AVANTech INCORPORATED

Modular Cesium Removal Technology
Tank Side Cesium Removal (TSCR)

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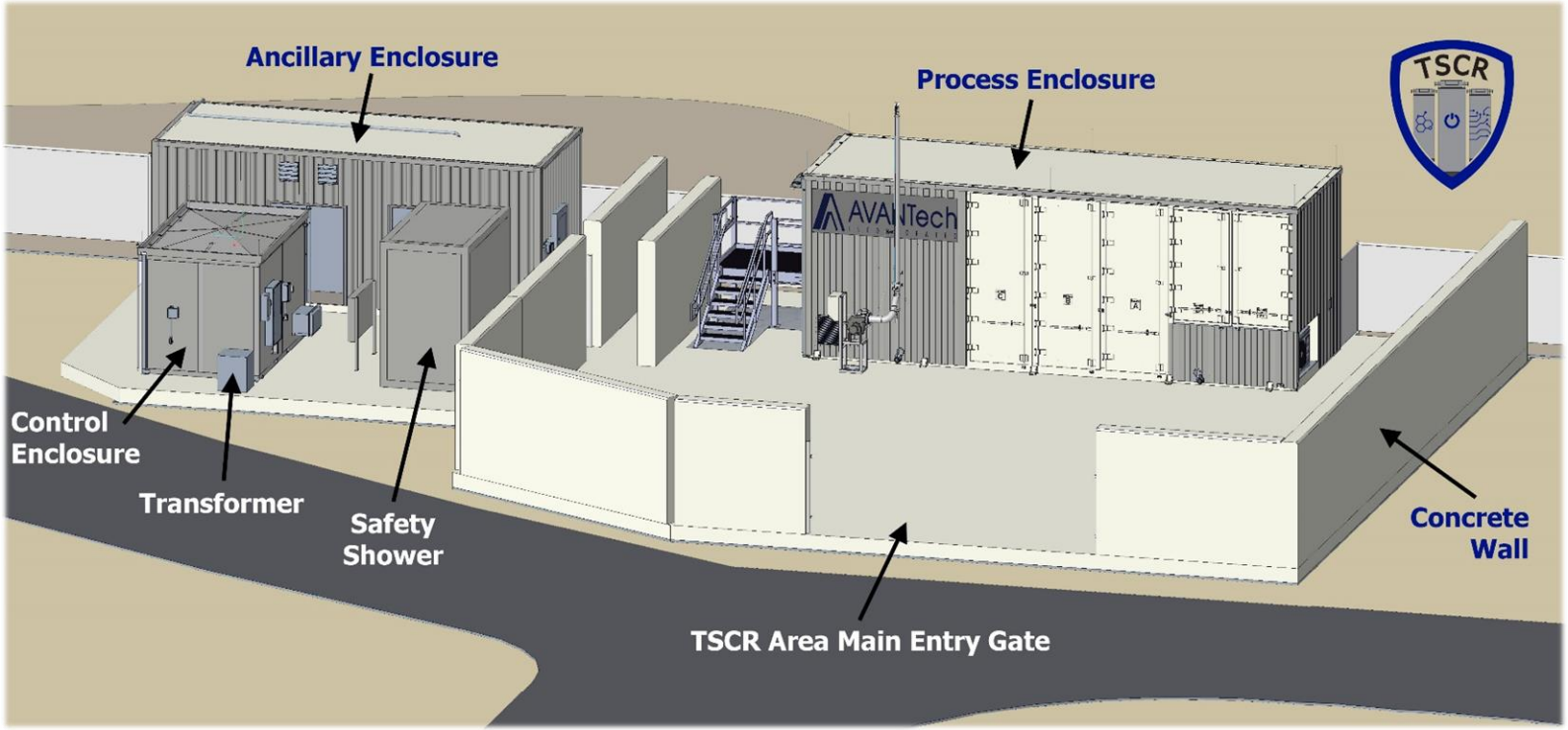
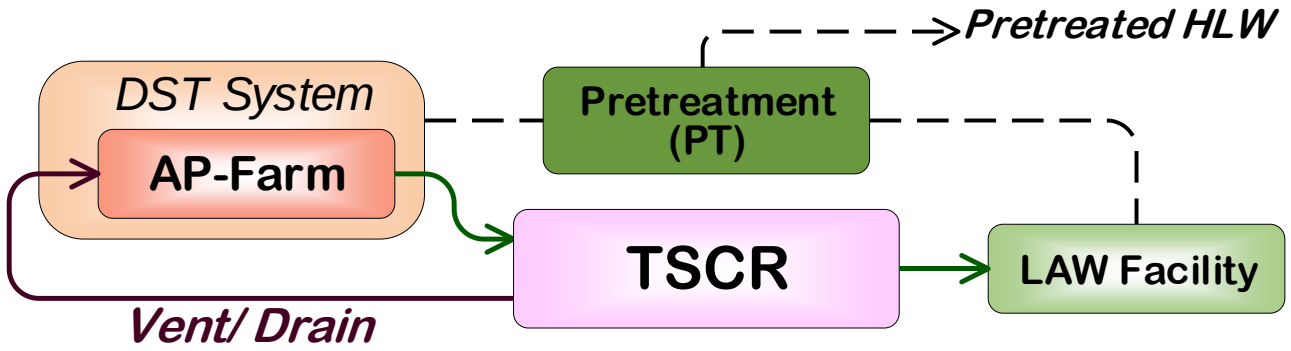


