funding

Funding needs solely depends on the number of teams approved. As each team is screened, funding is evaluated for approval. Each team averages $70K for the 200 hours of technical support.

Resource Team Budget Memorandum Purchase order (MPO), DOE Work Package (WP)

National Laboratory	FY21 Used	FY22 Provided as of 1/31/22
ANL	WP 39k, MPO 60K	WP carryover 8K, MPO 85K*
INL	WP 92.6K	WP 100K, WP carryover 20k
LANL	MPO $15K	
LLNL	MPO $64.5K	
ORNL	WP 1.2K	WP Carryover 17K, MPO 45k
PNNL	WP .7K	WP Carryover 17K, MPO 45k
* In discussion		

Risk Management plan in place with minimal risks. Main risk is not having enough funding to cover the demand.

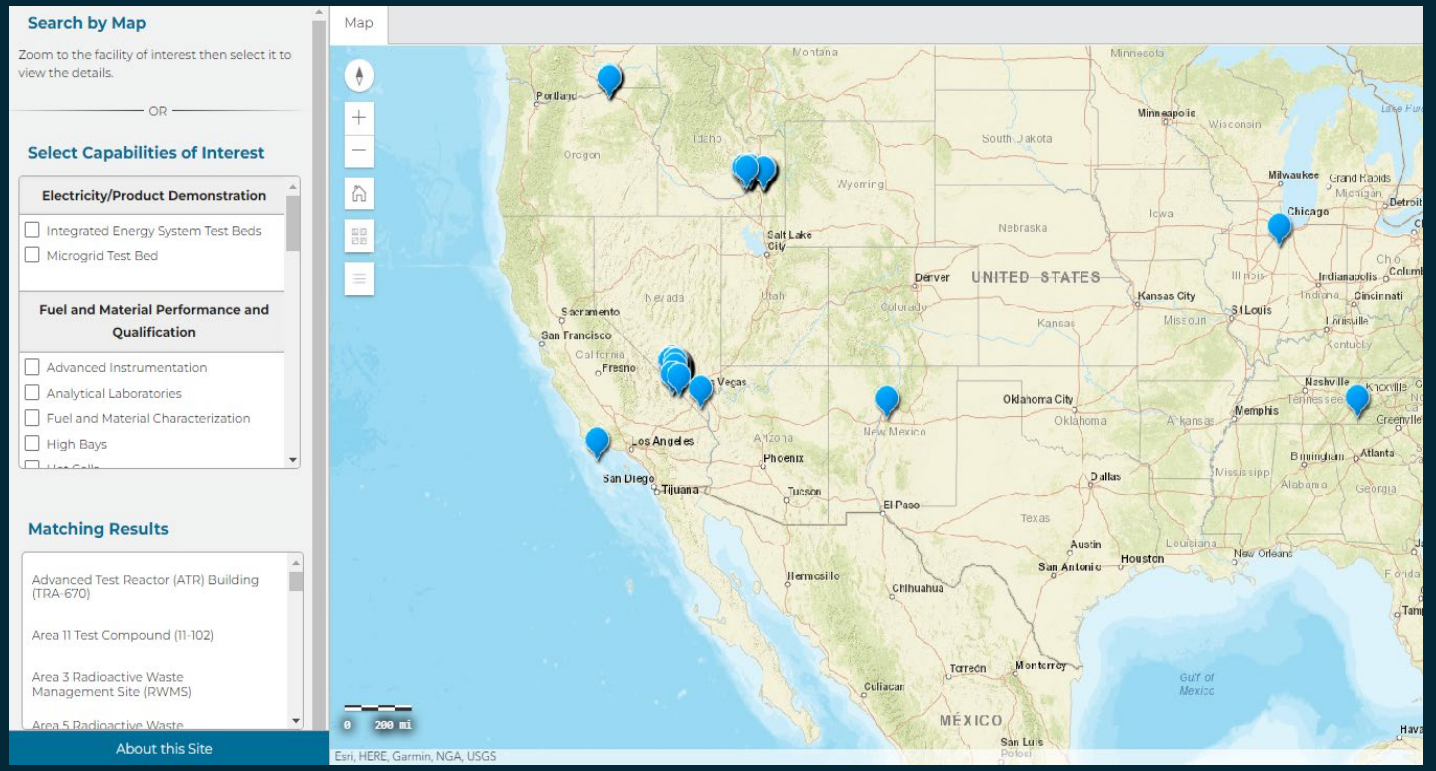
NRIC Resource Team Program Process

- Innovator inquires about program
- Innovator completes screening application requirements
- Application review for approval (which includes funding review)
- Innovator notified of decision
- If approved, innovator provided scope or work for approval
- Technical agreement established and NDA, if needed
- Initiation of support
- Hours controlled by innovator, tracked by NRIC program manager
- NRIC program manager tracks scope to completion
- Innovator provides feedback or summary of assistance to program manager.

NRIC Demonstration Resource Network

Map of DOE lab resources most relevant to demonstrations to help innovators find key capabilities. National labs currently featured on the tool are:

- Argonne National Laboratory
- Idaho National Laboratory
- Los Alamos National Laboratory
- Nevada National Security Site
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory.



https://nricmapping.inl.gov/

NRIC Resource Team Program Summary

Per industry innovators, this program allows for rapid direct access to leading national laboratory experts in select areas of nuclear research, development, deployment, and demonstration to fill knowledge gaps, support analyses, and aid in risk reduction development areas to further nuclear demonstration success.

