ADVANCED MICROREACTORS ARCTIC DEPLOYMENT WORKSHOP

OUTBRIEF
22 October 2026

Dr. Orian Welling
Senior Research Engineer
U.S. Army ERDC Cold Regions Research and Engineering Laboratory
orian.z.welling@erdc.dren.mil

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER





OBJECTIVES FOR TODAY

1. Provide Background for ADVANCED MICROREACTORS ARCTIC DEPLOYMENT
2. Describe Workshop and Tabletop Exercise Approach
3. Share and Explain the Key Findings and Answer Your Questions

GOAL OF ADVANCED MICROREACTORS ARCTIC DEPLOYMENT

To assess the **applied research and development needed** to **deploy advanced microreactors in the Arctic**, focusing on **operational and technical aspects** of Arctic deployment for **defense applications** and commercial **fast followers**.

AMAD IS A JOINT EFFORT

Office of the Assistant Secretary of the Army for Installations, Energy, and Environment

Includes:

- Army Nuclear Energy Office
- Janus Program

U.S. Arctic Research Commission

Advises White House and Congress on scientific research goals for the Arctic

Builds cooperative links in Arctic research within federal government

U.S. Army Corps of Engineers Engineer Research and Development Center

Research Arm of Army Corps of Engineers

Expertise and history in Arctic & nuclear power infrastructure

SUPPORT AND PARTICIPATION FROM MANY OTHERS

OBJECTIVES FOR TODAY

1. Provide Background for ADVANCED MICROREACTORS ARCTIC DEPLOYMENT
2. **Describe Workshop and Tabletop Exercise Approach**
3. Share and Explain the Key Findings and Answer Your Questions

