

June 1, 2021

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Associate Laboratory Director

# Advanced Test Reactor Ageing Management Program Implementation

# ATR Specifications

## Reactor Type

- Pressurized, light-water moderated and cooled, beryllium reflector, 250 MWt design

## Peak Flux @ 250 MWt

- $1 \times 10^{15}$  n/cm<sup>2</sup>-sec thermal
- $5 \times 10^{14}$  n/cm<sup>2</sup>-sec fast

## Reactor Vessel (stainless steel)

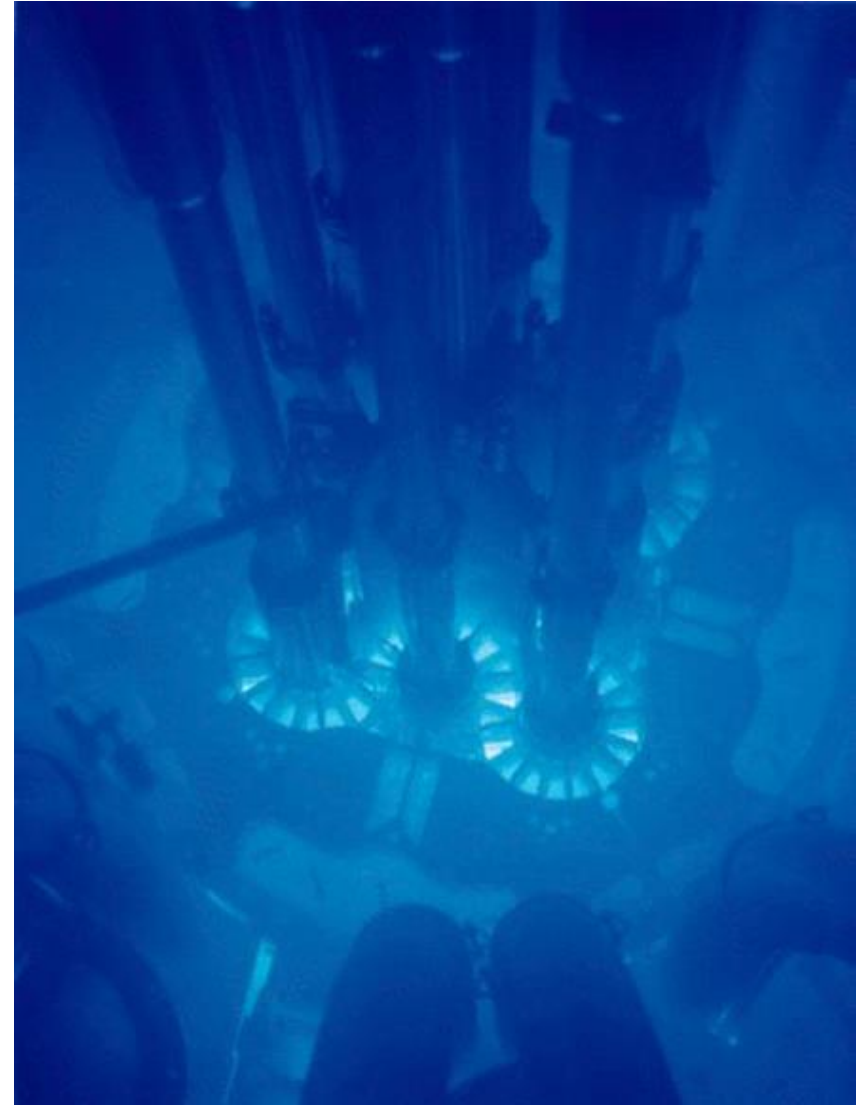
- 3.65 m (12 ft) diameter, 10.67 m (36 ft) high

## Reactor Core

- 1.22 m (4 ft) - diameter & height
- 40 fuel elements, highly enriched U-235

## Temperature, Pressure, Flowrate (3 pump operation)

- Inlet 51.7°C (125°F)
- Outlet 71.1°C (160°F)
- Vessel Inlet 2.7 MPa (390 psig)
- Coolant flow rate 185,485 L/min (49,000 GPM)



# Age Management at ATR over 50+ years (short version)

- The time clock measurement on any system begins on first day of use
- ATR went critical in 1967, achieving full design power in 1969, and thus began the wear and tear cycle on all equipment
- Long term asset management (age management) was not formally considered, only normal corrective and preventative maintenance to ensure safety and regulatory compliance
- Radiation damage to Beryllium was known but also unknown for fluxes of ATR
- First reflector change was required less than 6 years after initial criticality (CIC-1)
- Major upgrade of Plant Protective System in 1978
- Major upgrade to Reactor Control Room (computers using VAX 11/750) in 1989 due to obsolescence and lessons learned from TMI also included an improved simulator that matched RCR configuration
- Other than necessary CICs, very few major upgrades or improvement occurred for next ~25 years

