



MARVEL: REMOTE OPS AND CONTROL GE VERNOVA TEST IMPLEMENTATION PLAN

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GE VERNOVA HITACHI: BWRX-300



REACTOR TYPE

BOILING WATER REACTOR



for proven scalability and cost-effectiveness

ELECTRICAL CAPACITY

300 MW(E) NET TO THE GRID



equal to powering 300,000 homes

FUEL SUPPLY

PROVEN FUEL CONFIGURATION



utilizing established and reliable supply chain

APPROACH TO SAFETY SYSTEMS

PASSIVE



enhancing safety margin

DESIGN LIFE

60 YEARS



reinforcing stability and sustainability

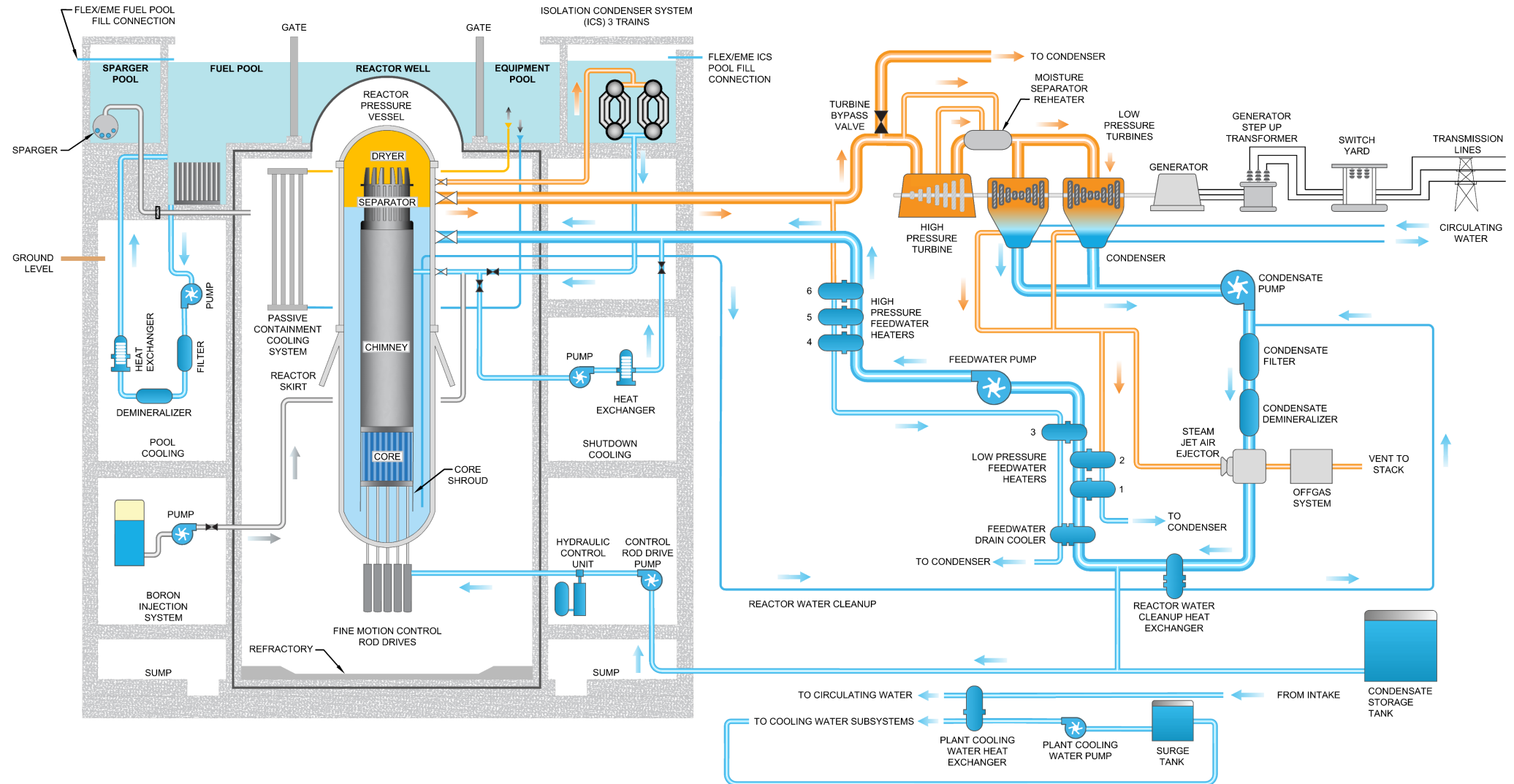
REFUELING CYCLE

12-24 MONTHS



bolstering efficiency and reducing operating costs

GE VERNOVA HITACHI: BWRX-300



Proposed MARVEL Implementation Plan: Remote Ops and Control

Background and motivation

- Traditional Secondary Control Rooms (SCRs) are **physically located** within the plant and serve as backups to the Main Control Room (MCR) during an accident scenario.
- An onsite SCR is subject to **safety risks during an accident scenario** and is expensive as one is required per unit with **24/7 staffing (post-SCRAM)**.
- Remotely operating a Secondary Control Room (SCR) can **improve safety, demonstrate efficiency, and reduce costs** through centralized staffing.