Positive Feedback About NRIC Resource Team

- ***NRIC Resource Team support*** *has been critical in the design progress made by [company] in 2021 and* ***is the single most flexible and rapid federal support we have experienced to date.***
- ***Both of our NRIC partnerships have provided valuable interactions*** *in understanding the scope of some technical challenges, where the researchers are clear leaders in their technical area, and where access to other knowledgeable technical experts is very limited. We look forward to continued engagement with these experts in executing on analytical and experimental programs that would take considerable resources for us to accomplish otherwise.*

- *I wanted to take this opportunity to again thank you for facilitating NRIC support for our reactor development toward demonstration and provide an update on progress. As you know Argonne National Laboratory is constructing a SAM model of our … design…. Information critical to model construction has been discussed and transmitted.* ***Valuable technical feedback and questions*** *have prompted us to conduct further design optimization evaluations and improvement opportunities.*
- *This independent … V&V effort, coupled with the modest government support,* ***has helped build stakeholder confidence and allow [company] to continue on a path toward commercialization.*** *This grant also helped identify a few potential ongoing collaboration opportunities with LLNL, which we hope to explore in the future.*

Thank you!

Questions?
Time Permitting

Contact: trina.davis@inl.gov

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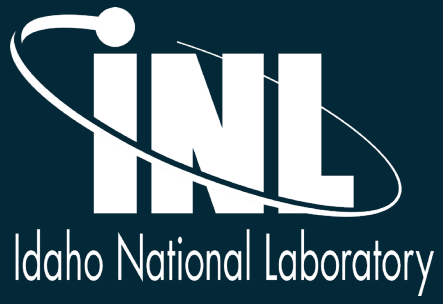

Siting Preparation and Demonstration Studies

Steve Grabinski, PM and Alison Conner, WPM

Siting Preparation and Demonstration Studies Overview

- Federal Reserved Water Rights Usage at INL Report
- ARD Electrical Grid Connection at INL Roadmap.

Water Rights Usage Project Progress

- Federal Reserved Water Rights Usage at INL Roadmap Objective: Define the requirements and constraints associated with DOE's federal reserved water rights at INL in the context of water use in support of the demonstration of advanced nuclear reactors and associated nuclear technologies. This will also define uses of INL federal reserved water rights, conditions of use, and a potential path forward for obtaining state concurrence. An interpretation of the Water Rights Agreement of 1990, between the state of Idaho and DOE, for implementation of water use in reactor demonstrations at INL will be included and feedback from key stakeholders (INL Senior Leadership, DOE-ID, State, Tribes, etc.) will be included as available.
- Project Team (as needed): MW Patterson, Nuclear Engineer; George Griffith, NS&T Siting POC; Stephen Burdick, Legal Counsel; Kara Cafferty, Water Program Lead; Alison Conner, Systems Engineer/WPM
- Total Project Cost in FY22: $48,692.

Water Rights Usage Project Progress

- Benefit: In support of NRIC's mission to enable testing and demonstration of reactor concepts by the private sector, the goal is to provide a clearer understanding of what water is potentially available for demonstration use and what actions will be expected for reactor demonstrations located at INL
- Accomplishment in FY21: INL/EXT-21-64460 – NRIC Advanced Reactor Demonstration Water Use Options at INL.

Water Rights Usage Plan for FY22

Activity	End Date
Review comments received to date	
Present to INL SLT and incorporate comments	
Engage DOE-ID in the discussion and capture feedback	
Next steps as advised by DOE-ID	
Incorporate comments into draft assessment report as they are received	
M4RC-22IN0205012 - Draft Federal Reserved Water Rights Usage at INL Report	4/29/2022
Capture feedback on draft report via email or focused review meeting	
Incorporate comments into draft assessment report	
M3RC-22IN0205013 - Final Federal Reserved Water Rights Usage at INL Report	6/17/2022

Water Rights Usage Accomplishments

- Reviewed comments received on draft white paper from INL Management – 11/18/21
- Developed water rights usage roadmap outline and began to populate it with draft white paper content
- Collected input from INL Water Program Lead and MFC environmental SME to provide clarification on question from NRIC management.

Water Rights Usage Risks

- Forward progress depends on engagement and concurrence from INL leadership and DOE-ID.

Water Rights Usage Summary

- Completion of work to date has been to inform potential future advanced reactor developers (ARDs) of the conditions and requirements needed to manage the water used at INL.
- Completion of the, “Federal Reserved Water Rights Usage” roadmap would provide a better understanding of the definition of what federal reserved water rights may be available and under what constraints they may be used.
- Clarification will enhance the viability of INL to be a preferred site for advanced reactor demonstrations.

ARD Electrical Grid Connection Roadmap Project Overview

- Advanced Reactor Demonstrations Electrical Grid Connection at INL Roadmap Objective: Develop a path forward to connect demonstration reactors to the INL grid (without transmission rights). This will include working with DOE-ID and INL power management to determine the most appropriate path forward for enabling advanced reactor developers with the opportunity to demonstrate power generation and address FERC and NERC regulations.
- Project Team: James Case, Lead Systems Engineer; Jakob Meng, Systems Engineer; Kurt Myers, Distributed Energy & Grid Systems Engineer; Alison Conner, WPM
- Total Project Cost: $207,006
- Benefit: Completion of this work will provide guidance on the steps necessary to connect demonstration reactors to the grid. This may also enable INL's Net Zero goals.

