Molten Salt Reactor Experiment Project Initiatives

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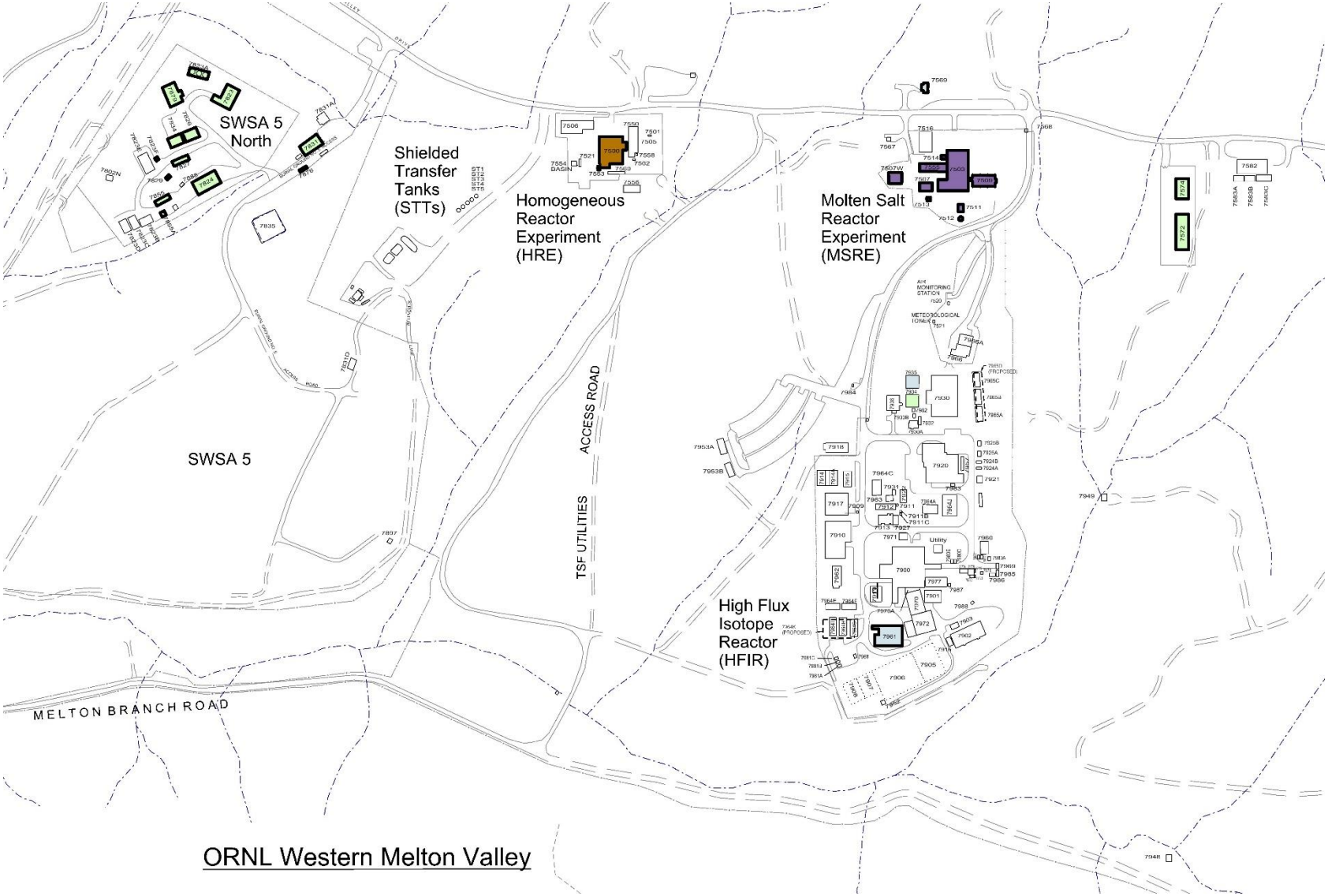
Facility Background