# 2004: ATR Equipment Condition Becomes an Issue

- Increasing failure rate of aged equipment was an operational risk to research programs
- 2006 to 2015: ATR Life Extension Program (LEP) to assess condition and support operation to **2040**
  - Multiple equipment condition assessments (12 reports)
  - Seismic evaluations and upgrades for safety
  - Multiple PRA performed for safety analysis
  - Replace console display in Control Room with improved information and graphics
  - Upgrade modeling code to HELIOS
  - Replace most reactor nuclear instruments
  - Reactor remote monitoring and controls
  - Compliant ASME Section XI In-Service Inspection (ISI) Program

# ATR Age Management 2015 to Today

- Additional annual funding was provided that supported a stable age management planning and implementation program with \$100M USD invested to date
- In 2017, ATR management was asked to evaluate **operation to 2085** and concluded it would be possible if continuing upgrades or replacements occurred
- From 2018 to 2020, additional condition assessments were performed following US NRC guidance for age management of nuclear power plants
  - ATR Age Management Strategy for Long-Term Facility Operation was prepared which concluded, if activities and recommendations were completed, ATR could operate until 2085
- ATR continues to use a formal Plant Health Program to risk-rank priorities for equipment refurbishment or replacement as funding allows
- This past year, we began to use a commercial software for equipment and facility age management

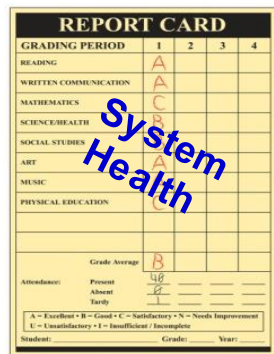
# ABB Ability™ Asset Suite Equipment Reliability (ER) Long-Term Asset Management (LTAM) Overview



**Ranking**



**Cost**



**System Health**

**LTAM Issue**

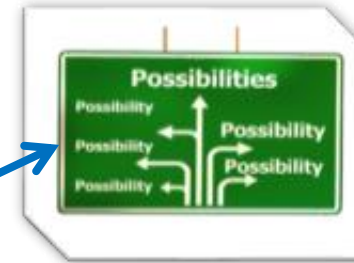
Issue Title: ATRC Control System Replacement1  
 Problem Statement: PHC ID 3: Replace antiquated control system, ATRC control system console and transmitter interfaces are beyond their design life, obsolete, and continued material degradation from aging is observed. Replacement is the recommended option.  
 Asset Type: Not Applicable  
 Facility: 70A  
 Unit(s): 670  
 Date Identified: 3/20/2020  
 Target Start Year: 2021

**Plant Health Issue Types**

Not A Plant Health Issue	No	Vulnerability	Yes	2040 Life Extension	No
Abandoned Equipment	No	Aging Management	Yes	Circuit Problems	Yes
Control Room Distraction	Yes	Critical Spare	No	Environmental Impact	No
Facility Improvement	No	Long Term Asset Mgt Strategy	Yes	Long Term Enhancement	No
Operational Risk - Very High	No	Operational Risk - High	Yes	Operational Risk - Medium	No
Personal Safety Improvement	No	Radiological Safety/ALARA	No	Regulatory Commitment	No
Replace Obsolete Equipment	Yes	System Health Monitoring Action	No		

**Issue Assignment**

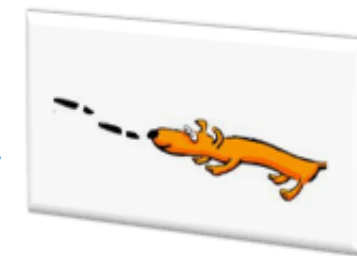
Outage Configuration Change	No	Online Configuration Change	No	Long Lead Time Material Project?	No
Use Reverse Engineering?	No	IT Required	No	Business Plan Initiative	No



**Alternatives**



**Associated Work**



**Issue Tracking**

Supports INPO AP-913 Programs

# LTAM Home Page – consists of menu header and Dashboard

The screenshot shows the LTAM Home Page interface. At the top left is the 'LTA MANAGER™ Home' logo. The main navigation bar includes 'Home', 'Issues', 'Cashflow', 'Cashflow Forecast', 'Links', 'Reports', and 'Admin'. The user profile 'Osburn, Nally' is shown on the right. Below the navigation bar is a 'Main Dashboard' section with a 'Configure Dashboard' button. The main content area is divided into two columns of issue lists. The left column is titled 'Issues: Iss' and the right column is 'Issues: Recently Created'. Each issue entry includes an ID, a title, a status, and an access date. Callout boxes provide additional information: 'Main Menu (Some options shown may not be available based on user profile)' points to the navigation bar; 'Use to create new or search for LTAM Issues' points to the 'Issues: Iss' header; 'Access to HELP menu' points to a help icon in the top right; and 'Use to select and customize your personal Home views with "Gadgets"' points to a gear icon in the top right of the dashboard area.