ARD Electrical Grid Connection Roadmap Plan for FY22

Activity	Start Date	End Date
Planned kick-off	2/14/2022	2/18/2022
Gather data and formulate document outline	2/21/22	5/27/22
Capture SME and stakeholder input	5/31/22	7/28/22
M4RC-22IN0205016 - Draft ARD Electrical Grid Connection Roadmap		7/29/2022
Capture feedback on draft report via email or focused review meeting	8/1/2022	8/5/2022
Incorporate NRIC management comments into draft document	8/8/2022	8/11/2022
Distribute draft report for technical editor and peer reviews (PRS)	8/15/2022	8/23/2022
Incorporate technical editor and peer review comments	8/24/2022	8/25/2022
Initiate LRS document reviews NLT 8/29/2022	8/29/2022	9/12/2022
M3RC-22IN0205017 - Final ARD Electrical Grid Connection at INL Roadmap		9/16/2022
Upload final document in PICS and SORT		9/16/2022

ARD Electrical Grid Connection Roadmap Risks

- Completeness of the path forward will be contingent on integration with proposed INL electrical infrastructure upgrades.

ARD Electrical Grid Connection Roadmap Summary

- Desire to demonstrate and prove ability to add power to the electrical grid has been made by several advanced reactor developers (ARDs).
- Completion of this work will provide them with guidance on the steps necessary to connect their demonstration reactors to the grid, with consideration to commercial power distribution regulations.
- Publication will enhance the viability of INL to be the preferred site for interested advanced reactor demonstrations.
- Grid connection guidance for advanced reactor demonstrations will support INL's Net Zero goals.

Thank you!

Questions?
Time Permitting

Contact: alison.conner@inl.gov

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Siting and Regulatory Strategy

Stephanie Weir, NRIC Siting & Regulatory Strategy Manager

Siting and Regulatory Strategy - Overview

- Key Objectives:
  - Support NRIC's goals of empowering innovators and reducing regulatory risks
  - Maximize benefit of NRIC projects by identifying and leveraging crosscutting issues and opportunities.
- Work Includes:
  - NEPA – experience, support, and coordination
  - Siting analysis and tools – develop and deploy
  - Coordination and collaboration – among regulators, innovators, national laboratories, and other stakeholders.

NEPA: DOME EA – Purpose and Benefits

- Objectives:
  - Perform and document NEPA analysis of surrogate reactor in the Demonstration of Microreactor Experiments (DOME) test bed using the plant parameter envelope (PPE) approach developed by NRIC during FY-20 and FY-21 and additional information from potential demonstrators.
- Key benefits:
  - By completing a NEPA analysis early, using bounding conditions anticipated to cover the various reactors that may use the DOME test bed, we reduce risks to schedule and budget.
  - The time and effort to complete subsequent NEPA analyses for individual reactor experiments is significantly reduced, provided the experiment falls within the bounding conditions analyzed.

NEPA: DOME EA

- Funding: FY21 carryover funding of $513K

- INL Team:

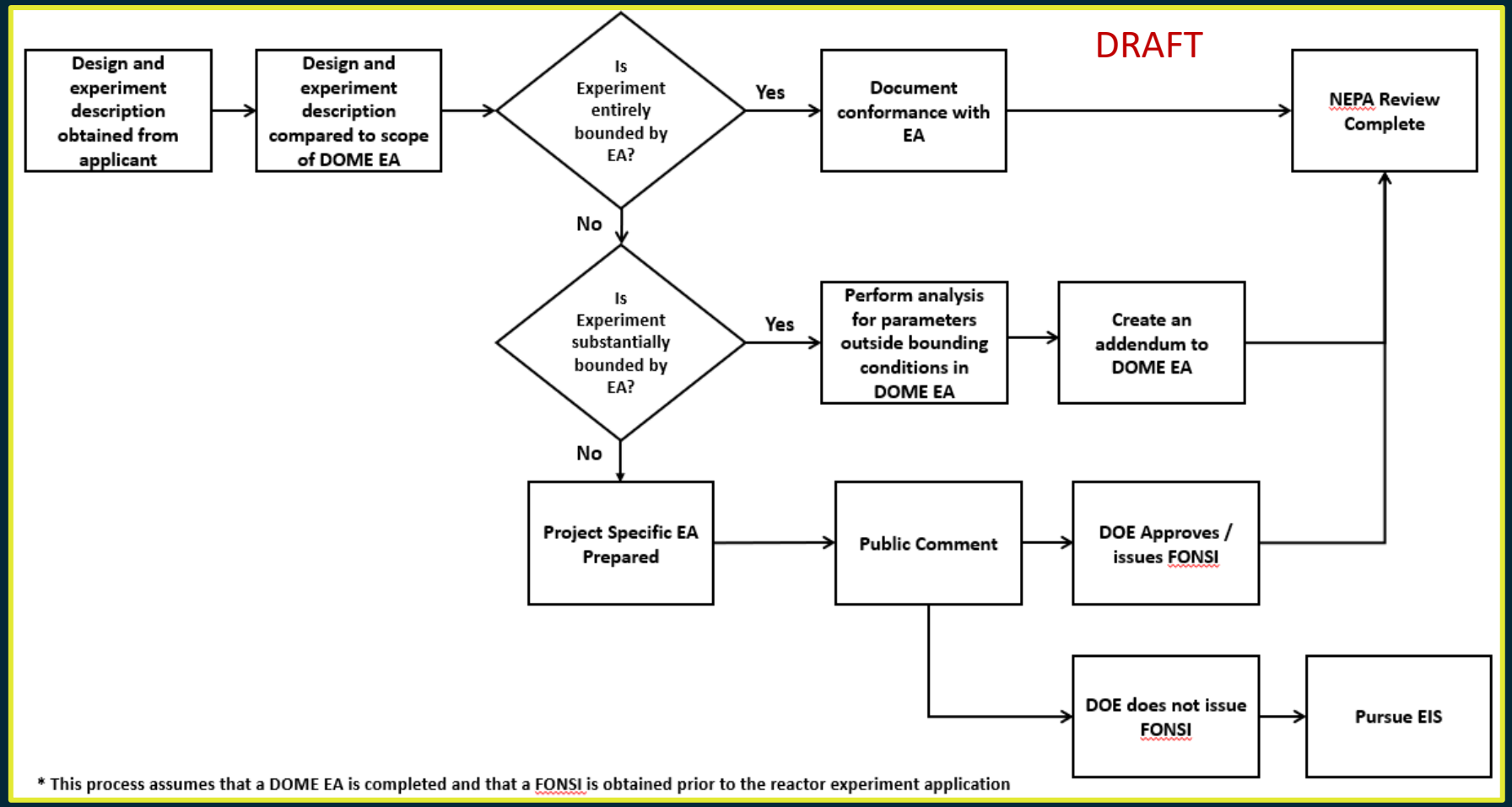
Resource Name	Role/Title
Jim Jackson	INL Enivironmental - NEPA
Stacy Nottestad	INL Enivironmental - NEPA
Stephen Grabinski	NRIC Project Manager
Phil Schoonover	NRIC Test Bed Program Manager
Stephanie Weir	NRIC Siting and Regulatory Strategy Manager
Stephen Burdick	INL Legal
A.J. Sondrup	INL Enivironmental - Modeling
Amy Forman	INL Enivironmental - Natural Resources
Colby Kramer	INL Enivironmental - Natural Resources
Daniel Mota	INL Enivironmental - Natural Resources
Elizabeth Cook	INL Enivironmental - Cultural Resources
Jason Andrus	INL Nuclear Safety