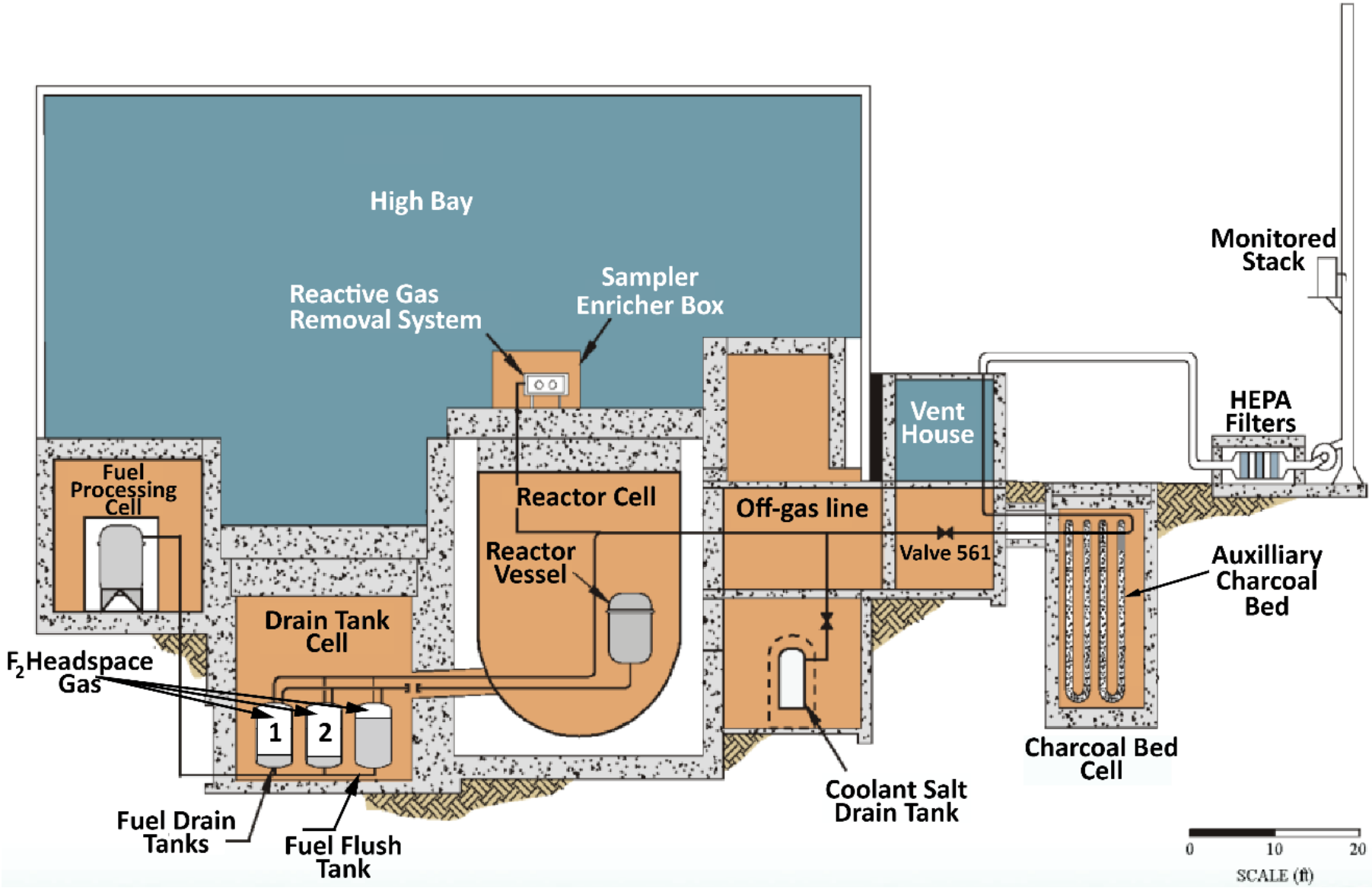
The Molten Salt Reactor Experiment (MSRE) is an experimental reactor at ORNL that successfully operated from 1965-1969

- Used molten fuel salt mixture
  - U-235 and U-233 fluoride salts
  - Trace of Plutonium (<1 Kg)
- Residual fuel salt remains stored in Fuel Drain Tanks today
  - In “frozen” state (density similar to concrete)
  - Contaminated with fission products
    - <2.5 kg U per tank
    - 98% of the radioactivity is from Cs-137 and Sr-90
  - Constantly generates fluorine gas from radiolysis