**Main Menu**  
(Some options shown may not be available based on user profile)

**Use to create new or search for LTAM Issues**

**Access to HELP menu**

**Use to select and customize your personal Home views with "Gadgets"**

Issue ID	Issue Title	Status	Accessed On
345	TRA-20-0010	Draft Issue - 3/27/2020	3/27/2020
275	TRA-20-0026	Draft Issue - 4/7/2020	4/7/2020
120	TRA-20-0007	Draft Issue - 3/27/2020	3/27/2020
315	TRA-20-0020	Draft Issue - 3/27/2020	3/27/2020
1045	MFC-20-0006	Approved by MFC Complex HC PH I - 6/9/2020	5/28/2020
300	MFC-20-0009	Approved by MFC Complex HC PH I - 5/29/2020	5/28/2020

Issue ID	Issue Title	Status	Accessed On
300	MFC-20-0009	Approved by MFC Complex HC PH I - 5/29/2020	5/28/2020
200	MFC-20-0008	Approved by MFC Complex HC PH I - 5/29/2020	5/28/2020
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275	TRA-20-0026	Draft Issue - 4/7/2020	4/7/2020

# Plant Health/Equipment Reliability Program

- ER Suite – Long Term Asset Management (LTAM) database

LTA Manager - Issue Details - Internet Explorer

TRA-21-0112 Ranking: 0 Status: Draft Issue Issue Owner: LTA MANAGER™

Upper EFIS Contamination LCV-1-6... Target Start Year: 2021

ER Links (0) Associated Work (0) Attachments (1) Issue Associations (0) Status (1) Issue Roles (0)

Issue Details Issue Tracking Alternatives (0) Risk Ranking Cashflow (0)

### Issue Details

Issue Title: Upper EFIS Contamination LCV-1-615/616 PHC-129 Initiated By: Hong, Don on 3/26/2021  
 Problem Statement: PHC-129: Contamination in Firemain Piping Upstream of Upper EFIS Level Control Valves (LCV-1-615/616)  
 Asset Type: Valves Date Identified: 3/26/2021  
 Facility: TEST REACTOR AREA Target Start Year: 2021  
 Unit(s): 670

...let side of the raw water supply to the ATR fire protection system (inlet side of LCV-1-615 and LCV-1-616). The primary concern ...  
 ...ated water to the ATR Cold Waste Pond (CWP) since the raw water waste discharge line is plumbed in approximately 18 inches ...  
 ...he was isolated and ATR Operations has initiated process control to prevent use of this drain line. Water samples were taken and ...  
 ...stems at buildings TRA-625, 670, 614 and 608 to verify no contamination indicates the likely potential that the contamination may be ...

...contamination in the firemain piping to become friable and potentially move to the cold waste system when draining the firemain piping ...  
 ...firemain drain piping hard piped to the cold waste system drains. If contamination were to enter the cold waste system it could enter ...  
 ...the environment through the cold waste pond. Procedures require this section of piping to be drained when the plant is shutdown and depressurized. Temporary field changes have been ...  
 ...made to direct this drain water to the cold waste. This effort requires removal of the hard pipe to cold waste and the installation of temporary hose to direct drain water to warm ...  
 ...waste.

**Consequences of Failure to Mitigate Problem:**  
 Potential for contamination to enter the environment contamination is non radioactive piping is a significant liability with DOE.

**Extent of Condition:**  
 Not provided

**Interim Actions & Mitigation Strategies:**  
 The resolution (Option 3 of 3 suggested in 2013) is to remove and replace section of firemain piping that has internal contamination and modify the drain piping such that the option of draining the ...  
 ...firemain line could be directed to either cold waste or warm waste.