Proposed MARVEL Implementation Plan: Remote Ops and Control

Alignment with DOE Microreactor Program (MRP)

- Microreactor I&C goals are to demonstrate “far-field” remote ops, autonomous ops testing and **sensor & controller testing**
- Main Control Room (MCR) for MARVEL: 1 analog panel, SCRAM button, 2 monitors, key switch



Now:
**MACS
ViBRANT**



EO 2026:
MARVEL
dry
criticality



2028:
MARVEL
Full power

LED driven, full-scale config

Proposed MARVEL Implementation Plan: Remote Ops and Control



Program Objectives

Task I: Understand Current Technical and Regulatory Pathways

- Define challenges around remotely operating SCR from **regulatory/technical** perspective
- Establish test plan to mitigate identified challenges with reliability and security
 - Design test plan to **nuclear standards (DOE, NQA-1)**
 - Identify communication pathways for redundancy (Starlink vs. Verizon)
 - Perform **Probabilistic Risk Assessment (PRA)**
 - Seek regulator (NRC) input on plan

Task II: Assess Cyber Security risk profiles and mitigation strategies with testing

- Execute test plan to mitigate challenges identified in Task I
 - Evaluate impact on signal delay
 - Failure modes
 - Controller/hardware selection

Task III: Recommendations for pilot implementation and regulatory engagement

- Summary report with recommendations to NRC

Proposed MARVEL Implementation Plan: Remote Ops and Control



Key Technical Milestones

2026: MACS-ViBRANT

- Define wireless remote-control room and path back to reactor

2027: MARVEL Dry-criticality

- Submit safety documentation to DOE→EO Q2 2027
- Submit proprietary white paper to NRC on remote ops/control
- Prepare remote ops/ control report for MACS ViBRANT

2028: MARVEL Full-Power

- Demonstrate wireless control and safe operation
- Submit final report to DOE/NRC

Proposed timeline (2026-28) with technical milestones



TASK	FY2026: Demo on MACS ViBRANT		FY2027: MARVEL Dry Criticality		FY2028: MARVEL Full Power	
	INL Scope	GE Vernova Scope	INL Scope	GE Vernova Scope	INL Scope	GE Vernova Scope
I. Technical/Regulatory Pathways	Define regulatory/technical challenges of remotely ops of SCR	Define industry test objectives	Report with remote ops and automation recommendations to DOE/NRC	<ul style="list-style-type: none"> Mock-licensing exercise White paper to NRC 		
II. Cyber Security risk profiles and mitigation strategies with testing	<ul style="list-style-type: none"> Demonstrate control and 2-way wireless communication of a non-safety input to a safety function Control will not impede safety function Proposed control function via remote insertion of a SCRAM Consider network boundaries/ red teaming and cyber security 	<ul style="list-style-type: none"> Ship & configure Mark VIe (UCSE Controller/ Gateway) to drum control for MACS ViBRANT 	<ul style="list-style-type: none"> Continuation to complete MACS ViBRANT demo Dry-criticality testing on MARVEL: start with analog 1-way signal to bridge gap from TREAT to MARVEL Verification and validation 	<ul style="list-style-type: none"> Support verification and validation to industry standards 	<ul style="list-style-type: none"> Demonstrate control and 2-way wireless input to a safety-related function (e.g. drums are a safety system- their controllers are not safety functions) Architect a MARVEL safety system (drum controls, SCRAMS) 	<ul style="list-style-type: none"> Ship & configure Mark VIe (UCSE Controller/ Gateway) to drum control for MARVEL
III. MILESTONES	<ul style="list-style-type: none"> Define wireless remote-control room and path back to reactor 		<ul style="list-style-type: none"> Submit safety documentation to DOE EO Q2 2027 Proprietary white paper to NRC on remote ops/control Evaluate/report MACS ViBRANT Results 		<ul style="list-style-type: none"> Milestone EO FY2028: -Demonstrate wireless control and safe operation -Submit final report to DOE/NRC 	



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