MSRE Location



General Facility Layout



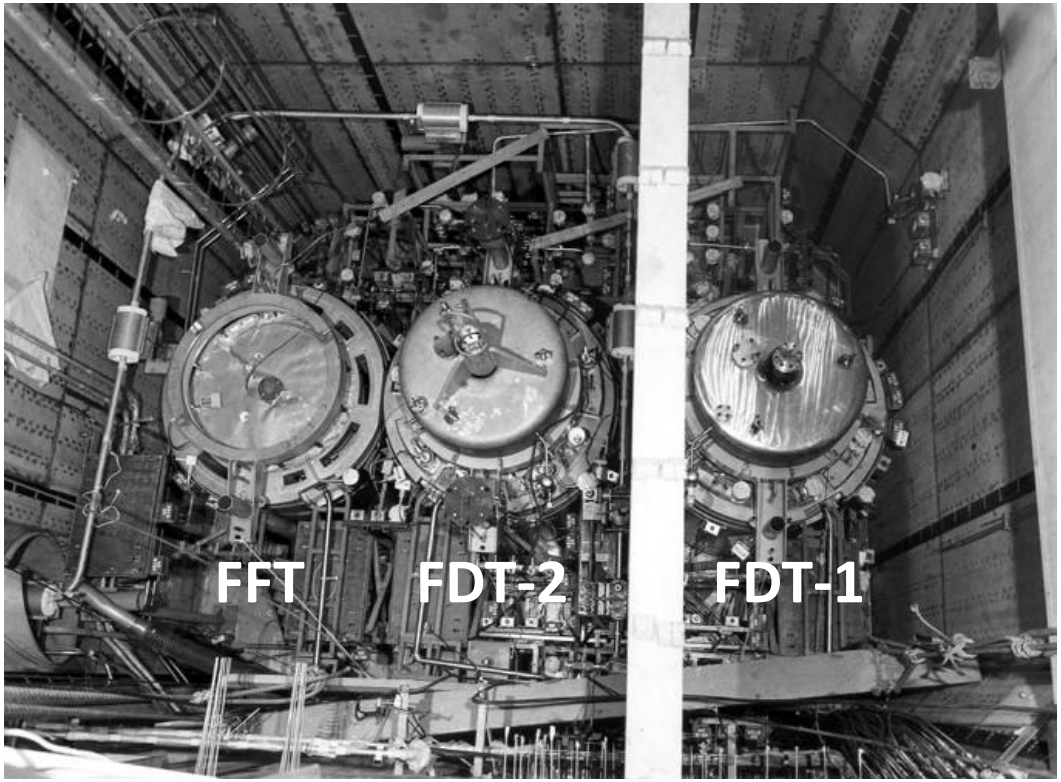
Key Operations

Timeframe	Notable Activities
After 1969 Shutdown	Fuel Salt drained into two drain tanks, and reactor loop flushed and drained to flush tank
1994	Positive confirmation of uranium migration • Significant concentrations of F_2 and UF_6 gasses in off gas system led to contamination of auxiliary charcoal bed
1995-2000	Cleanup of auxiliary charcoal bed, install Reactive Gas Removal System (RGRS)
2001-2008	Defueling, attempted salt transfer
2008-Present	Reactive gas management operations, surveillance and maintenance

Current Facility Operations

Constant generation of fluorine gas in the tanks poses the most immediate hazard at MSRE

- Fuel salt generates 2.63×10^{-4} or 0.000263 psia/hr of fluorine gas
- Tanks are held at vacuum (i.e. negative) pressure to prevent gas leakage into facility
- Fluorine gas is pumped out of tanks and sent through a treatment system every six months
- Significant maintenance is performed daily throughout the rest of the aging facility



Reactive Gas Removal System (RGRS) Operations

- Reactive Gas Removal System is used to remove fluorine and uranium contaminants during pumpdown cycles
- Several recent failures have occurred due to aging and non-optimal system design
  - Harsh fluorine environment degrades piping and components
- Continuous equipment, process, and procedure upgrades

Failed RGRS Discharge Line

2016 Engineering Evaluation

Engineering Evaluation was completed to identify recommended actions to assure reliable operations at MSRE

Two key recommendations:

1. Design and install a continuous vent and purge system to replace the Reactive Gas Removal System
   - Eliminate large concentrations of fluorine gas by current process
   - Eliminate risk from corroded RGRS components
2. Layup MSRE to address aging electrical systems, personnel, and environmental risks
   - Reduce risk of electrical system failures and hazards
   - Prepare facility for future decommissioning