THREE-DAY WORKSHOP AND TTX EFFORT

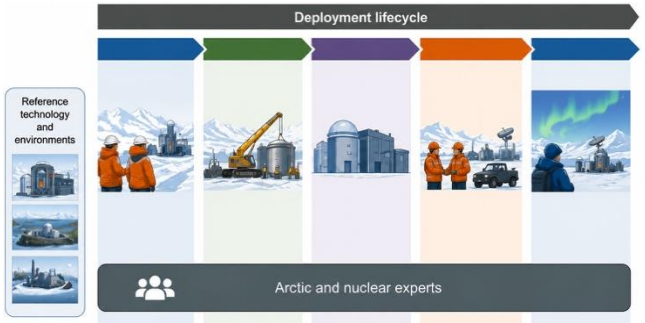
~50 Technical and Operational Experts

Arctic Engineering

Nuclear Power

DoW Requirements

Lifecycle Scenario Evaluation

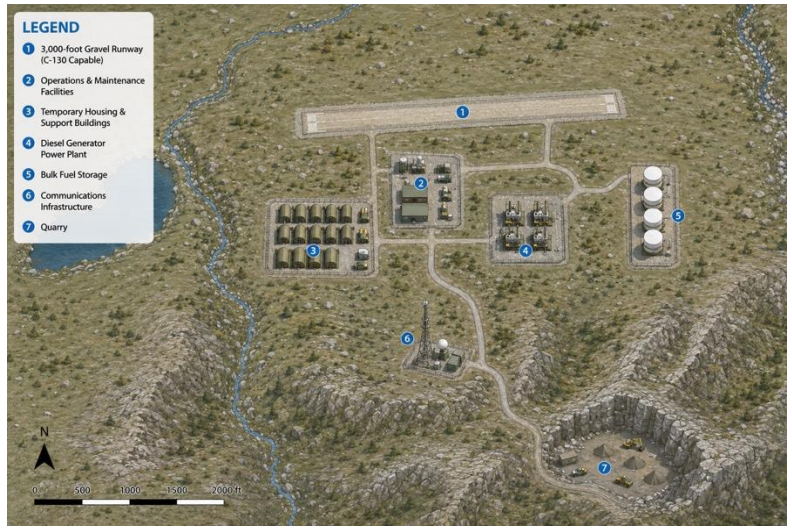


Synthesized Results



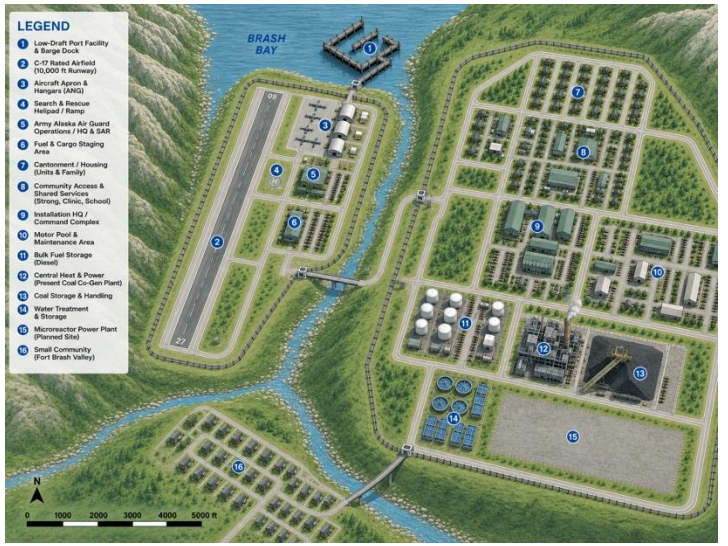
TWO DEPLOYMENT SCENARIOS

Bush Camp



Austere inland site in the far north

Fort Brash



Rugged tectonically active coastal installation w/ established infrastructure

TABLETOP EXERCISE – 4 SESSIONS, 12 TURNS

SESSION I: Site Selection, Transportation, Logistics, and Civil Works

- TURN 1.1: Site Selection and Characterization
- TURN 1.2: Transportation
- TURN 1.3: Site Prep and Civil Works

SESSION II: Construction, Commissioning, and Infrastructure Integration

- TURN 2.1 Construction
- TURN 2.2 Commissioning and Integration
- TURN 2.3 Initial Criticality

SESSION III: Operations, Sustainment, and Lifecycle Support

- TURN 3.1 Operations and Maintenance
- TURN 3.2 Fuel Management and Radiological Safety

SESSION IV: Safety, Security, and Operational Resilience

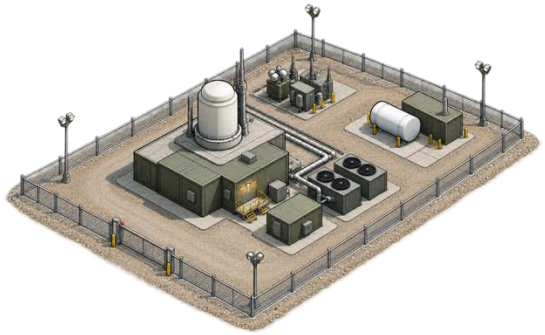
- TURN 4.1: Physical Safety and Security
- TURN 4.2: Cybersecurity
- TURN 4.3: Decommissioning
- TURN 4.4: Reverse Transportation