**Plant Health Issue Types**

Vulnerability	No	Operate to 2040	No	Aging Management	No
Operational Risk - Very High	No	Operational Risk - High	No	Operational Risk - Medium	No
Abandoned Equipment	No	Chronic Problem	No	Control Room Distraction	No
Critical Spare	No	Environmental Impact	No	Facility Improvement	No
Long Term Asst Mgt Strgy	No	Long Term Enhancement	No	Personal Safety	No
Radiological Safety/ALARA	No	Regulatory Commitment	No	Improvement	No
System Health Action	No	Not A Plant Health Issue	No	Obsolete Equipment	No

System, Condition, Issues, Mitigation or Risk Detail

LTA Manager - Issue Risks - Internet Explorer

TRA-20-0020 Ranking: 315 - PHC Ranking Status: Legacy Issue Issue Owner: Lanier, Paul

Canal Short Bulkheads Seal Leak ... Target Start Year: 2020

ER Links (1) Associated Work (0) Attachments (1) Issue Associations (0) Status (2) Issue Roles (1)

Issue Details Issue Tracking Alternatives (0) Risk Ranking Cashflow (1)

### Risk Information

6-10Y LTAM Probability of Failure:  
 Target Start Year: 2020  
 Risk / Impact of Deferral:  
 Basis for Deferral:

Year out	Risk Types		Status	Action
	Safety / Operational	Regulatory / Environmental		
2020 Inherent Risks	Occurred & Continuous - Operations Adversely Impacted			
2021 1 Year out	Occurred & Continuous - Facility Shutdown <1 Month			
2022 2 Years out	Occurred & Continuous - Facility Shutdown >1Month <1YR			
2023 3 Years out	Occurred & Continuous - Facility Shutdown >1Month <1YR			

**Ranking**

Basis for Scoring:  
 PHC Package

PHC Ranking	Weighting Factor	Multiplier	Total	Sum
<b>1. Nuclear Safety / Regulatory</b>				
a. Issue that affects ability to control or monitor the reactor / facility	25	X	0 - N/A	0
b. Issue could result in inability to meet or violation of regulatory commitments (DOE, EPA, etc.)	25	X	0 - N/A	0
c. Failure could result in civil penalties, regulatory or permit violations	25	X	0 - N/A	0
d. Issue that affects a ability to control or monitor important support equipment for the reactor / facility	20	X	0 - N/A	0
<b>2. Issue Impacts Operability or Functions of Safety SSC's</b>				
f. Resolution needed to resolve Nonconformance (e.g., USQ issue resolution with a facility change)	15	X	5 - Continuous	75
g. Operator workload resolution	10	X	0 - N/A	0
h. Control Room / Control Station deficiency/distraction resolution	9	X	0 - N/A	0
<b>2. Industrial /Radiological Safety</b>				
a. Industrial Safety Issue that could lead to a fatal or disabling accident or injury (interim actions ARE in place)	25	X	0 - N/A	0
b. Industrial Safety Issue that could lead to a fatal or disabling accident or injury (interim actions ARE in place)	20	X	0 - N/A	0
c. Issue could result in leak or unpermitted radiological or chemical exposure above Limits	15	X	0 - N/A	0
d. Radiological Safety/ALARA initiatives with high value benefits (>2R)	15	X	0 - N/A	0
e. Radiation exposure reduction with lower value benefits (<=2R)	10	X	0 - N/A	0
f. Issues Involves reliability of equipment that provides protection of people and equipment (fire protection, detection, alarms, or responses)	10	X	0 - N/A	0
<b>3. Facility Mission / Reliability</b>				
a. Issue resolution required for direct support to execute a committed experiment project...	25	X	3 - Likely	75
b. Reduce likelihood of a forced shutdown or eliminates a single-point (Critical components) vulnerability	25	X	0 - N/A	0
c. Significant (>\$50K labor/parts) corrective maintenance / restoration of Critical components	20	X	0 - N/A	0
d. SSC failure results in forced shutdowns with more than 2 Irradiation or Mission days lost	20	X	0 - N/A	0
e. Infrastructure replacement or repair affecting Critical or Important SSC's	20	X	0 - N/A	0
f. Red/yellow system/program/component issued required by a formal recovery plan action(s)	15	X	0 - N/A	0
g. Equipment upgrade (design change) for facility reliability	15	X	0 - N/A	0
h. Issue identifies obsolete or aging of high risk (TSR/Safety) equipment	15	X	3 - Likely	45