Current MSRE Initiatives

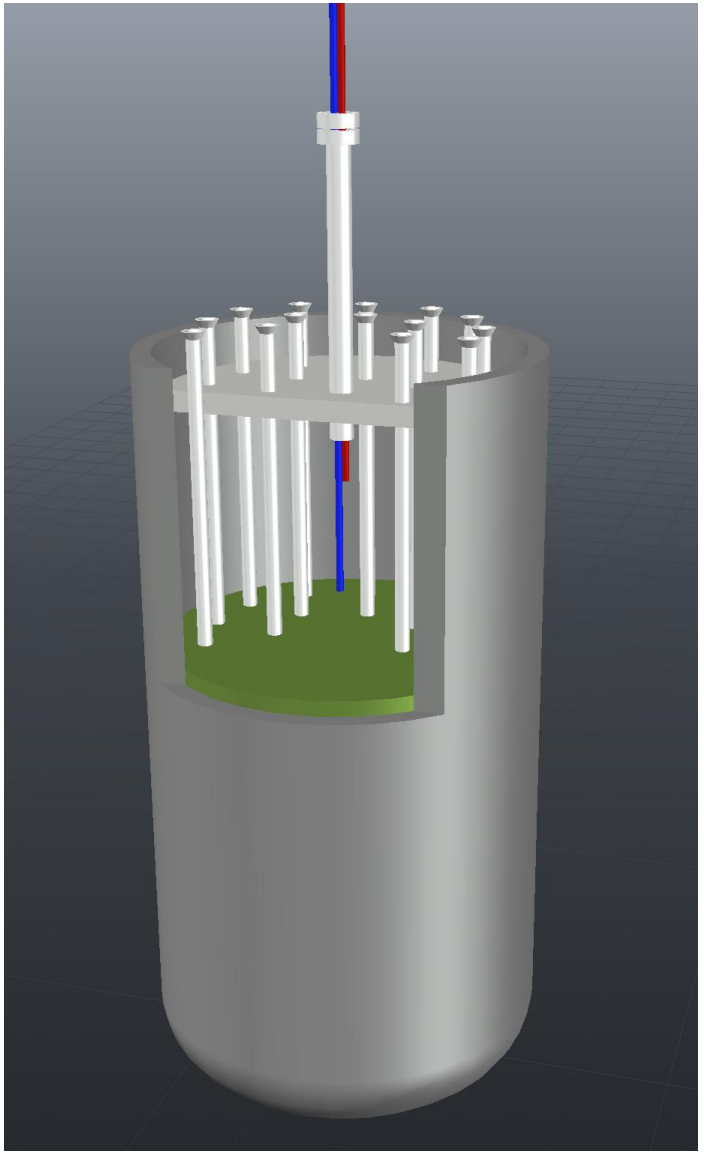
Three primary actions are underway at MSRE to improve reliability and long-term effectiveness:

- Continuous Purge System
- MSRE Layup
- In-Situ Decommissioning (ISD)