Resource Name	Role/Title
Johnathan Grams	INL Enivironmental - Cultural Resources
Kara Cafferty	INL Enivironmental - Water Resources
Kristopher Murray	INL Enivironmental - Air Quality
Marrisa King	INL Enivironmental - Cultural Resources
Matthew Lund	INL Nuclear Safety
Morris Hall	INL Radiological Engineering
Rob Black	INL Environmental - Waste Management
Scott Lee	INL Enivironmental - Natural Resources
Suzette Payne	INL Environmental - Geophysics
Tim Solle	INL Environmental - MFC PEL
Troy Reiss	INL Nuclear Safety

NEPA: DOME EA – Example Timeline

- Risks:
  - External scheduling factors (e.g., timing of NEPA for MCRE, PELE, etc.)
  - Sufficient vendor data
  - Extended public comment period
  - Potential need for EIS.

NEPA: DOME EA


DRAFT
Design and experiment description obtained from applicant
Design and experiment description compared to scope of DOME EA
Is Experiment entirely bounded by EA?
Yes
Document conformance with EA
NEPA Review Complete
No
Is Experiment substantially bounded by EA?
Yes
Perform analysis for parameters outside bounding conditions in DOME EA
Create an addendum to DOME EA
No
Project Specific EA Prepared
Public Comment
DOE Approves / issues FONSI
DOE does not issue FONSI
Pursue EIS
* This process assumes that a DOME EA is completed and that a FONSI is obtained prior to the reactor experiment application

Coordination and Collaboration - Examples

- DOE – NRC Memorandum of Understanding (MOU)
  - NRC Rotational Employees
    - Advanced Construction Technology Initiative
    - Leveraging DOE Authorization Work for future NRC licensing efforts
    - Potential coordination with international regulatory agencies.
  - DOE – NRC – NRIC periodic coordination meetings.
- DOE – NRC – NRIC – GAIN periodic coordination meetings
- Digital Engineering Tools
  - Using system engineering tools as part of MCRE and DOME EAs
  - Pilot use within INL Environmental for EA implementation documentation.

Siting and Regulatory Strategy - Summary

- NRIC is ideally situated to provide cross-functional support to inform and empower innovators, reduce regulatory risk, and deliver successful outcomes
- NRIC's siting and regulatory strategy has and will continue to provide support to existing projects and initiatives as well as grow to respond to the evolving needs of its stakeholders
  - Early completion of NEPA coverage for the DOME test bed should reduce costs and improve schedule predictability
  - Recently deployed siting tools will enable efficient review of potential siting locations and proposed siting tools will support environmental justice initiatives
  - Coordination and collaboration with regulators, innovators, national laboratories, and other stakeholders enables rapid identification of crosscutting issues and opportunities.

Thank you!