Highest Contributor: 315 PHC Ranking

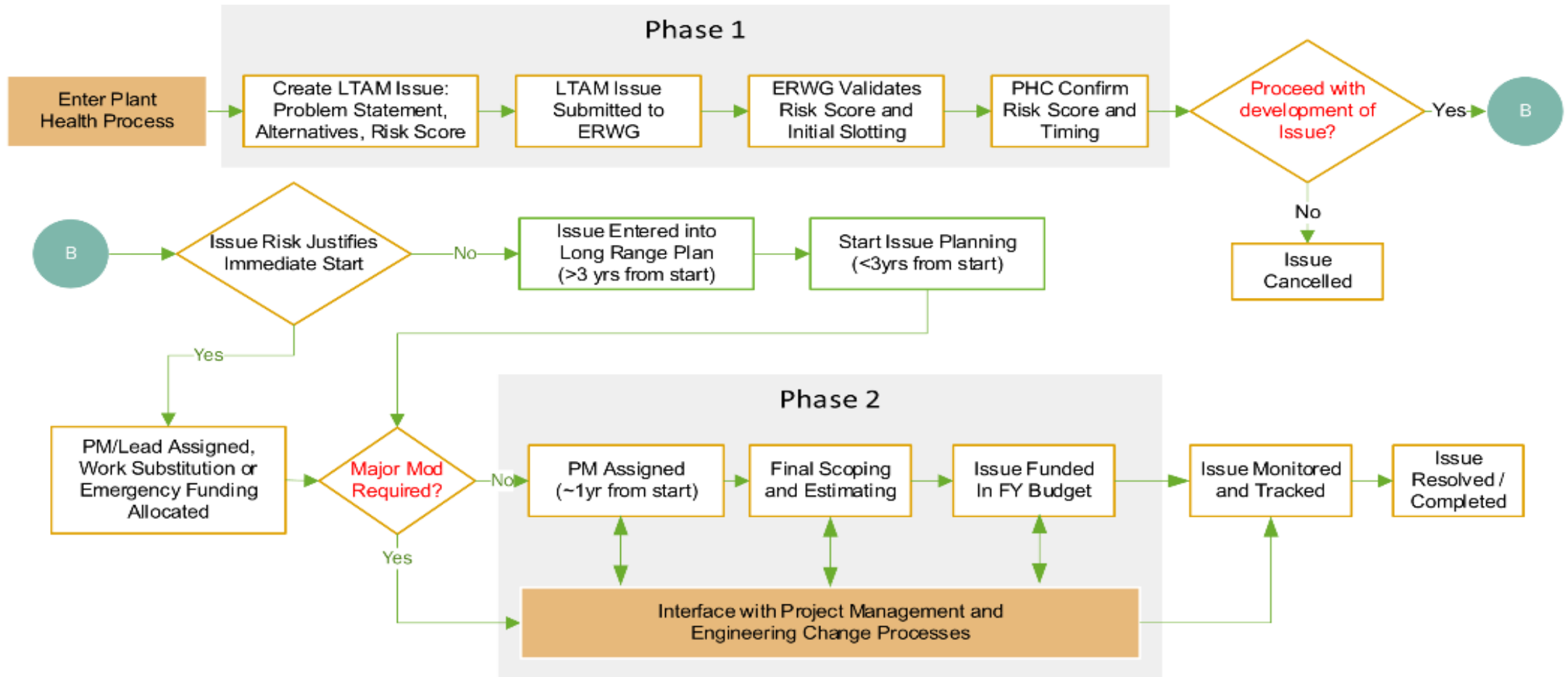
Ranking of Risk to Operations or Safety (High, Med, Low)

Numerical Scoring of Risk



# Plant Health/Equipment Reliability Program

## ATR Plant Health Process



# Primary Coolant Pump Refurbishment

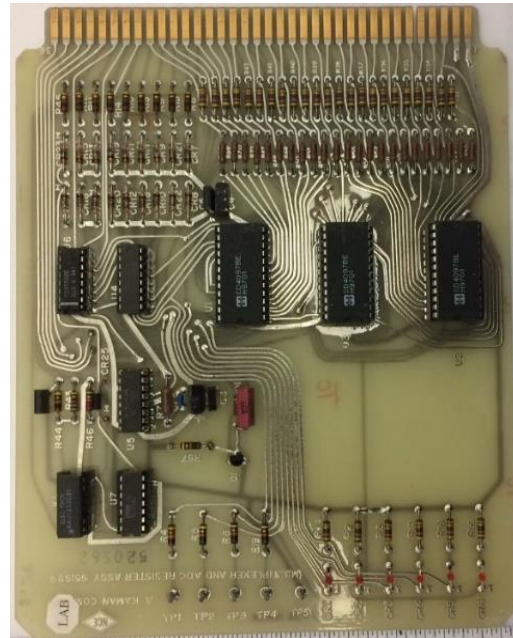
- Completed all (4) Primary Pump Motor Refurbishments
- Much less expensive than buying new pumps
- Rewound and refurbished motors
- Replaced pump rotating elements, bearings, and seals