Continuous Purge System

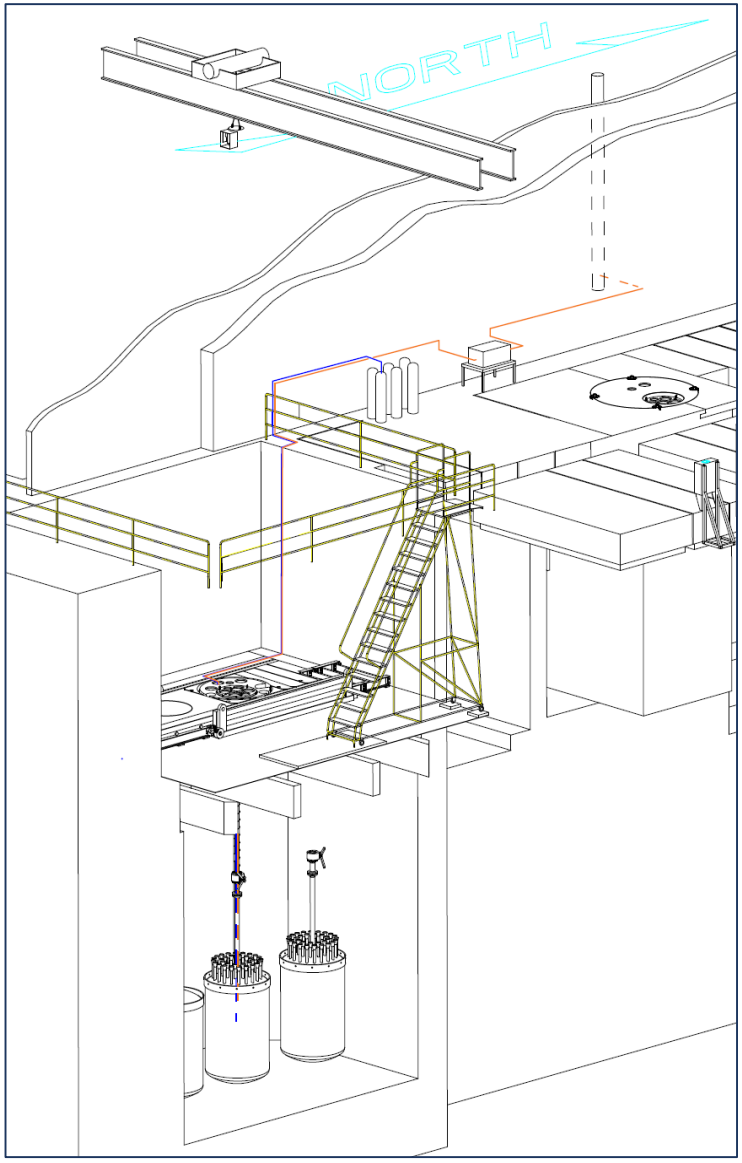
The Continuous Purge System is currently in the design phase and is expected to be operational by 2021

- Replaces the current Reactive Gas Removal System
- Streamlines the removal of hazardous gas
  - Minimizes process piping, components, and potential failure points within facility
- Reduces facility hazards, maintenance, and oversight
  - Less potential areas of exposure to facility workers
  - Passive system with significantly less maintenance
  - Operations will be less frequent, simplified



Continuous Purge System

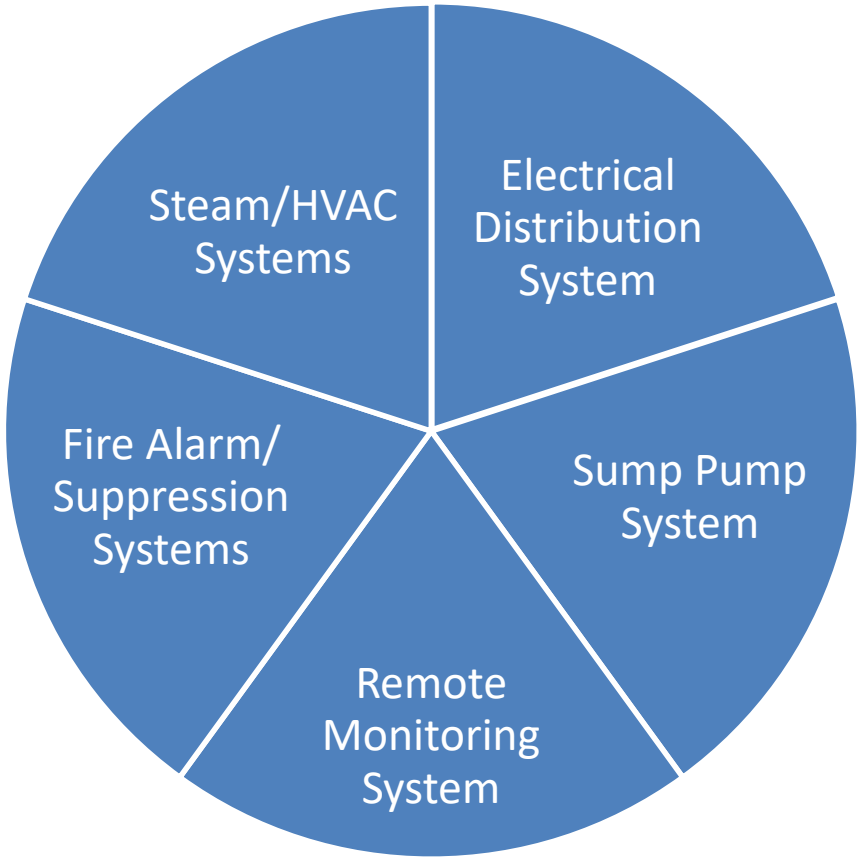
- Headspace gas will be purged with inert gas (i.e. nitrogen)
- Continuous venting of gas from the tanks
- Chemical traps will no longer be required
- Will be a more “hands-off” system, fewer operating costs
- Designed and built with materials compatible with F_2