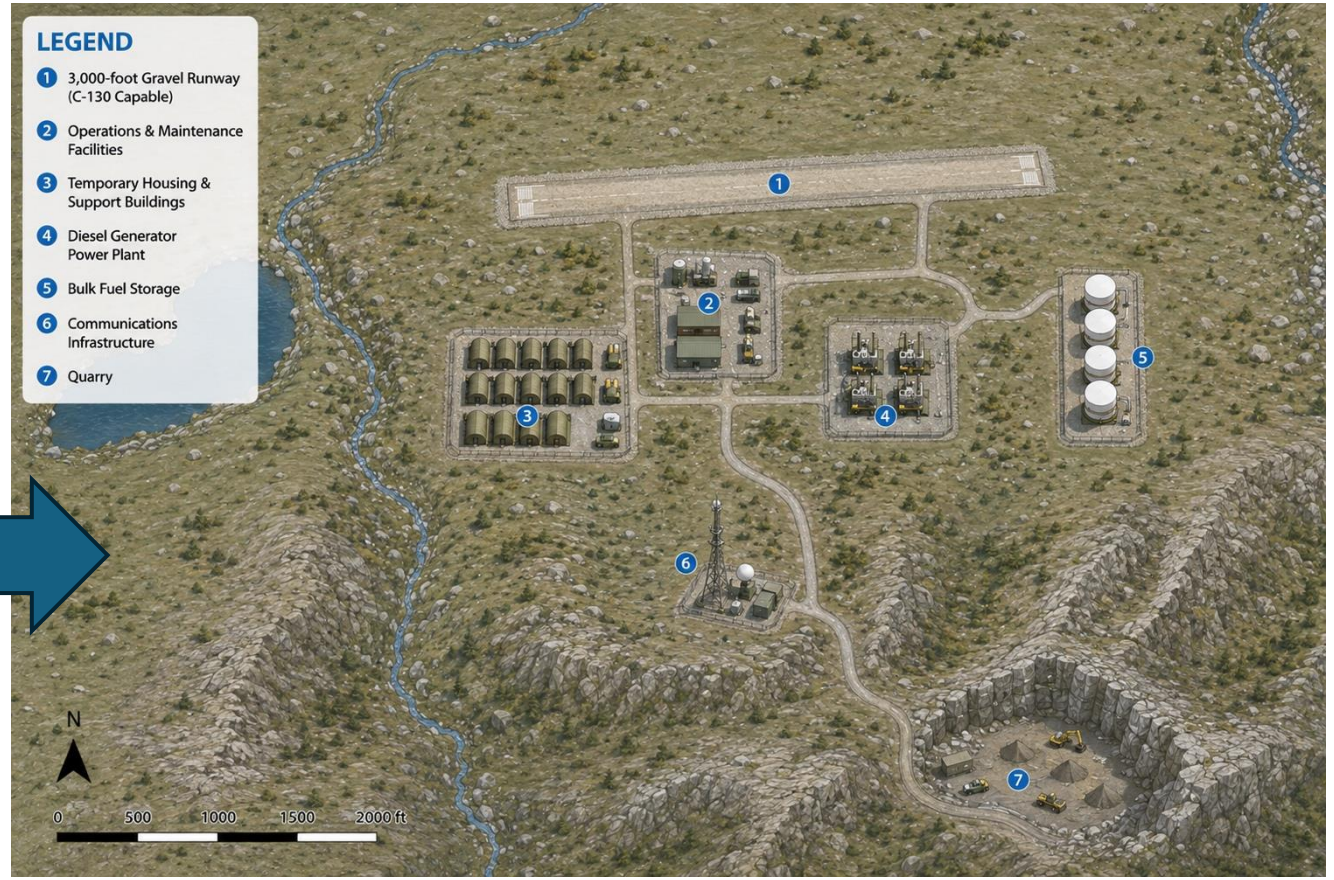
EXAMPLE TURN: SITE SELECTION AND CHARACTERIZATION

You've been asked to select the location of the reactor site at **BUSH CAMP.**

What
- **Information** must be collected?
- **Analysis** must be done?
- **Decisions** must be made?

What **ARCTIC** considerations drive or constrain this decision?



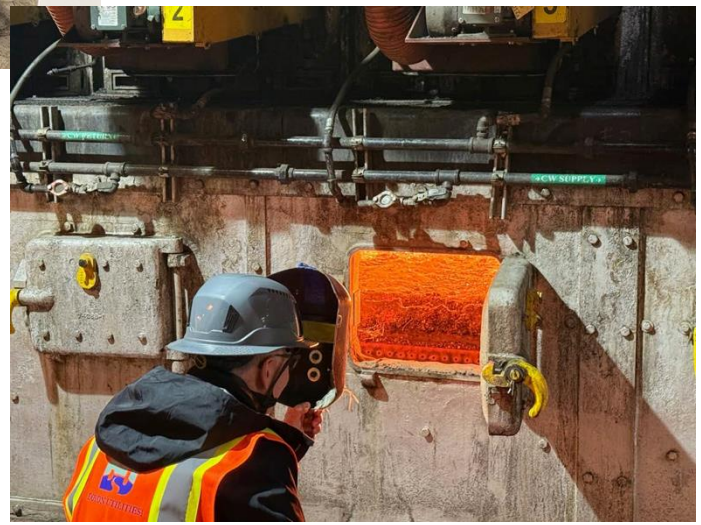


WORKSHOP FRAMING, TOURS, and SITE VISITS









OBJECTIVES FOR TODAY

1. Provide Background for ADVANCED MICROREACTORS ARCTIC DEPLOYMENT
2. Describe Workshop and Tabletop Exercise Approach
3. **Share and Explain the Key Findings and Answer Your Questions**