Questions?
Time Permitting

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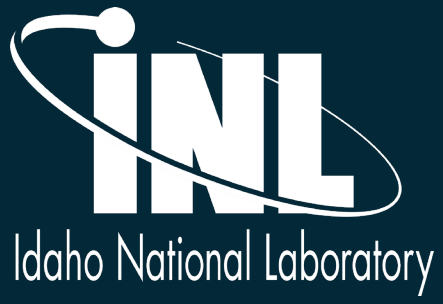
NRIC INL

NRIC
National Reactor Innovation Center



Transportation and Disposition Options

Evans Kitcher (INL)
Harold Adkins and Steven Maheras (PNNL)
Christine Williams (INL, Technical Point of Contact)

Transportation and Disposition Options Project Overview

Identify and address issues related to transport, management of microreactor spent fuel at the INL site as well as identify disposition alternatives for microreactors and a range of advanced reactors.

- Address transport of fueled unirradiated and irradiated microreactors on the INL site and offsite
- Address storage and disposition options for a microreactor on the INL site
- Provide general subject matter expertise and support to NRIC regarding management of irradiated nuclear fuel.

Transportation and Disposition Options Project Overview

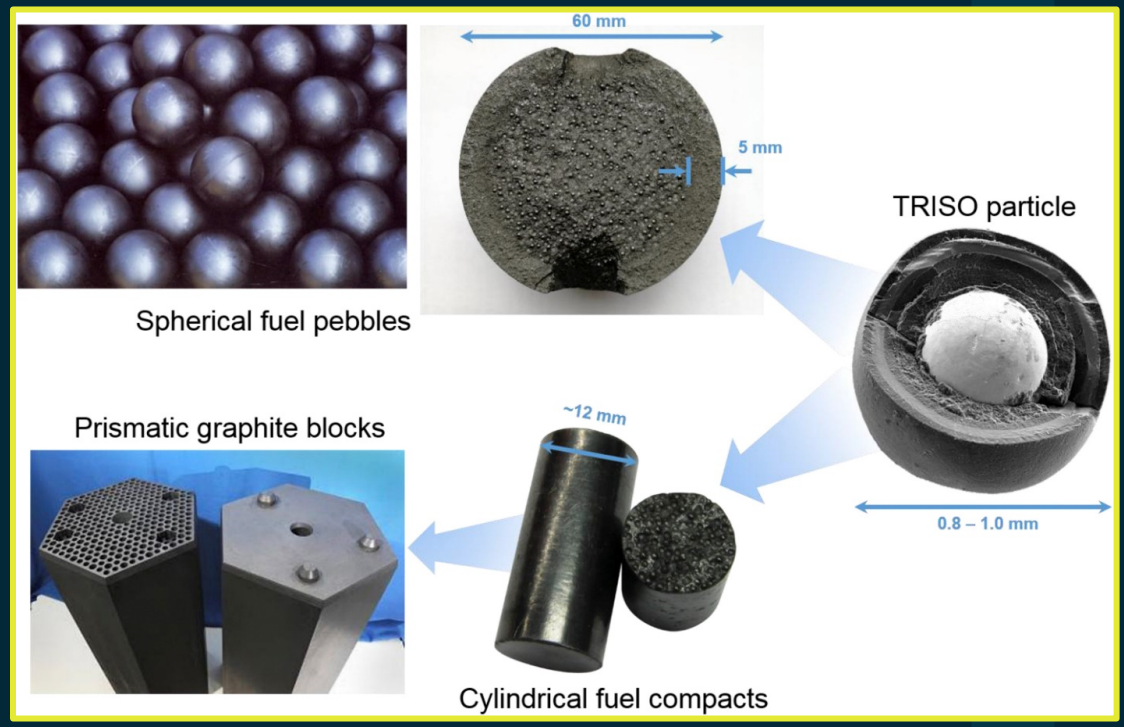
- Onsite management and storage – Evans Kitcher (INL)
  - Identify transfer cask and storage options for SNF
  - Perform preliminary criticality safety analysis
  - Perform preliminary radiation shielding analysis.

- Onsite and offsite transport – Harold Adkins and Steve Maheras (PNNL)
  - Evaluate transportation options for microreactors demonstrations
  - Document transportation regulator and associated regulations
  - Investigate transportation package and packaging design
  - Propose PRA-informed regulatory framework for offsite transport.

Transportation and Disposition Options - INL

Transportation and Disposition Options – INL Project Overview

- Provide management options for spent nuclear fuel coming from microreactors at INL. Areas evaluated included:
  - Treatment and neutralization options for spent microreactors
  - Storage options without treatment for spent microreactors
  - Sizing approaches for spent microreactors to facilitate more efficient disposition
  - Environmental regulations, regulators, and suggested approach.
- Focus was on TRISO based on the identified candidates for demonstrations.



Transportation and Disposition - INL Project Overview - continued

- Team includes:
  - Evans Kitcher – options identification, criticality and radiation shielding analysis.
- Financial commitments:
  - FY20 – $85k
  - FY21 – $150k
  - FY22 – No new funds. 17k of carryover from FY21.
- No risks.

Transportation and Disposition - INL Impact and Accomplishments

- INL/EXT-20-57291 - Initial Evaluation of Microreactor Disposition Options
- INL/EXT-20-59200 - Preliminary Criticality and Radiation Shielding Analysis for the Storage and Transfer of Irradiated MARVEL Reactor Fuel
  - Report and data informed MARVEL NEPA efforts.
- INL/EXT-20-59779 - Microreactor SNF Transportation, Management, and Disposition Options
  - Integrated report including PNNL work.
- White paper series on disposition options for microreactor (HTGR - INL/EXT-20-59157, SFR - INL/EXT-20-57831, MSR - INL/EXT-20-59581)
- INL/INT-21-62174 - Criticality and Shielding Analysis for the Transfer and Storage of TRISO-Based Microreactor Fuels
  - Identified storage and transfer cask options for PELE reactor SNF.