MSRE Layup Project

Updating and isolating utilities will allow MSRE to be maintained in a safe condition at reduced costs while awaiting final D&D

- Replacing aging electrical systems for critical components
- Installing new sump pump system to provide increased reliability
- Reducing heating costs by minimizing steam system
- Installing Remote Monitoring System for remote operations of new Continuous Purge System
- Upgrading fire alarm system and isolating fire suppression from office buildings



Current Regulatory Framework for MSRE D&D

- Current CERCLA decision documents were completed in late 1990s:
  - 1996 Action Memorandum (DOE/OR/02-1488&D2)
    - Uranium deposit removal
  - 1998 Record of Decision (DOE/OR/02-1671&D2)
    - Treat and remove fuel and flush salts
- NRC has recognized entombment as a decommissioning option since the 1970s
- In-Situ Decommissioning Options were not significantly considered due to lack of evidence as a proven technology

Conceptual Feasibility Analysis

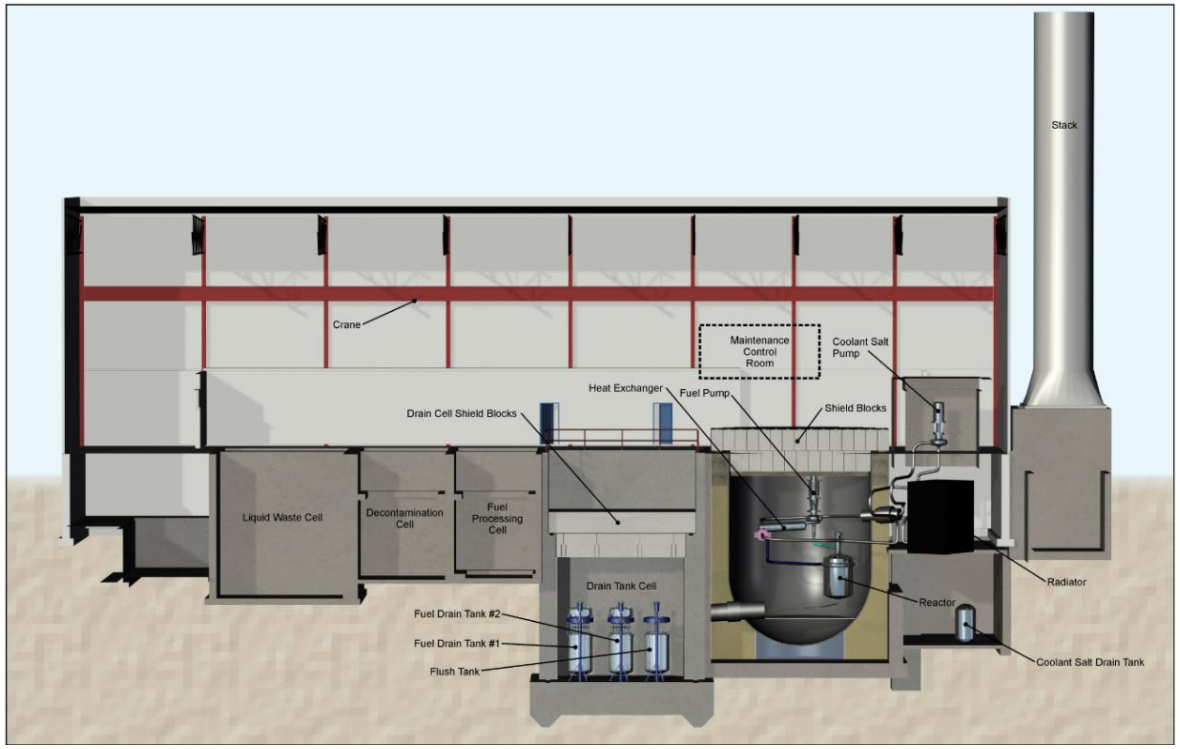
OREM directed a conceptual analysis of In-Situ Decommissioning to determine if the option should be further evaluated

- Utilized Subject Matter Experts at Savannah River National Laboratory
- Evaluated ISD successes at other DOE Sites and ORNL
- Evaluation Criteria established:
  - Implementability
  - Protection of Human Health and Environment
  - Cost
  - Land Use Controls
- Joint DOE, EPA, and TDEC workshop held at Savannah River Site