Tank Side Cesium Removal (TSCR) Objectives

- Demonstrates modular tank-side technology for treating waste supernatant
  - ✓ Filter solids using backwashable filter technology
  - ✓ Remove Cs-137 and Sr-90 with Crystalline Silicotitanate (CST)



TSCR Provides Early Feed to WTP-LAW Vit. Facility

- Early production of feed for WTP LAW-Vitrification commissioning and operation
  - ✓ **Bypasses WTP Pretreatment Facility**
  - ✓ Treated product meets WTP feed acceptance criteria
- Builds upon AVANTech's commercial Cs removal experience at Fukushima

Direct Feed Low Active Waste (DFLAW)

TSCR Facts
- 42 Ft. Long
- 12 Ft. Wide
- 12 Ft. Tall

AP FARM

Bypasses Pretreatment Facility

WTP PRETREATMENT (Work Halted 2012)

Storage of Separated Cesium For Future Disposition

TSCR

IXC-150 Storage

WASTE TREATMENT PLANT

TANK-SIDE CESIUM REMOVAL

LOW-ACTIVITY WASTE FACILITY

SUPPLEMENTAL LAW
- Onsite Grout
- Offsite Grout

Onsite Disposal

Waste Treatment Byproducts

Treated Waste

INTEGRATED DISPOSAL FACILITY

EFFLUENT MGMT FACILITY

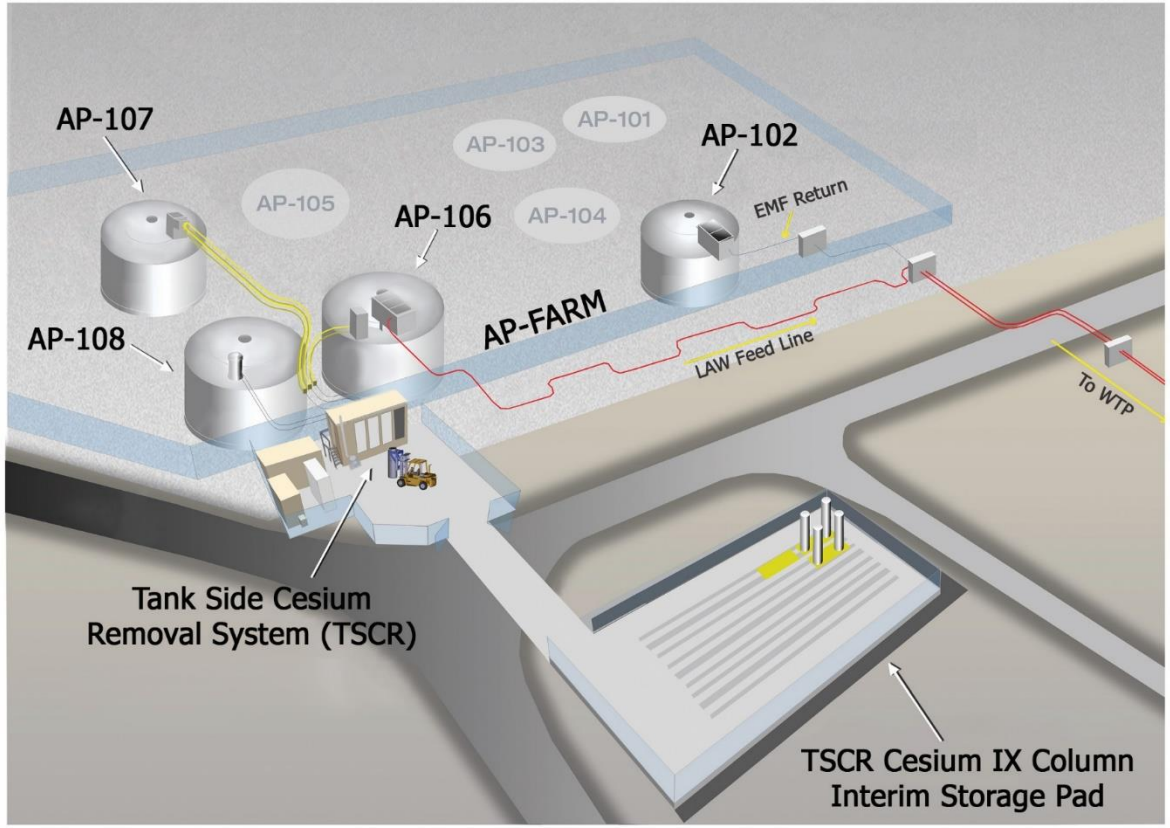
LIQUID EFFLUENT RETENTION FACILITY

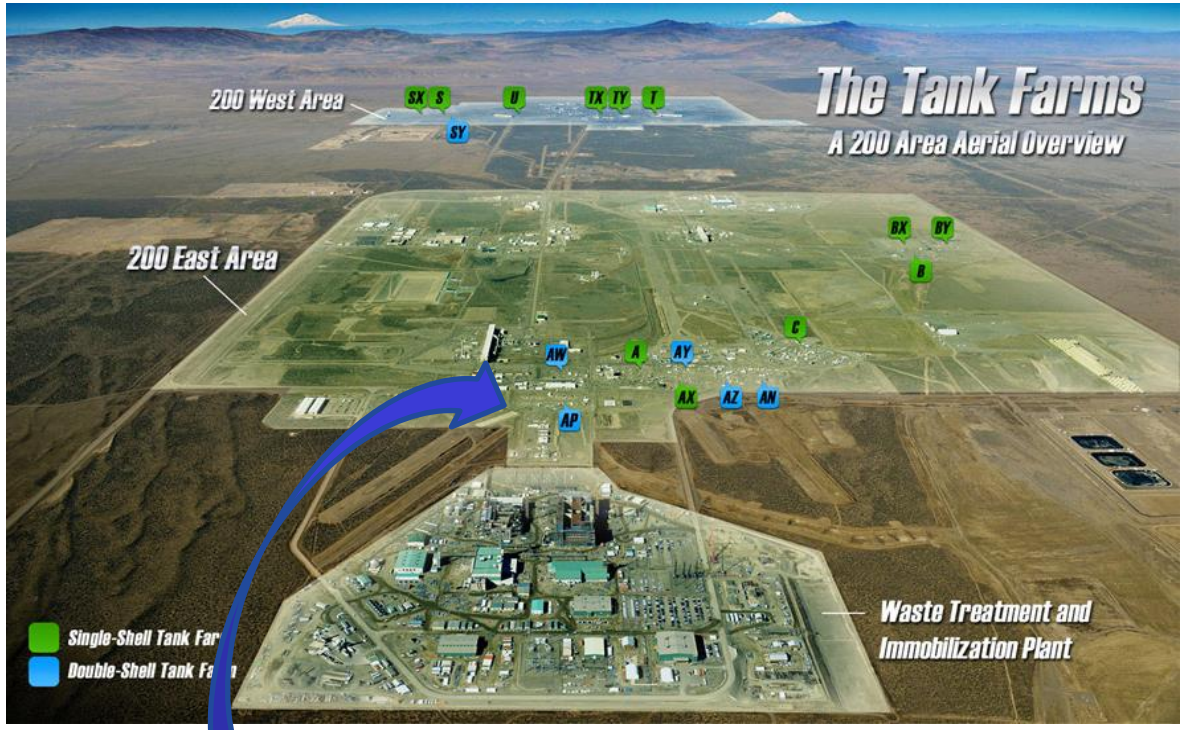
Effluent Treatment Facility (ETF)

Pretreatment Facility Facts
- 540 Ft. Long
- 215 Ft. Wide
- 120 Ft. Tall (12 stories)