# Protection System Surveillance and Test System (SATS) Rebuild Project

- System installed in 1978 and replacement parts are no longer available
- Reverse engineered original circuit boards
- Built new replacements utilizing modern design and manufacturing techniques
- Began replacements of circuit boards in 2020 and replacing some power supplies
- Backplane connections and wiring are still original, but this extends life by ~10-15 years

Original circuit board



New circuit board

# Reactor Data Acquisition System (RDAS) Replacement (VAX replaced with Emulator)

- Inspect & Replace Degraded I/O Signal Wires
- Replace RDAS Computer Platform (DAC/DAN) (Emulate VAX/VMS OS)
- Enhance Cyber Security Posture
- Replace Analog & Digital I/O Hardware
- Upgrade/Replace RDAS Software



# ATRC Upgrade – Control Console Replacement

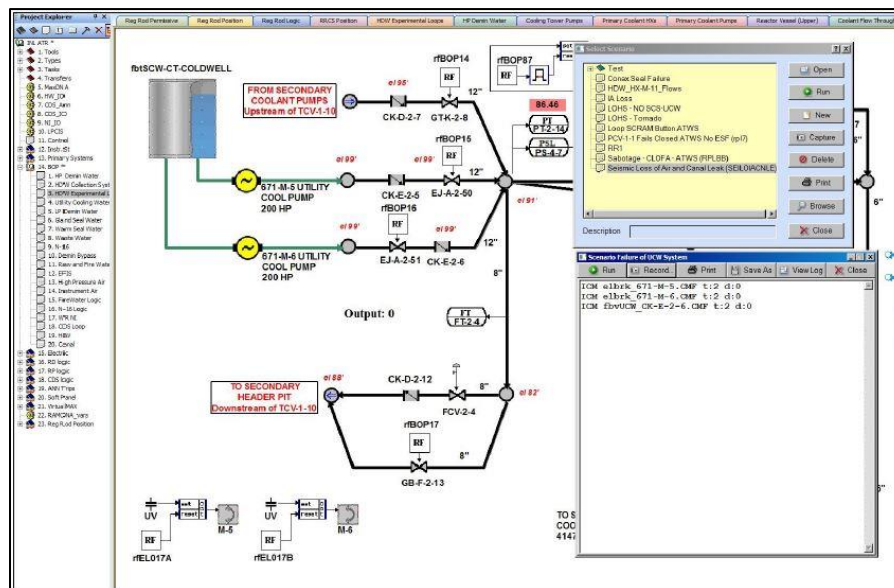
- Project
  - Completed mid FY-2020
    - On schedule and under budget
    - Feature article in ANS Nuclear News October 2020
  - Collaborative effort between Operations, Crafts, Engineering, and Subcontractor
  - 18-month design and 2-month installation effort



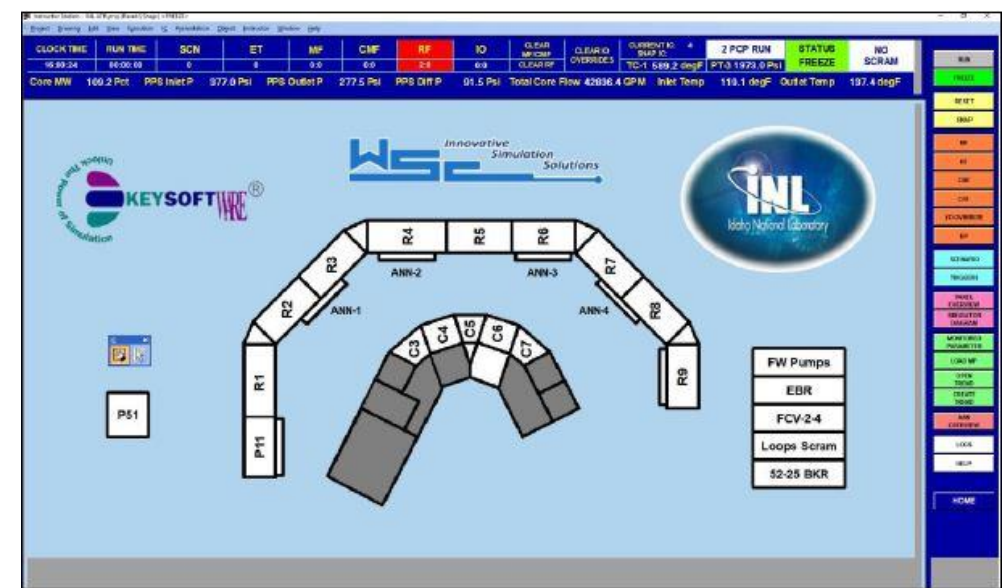
New Control Console

# Simulator Upgrade

- Upgrade completed on schedule and on budget
- Upgrade from 30-year old platform
- Increased fidelity in simulator to plant by modeling secondary systems to a greater extent
- Able to add external parameters such as air temperature, wind speed, wind direction and humidity
- Model developed using previous plant core and tested with actual plant parameters
  - Near perfect simulation of the plant
- Animated screens to visualize conditions in a modern object-oriented presentation