Next step planned is to conduct further evaluation in a revised CERCLA Feasibility Study, which may lead to a revision of the Record of Decision

In-Situ Decommissioning Strategy at MSRE

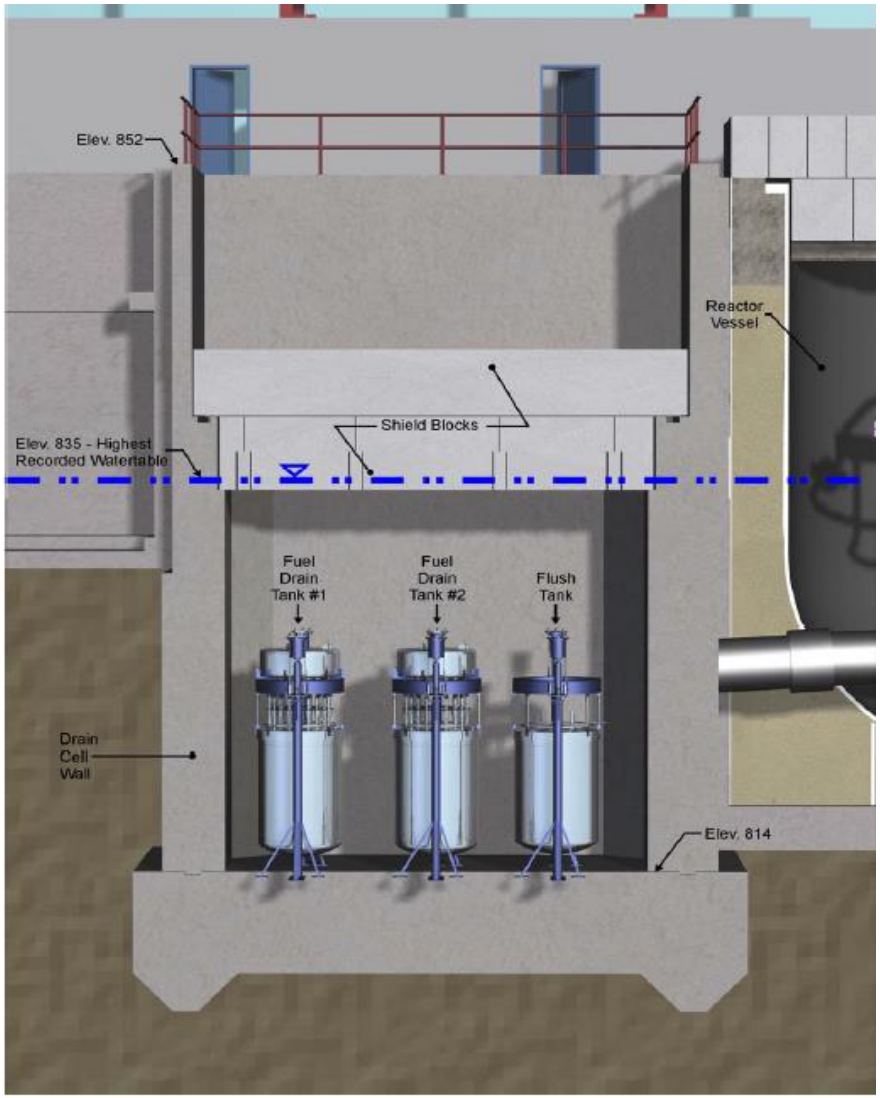
- ISD at MSRE would consist of grouting or “entombing” the contaminated below-grade structures in the reactor building
- Entering the Feasibility Study planning process to:
  - Evaluate the unique hazards and structures at MSRE
  - Identify and locate the required data that will be necessary for the study
  - Consider potential supplementary treatment options



Oak Ridge will be updating the RI/FS to include ISD

The update of the RI/FS will provide a thorough investigation to address:

- Options for extent of entombment
- Modelling of potential long-term releases
- Use of a “getter” material to capture fluorine
- Evaluation of grout materials to be used
- Monitoring systems required for long-term stewardship



Long-Term Monitoring and Stewardship

Under an ISD option, recommended post-closure controls and monitoring would include:

- Site access controls
- Surveillance and maintenance
- Groundwater monitoring
- Air monitoring
- Land use controls

Questions???