Transportation and Disposition - INL Areas Of Future Focus

- Future work should focus on three major technical challenges
  1. Availability of a representative source term data set for TRISO-based microreactor fuels.
  2. Consolidated whole core inventory management and storage to support proposed microreactor demonstrations.
  3. Integration of this new irradiated fuel inventory with the site wide strategy for extended road ready dry storage and final disposal of irradiated fuel.

Transportation and Disposition Options - PNNL

Transportation and Disposition Options – PNNL Project Overview

- Evaluate transportation options for microreactors demonstrations including:
  - Transporting HALEU fueled but-never-operated microreactor
  - Transporting HALEU fueled and previously-operated microreactor.
- Areas that will be evaluated related to transportation include:
  - The mode of transportation (e.g., air, barge, truck, rail)
  - The transportation regulator and associated regulations
  - Transportation package and packaging design
  - Develop PRA-informed framework for transport.

Transportation and Disposition - PNNL Project Overview - continued

- Team includes:
  - Harold Adkins – PM/WP manager & PI as SME w/Transportation Regs
  - Steve Maheras – Risk Evaluation Lead & SME w/Transportation Regs
  - Garill Coles – PRA strategy development lead
  - Steve Short – PRA modeling strategy lead
- Financial commitments:
  - FY20 - $60k
  - FY21 – $144k
  - FY22 – No new funds.
- No risks.

Transportation and Disposition - PNNL Impact and Accomplishments

- PNNL-29718 – Documentation of Applicable Regulations and Regulatory Authority for Microreactor Transportation
  - Addresses INL onsite transport and offsite transport.
- PNNL-30166 – Concept of Operations for Microreactor Transportation
  - Identifies options for onsite transport and offsite transport.
- INL/EXT-20-59779 – Microreactor SNF Transportation, Management, and Disposition Options
  - Integrated report including PNNL work.
- PNNL-31867 – Proposed Risk-Informed Regulatory Framework for Approval of Microreactor Transportation Packages
  - Framework under review by NRC
  - Presented to IAEA for consideration.

Transportation and Disposition – PNNL Areas of Future Focus

- Future work should focus on:
  1. Investigating current knowledge on TRISO release fractions during non-accident and accident conditions.
  2. Performing parametric study into potential dose consequences from traditional postulated transportation accidents using a representative source term, assumed accident conditions and environment, and different airborne release factions postulated for TRISO fuel or derived from literature.
  3. Continuing to develop PRA-based regulatory approach.

Transportation and Disposition Benefits

- Creating referenceable TRISO-based source term for use in transportation and storage
- Informing design about the relative significance of microreactor containment and shielding
- Contributing to the success of proposed microreactor demonstrations at INL
- Minimizing the magnitude and extent of potential offsite transportation compensatory measures required by NRC
- Contributing to the success of obtaining NRC transportation package approval for offsite transport of Microreactors
- Ultimately supporting the successful commercial deployment of microreactors.

Thank you!

Questions?
Time Permitting

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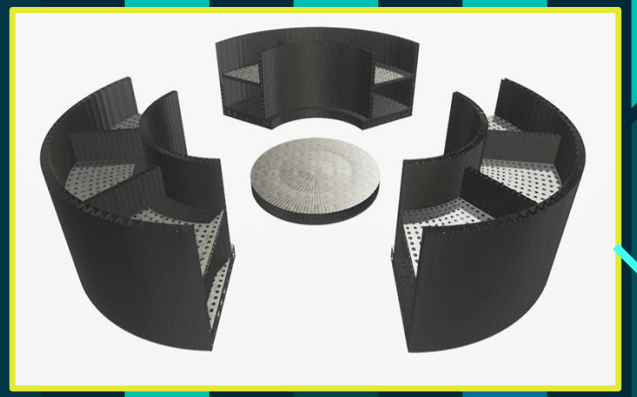
NRIC
National Reactor Innovation Center

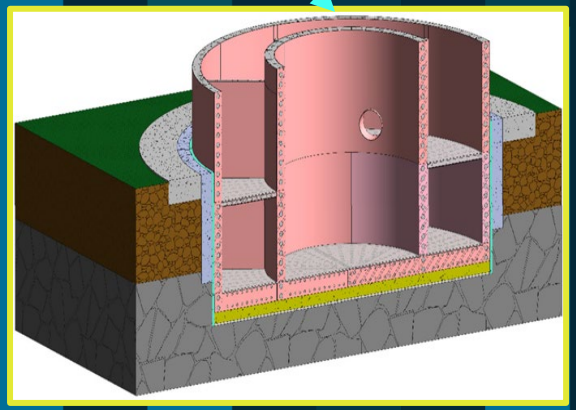
INL
Idaho National Laboratory

Advanced Construction Technology Initiative

NRIC WPM Christy Williams
GEH PM Juswald Vedovi Ph.D.
Purdue PI Amit Varma Ph.D.



Factory Built Wedge-Shaped Steel Forms Used in Nuclear Energy Construction



Advanced Construction Technology Initiative (ACT)

- ACT will significantly reduce the construction costs and schedule associated with new nuclear builds
- General Electric Hitachi Nuclear Energy (GEH) Team Lead
  - EPRI – Digital Twin, and NDE techniques
    - University of North Carolina at Charlotte – Digital Twin
    - Nuclear Advanced Manufacturing Research Centre (NAMRC) – Advanced Sensor.
  - Modular Walling Systems Holdings Limited (MWS) – Steel Brick™
  - Purdue University – Steel-Concrete Composite prototype testing
  - Black and Veatch – Boring Technology, Construction of Demonstration, Decommissioning Plan, Scaling Prototype, and Site Selection
  - Tennessee Valley Authority (TVA) – Industry Partner.