THREE UNIQUE ARCTIC CHALLENGES

Permafrost

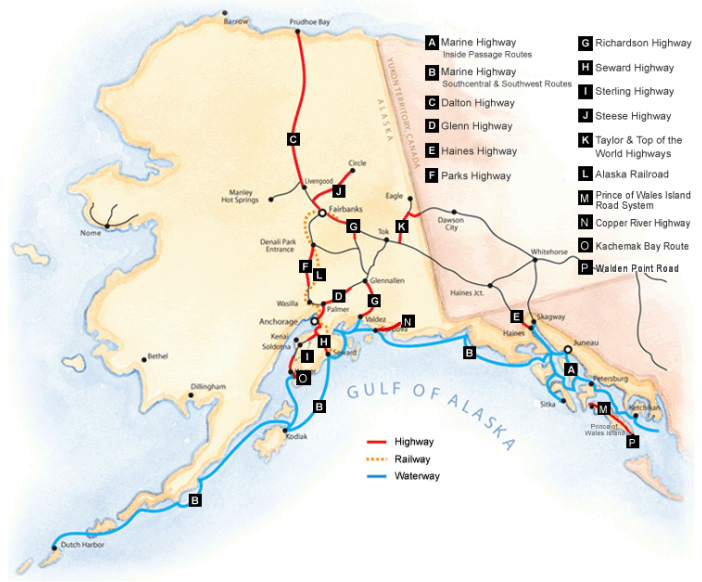




Extreme Temperatures



Remoteness



NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.



2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.



3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

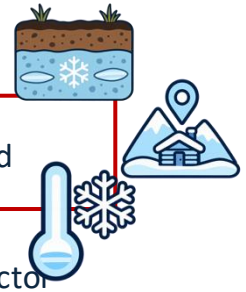
8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.



3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.