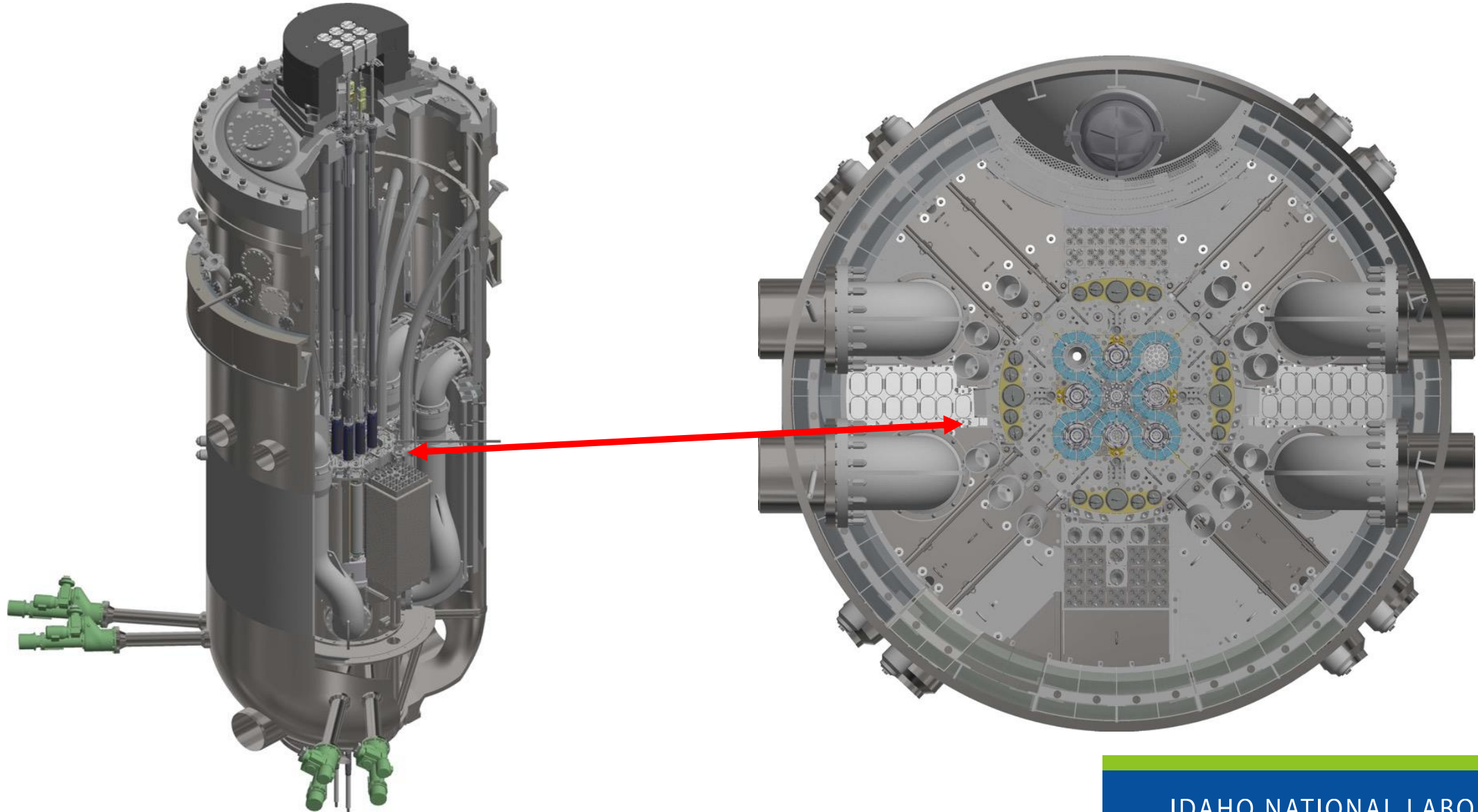


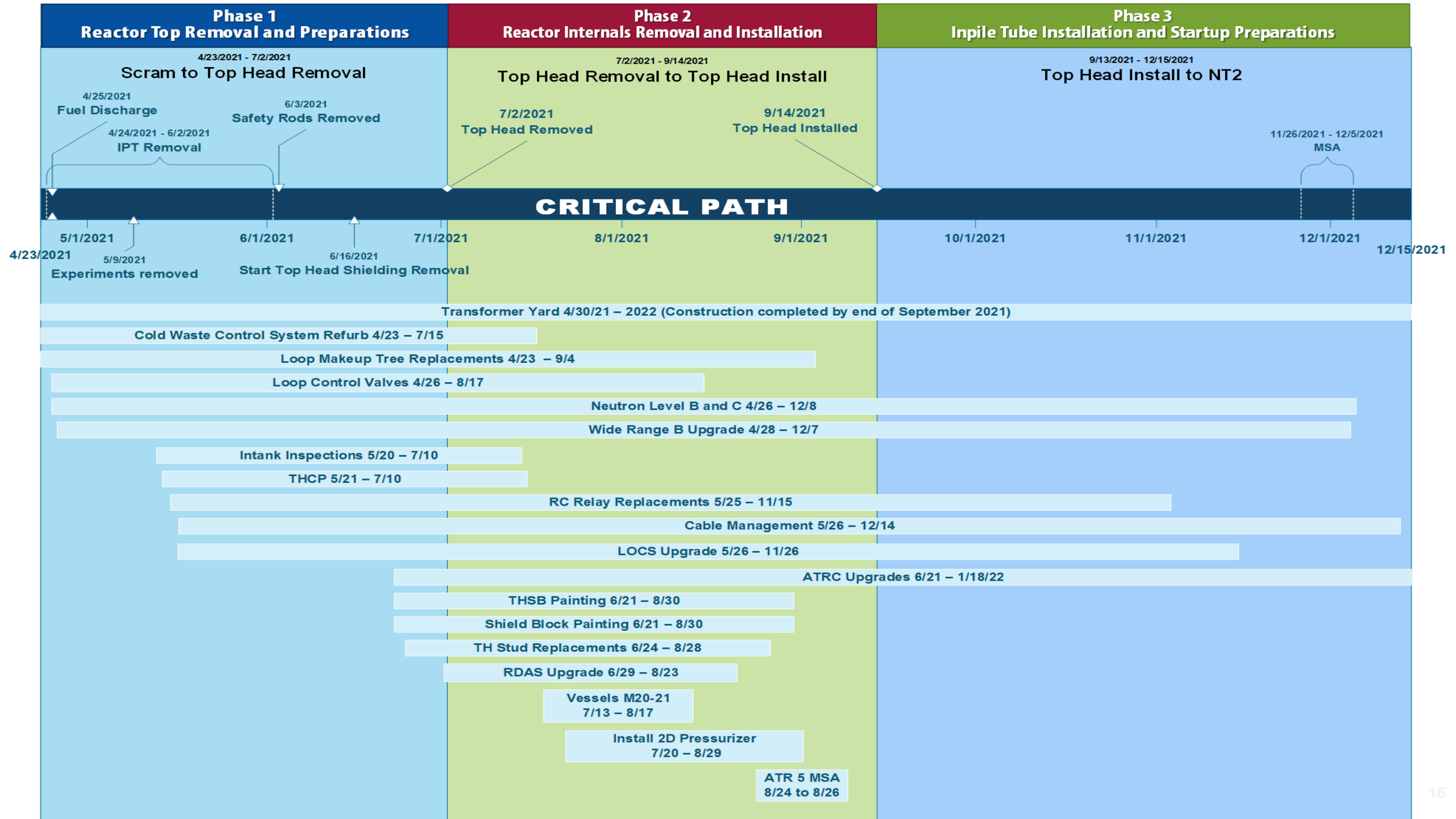
New software shows devices as they are connected



New Instructor Interface

# 2021: ATR Core Internals Change-Out (CIC-6)







# INL/ATR Mobile Work Package (MWP) Implementation

- DOE Complex leading MWP platform designed at ATR/INL
- ATR Maintenance staff provided INL business case, lead the pilot program, and initiated INL's first automated records process
- Leading INL MWP software development, mobile security protocol, implementation and training
- Supported INL with Covid-19 telecomputing, eSOMS, EDMS and Asset Suite-9 upgrades
- Started virtual and hands-on training with ATR staff using stationary & mobile devices
- As of 3/31/21 ATR completed 10 Work Orders in MWP from Asset Suite to EDMS record storage



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