ACT Overview

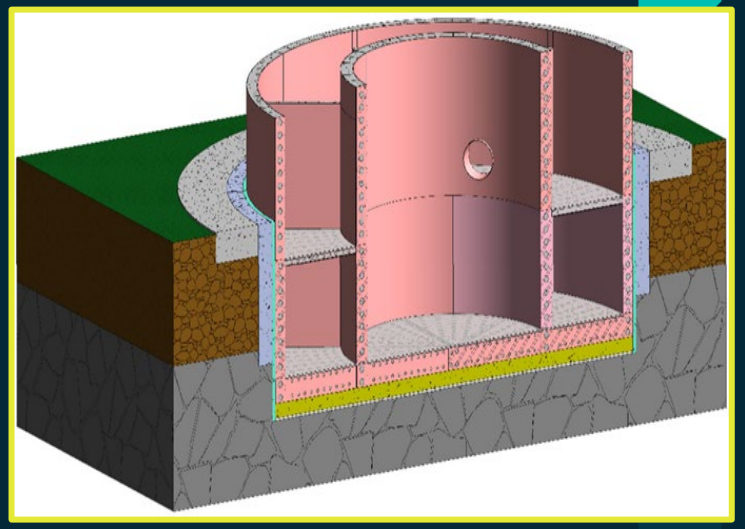
- ACT is a 1 year, $8.35M cost shared public private partnership
  - FY-22 & FY-23 Phase 1 DOE-NE $5.8M $2.53 GEH $0.2 TVA
  - FY-23 – FY-25 Phase 2 Cost Estimate generated during early part of Phase 1.
- Contract negotiations started in FY-21
- GEH/INL Contract was approved on December 16, 2021
- Kickoff Meeting: January 27, 2022
- Milestones
  - 30% Design is May 12, 2022
  - Final Design is January 26, 2023.
- Developing a Risk Register and Project Work Plan
  - Risks related to large team coordination, site selection, subcontractor selection, implementation of C-19 requirements, and complexities related to contracts for phase 2, approval to move to Phase 2.

ACT Milestones

Milestones	Date
Award Contract	12/16/21
M3 –RC-22IN0204042 ACTi Team Kickoff Meeting with Subcontractor	01/27/22
NRIC Program Review	02/14/22
M3- RC-22IN204043 ACT Phase 1 30% Design Review	05/12/22
M4 – RC-22IN20444 Nuclear Reactors and Construction Standards Report (BV)	09/15/22
M2-RC-22IN204045 ACT 60% Design Review (GEH)	09/22/22
M4 – RC -22IN204046 Report on NDE techniques, Test Results, processes and SB lessons learned (EPRI)	12/06/22
MX- RC-22IN204410 Select Demonstration Site	12/08/22
M3- RC-22IN204047 ACT Phase 1 - 90% Design Review (GEH)	12/08/22
M4-RC-22IN204048 Receive Prototype Lesson Learned Document (PUR)	12/22/22
M2-RC-23IN204049 ACT Phase 1 Final Design (GEH)	01/26/23

ACT Technologies

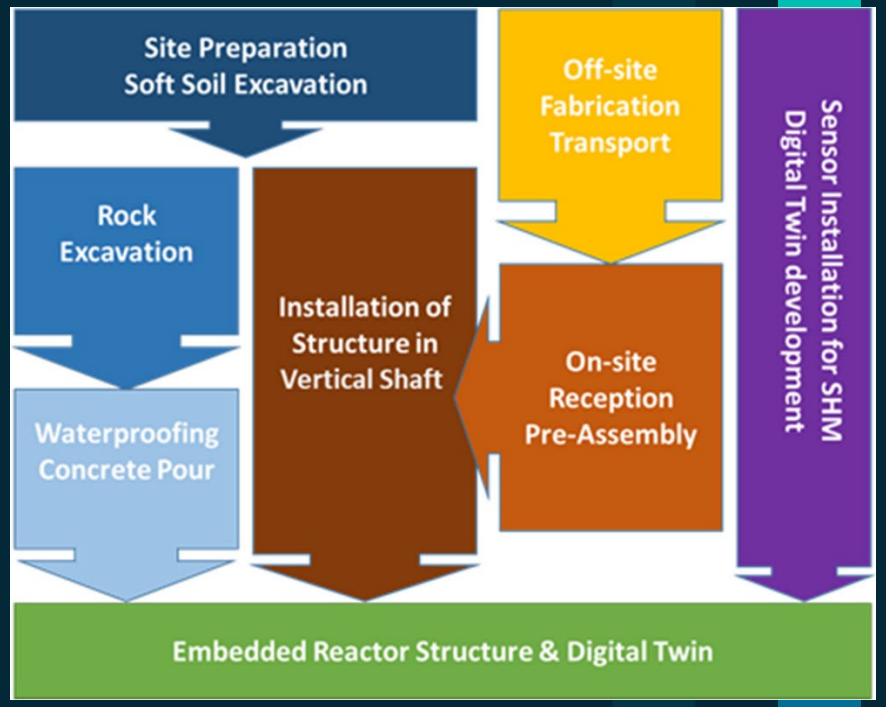
- **Steel Bricks™**: modular steel-concrete technology panels made in a factory and assembled in the field
  - Reduce labor and rebar welding in traditional concrete strengthening techniques
  - Steel Bricks is a trademark of Modular Walling Systems Holdings Limited.
- **Vertical shaft construction:** leverage best practices from the construction industry



- **Digital Twin and Advanced Monitoring Technology:** a digital replica of the scaled demonstration nuclear structure with a cradle-to-grave approach.