4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

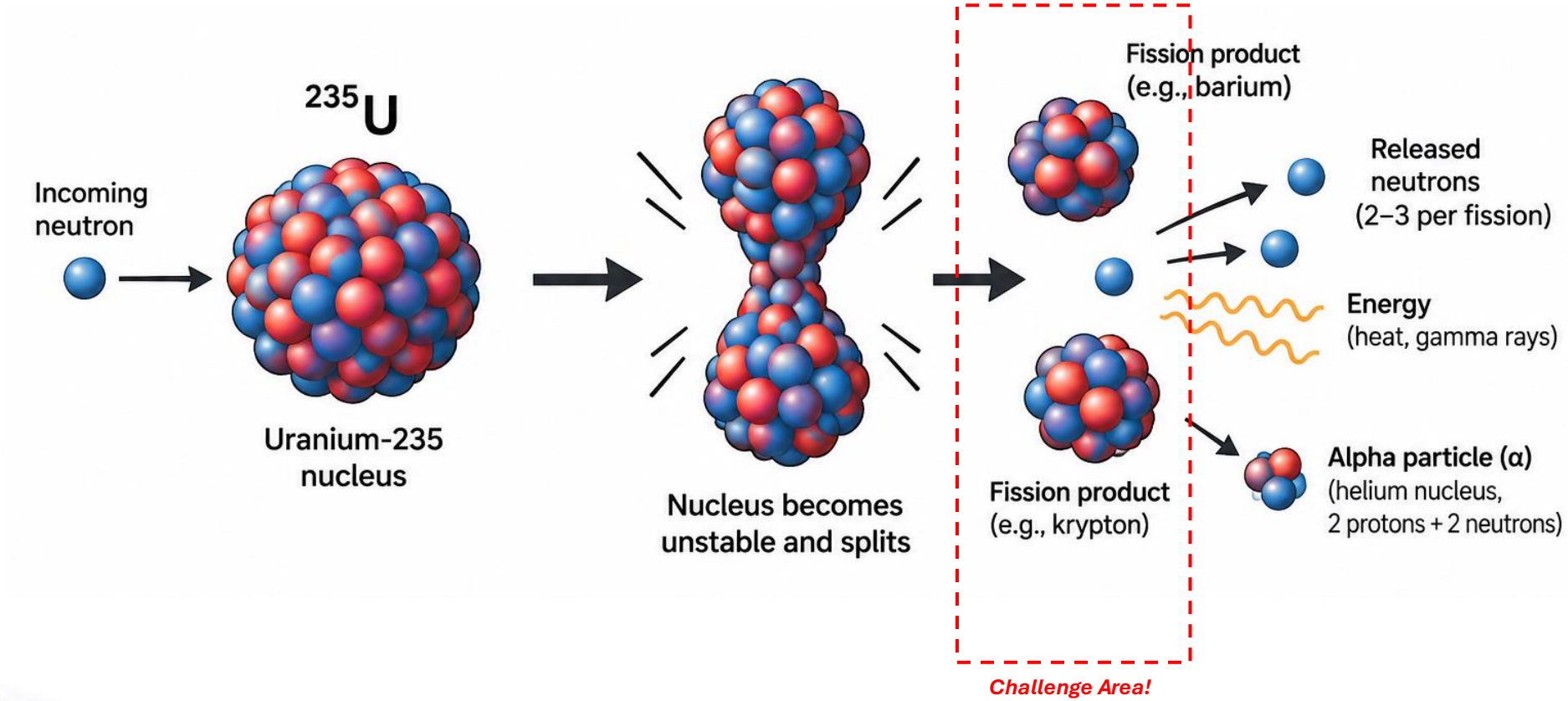
6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

CHALLENGE OF IRRADIATED FUEL



NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.



6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.



7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.



9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.

NINE PRIORITY RESEARCH AREAS IDENTIFIED

1. Permafrost foundations & thermal interactions
- Understand heat transfer, thaw settlement, frost heave, and foundation performance over the reactor lifecycle.

2. Local soil and aggregate analysis for irradiation effects
- Determine whether local soils and aggregates can safely support construction, shielding, and long-term nuclear operations.

3. Arctic transportation of reactor systems, nuclear fuel, and sensors
- Develop and demonstrate multimodal approaches using airlift, ice roads, overland vehicles, sealift, and other options, including regulatory and packaging requirements.

4. Remote field fueling, defueling and reactor break-down methods
- Develop field fueling and defueling methods, transport containers, cooling-time criteria, and safe approaches for removing irradiated fuel/reactor components from remote sites.

5. Cold-region construction, operations & sustainment
- Qualify equipment, materials (including locally available materials), construction methods, and maintenance approaches for reliable operation in extreme cold.

6. High Technical Level of Readiness research and engineering of complete deployed microreactor power plant system
- Ensure components such as system health monitoring sensors, safety sensors, microgrid controls, etc. operate reliably in arctic conditions.

7. Paired equipment to support remote operations, maintenance, and other mission tasks
- Evaluate opportunities and develop Arctic capable equipment such as additive manufacturing of spare parts, synthetic fuel, desalination, etc. that take advantage of reactors' available heat and electricity supply to further reduce logistics chain.

8. Arctic emergency & radiological response
- Develop Arctic-specific emergency procedures, including low/no-water decontamination, cold-weather CBRN equipment, casualty evacuation, remote assessment/robotics, and emergency-response kits.

9. Arctic system integration
- Evaluate integrated system architectures for Arctic applications, including efficient / effective approaches to microreactor combined heat and power systems.



ADDITIONAL RECOMMENDATIONS:

1. Arctic Microreactor Power Plant Test Beds (incl. non-radioactive)

2. Sustained community engagement on nuclear technology's benefits and risks

3. Follow-on FY27 tabletop exercise focused on North Warning System applications

Questions?

arctic.gov/amad-workshop