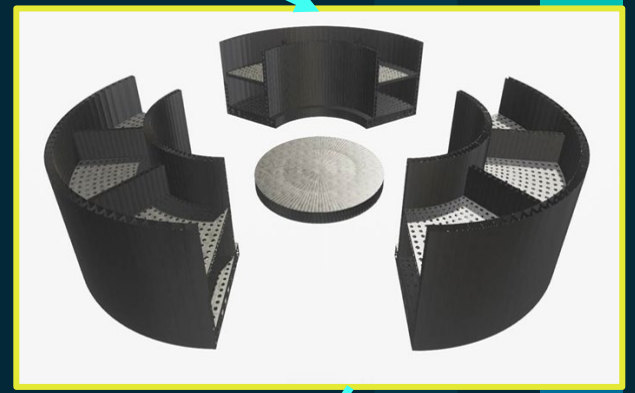
ACT Construction and Integration Process

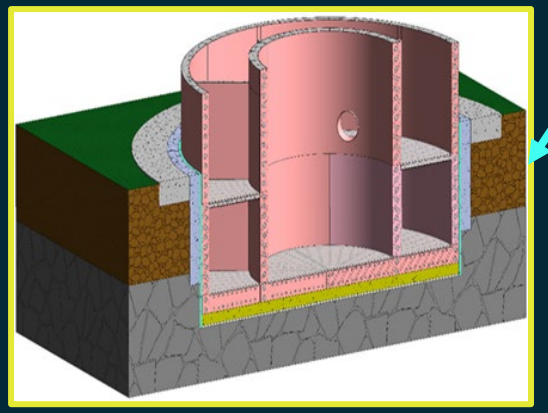
1) Preparation of site.
2) Excavation of the shaft.
3) Placement of the mud mat and foundation.
4) Assembly of the fabricated Steel Brick™. technology panel from offsite fabrication.
5) Lower panels into shaft.
6) Install sensors for digital twin.
7) Embedded reactor structure and digital twin.



Steel Bricks™ Technology Panel

- State-of-the-art system that is trademarked by Modular Walling Systems Holdings Limited (MWS).
- Prototype testing of representative MWS panels to expand current fabrication knowledge for rectangular structures to cylindrical structures.
- Prototype testing, at Purdue, will establish DB and beyond DB structural performance. To support use in Seismic Category 1 structures and containments.
- Steel-Concrete Composite Systems fabricated offsite and filled with concrete on site:
  - Are faster to install than traditional concrete forms and the reinforcing steel rebar due to offsite fabrication
  - Have higher resistance to flexural stress damage
  - Prevents spalling of concrete
  - Prevents buckling of the steel
  - Improves its resistance to compression.





Factory Built Wedge-Shaped Steel Forms Used in Nuclear Energy Construction

Vertical Shaft Construction

- Leverages best practices from the construction industry
  - Reduce costs associated with excavation, inspections, and testing of safety-related backfill.
- Conceptual design for scaled structure for demonstration
  - Outer diameter 16 meters
  - Shaft depth 5 meters
  - Height above grade 2 meters
  - Commercial roof will keep structure weather tight.
- Potential to reduce the amount of excavation and engineered backfill needed, for reactor builds, by 1 million cubic feet.
- B&V is the lead on selection of boring technology, scaled structure, and site selection.

Digital Twin and Advanced Monitoring Technology

- Demonstrating advanced condition and performance monitoring techniques for implementing construction and in-service surveillance programs to address NRC's Regulatory Inspection and Monitoring requirements in 10 CFR 50.65.
- Demonstrating state-of-the-art digital twin replica of the structure to integrate sensor data, artificial intelligence, machine learning, and data analytics.
- A mini digital twin will be deployed by EPRI and UNCC with the prototype at Purdue to collect data and validate sensor types determined by NARMC.
- Allows for continuous monitoring of the strains developed in the Steel Bricks™ and the subgrade in real time. This level of monitoring can be maintained during the life of the building.
- A goal is to engage the U.S. NRC and other national regulators to review the techniques, evaluate inspection and acceptance criteria, and update the NRC Inspection Manuals and Inspection Procedures.

ACT Summary

- ACT will utilize expertise from industry, academia, and science centers to demonstrate construction technologies, not yet being used in the nuclear industry
- Demonstrating these advanced construction technologies will build confidence with the advanced reactor developers, regulators, and nuclear construction entities
- Utilization of these techniques in nuclear builds will significantly reduce cost and schedules for building new nuclear energy projects.

ACT Summary

- ACT will be engaging the U.S. NRC and potentially other global regulators to review the techniques, evaluate inspection and acceptance criteria, and update the NRC Inspection Manuals and Inspection Procedures.
- Leverage GEH experience; Capstone project with Penn State evaluating shielding factors utilizing Steel Brick™.

Thank you!

Questions?
Time Permitting

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