Hanford – 200 Area

- TSCR located on edge of 241-AP Tank Farm

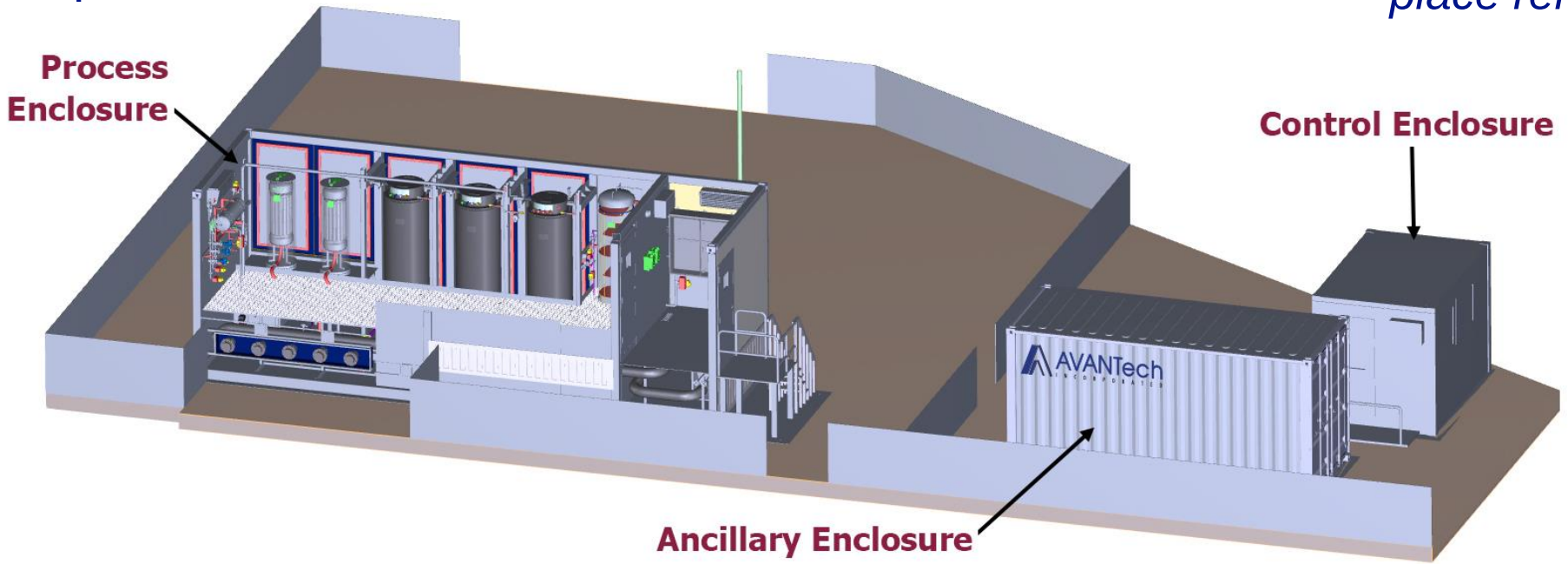




- Capable of treated 80% of Hanford tank waste

TSCR Overview

- Modular cesium removal technology within 3 enclosures
  - ✓ Process Enclosure
    - Contains all process and waste wetted components
  - ✓ Ancillary Enclosure
    - Air/ Water/ Reagent
  - ✓ Control Enclosure
    - Operator Workstation
      - *All operations take place remotely*



Technical Evolution of Cesium/ Strontium Ion Exchange Columns (IXC-150)

SCIX Prototype
2010
Water Cooling

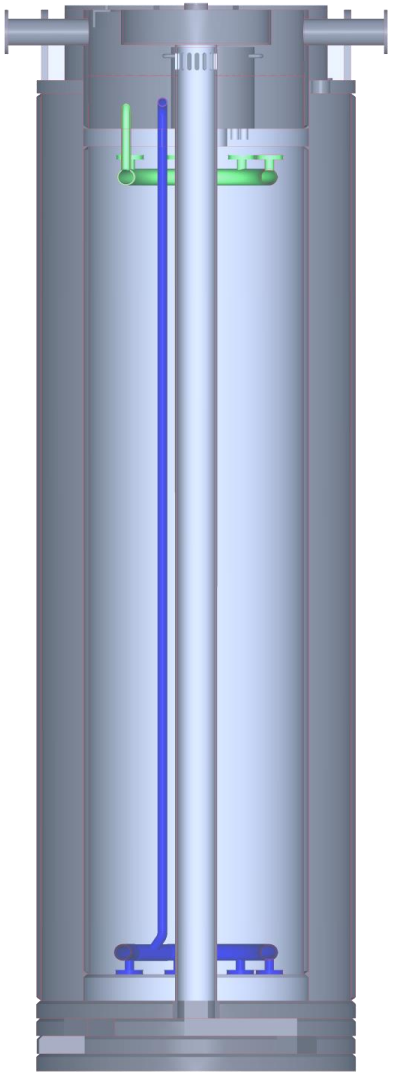
SARRY (Gen-1)
Fukushima – 2011
Air Annulus Limited Cs Loading

HERO (Gen-2)
Fukushima – 2015
Used Cooling Core to Increase Ci Loading

IXC-150 (Gen-2+)
Hanford TSCR
Improved Shielding

Description	SCIX	SARRY	HERO	TSCR
Cooling Features	Active Water Cooling	Convective air flow in annulus between shield and IX Vessel	Convective air cooling through cooling core and conductive cooling through IXC sidewall	Convective air cooling thru cooling core and improved conductive cooling thru IXC sidewall
Shielding	Inside tank, so tank structure provided shielded	Lead shot filled compartment around IX Vessel	Poured lead in removable annular cylinder around IXC	Poured lead in cavity formed by the IXC wall and outer shell
Handling Method	Placed in tank w/ crane. CST transferred to tank bottom for transfer to DWPF	Overhead crane. Spent IXCs with spent media placed in interim storage	Forklift Handling. Spent IXCs with spent media placed in interim storage	Forklift Handling. Spent IXCs with spent media placed in interim storage

Ion Exchange



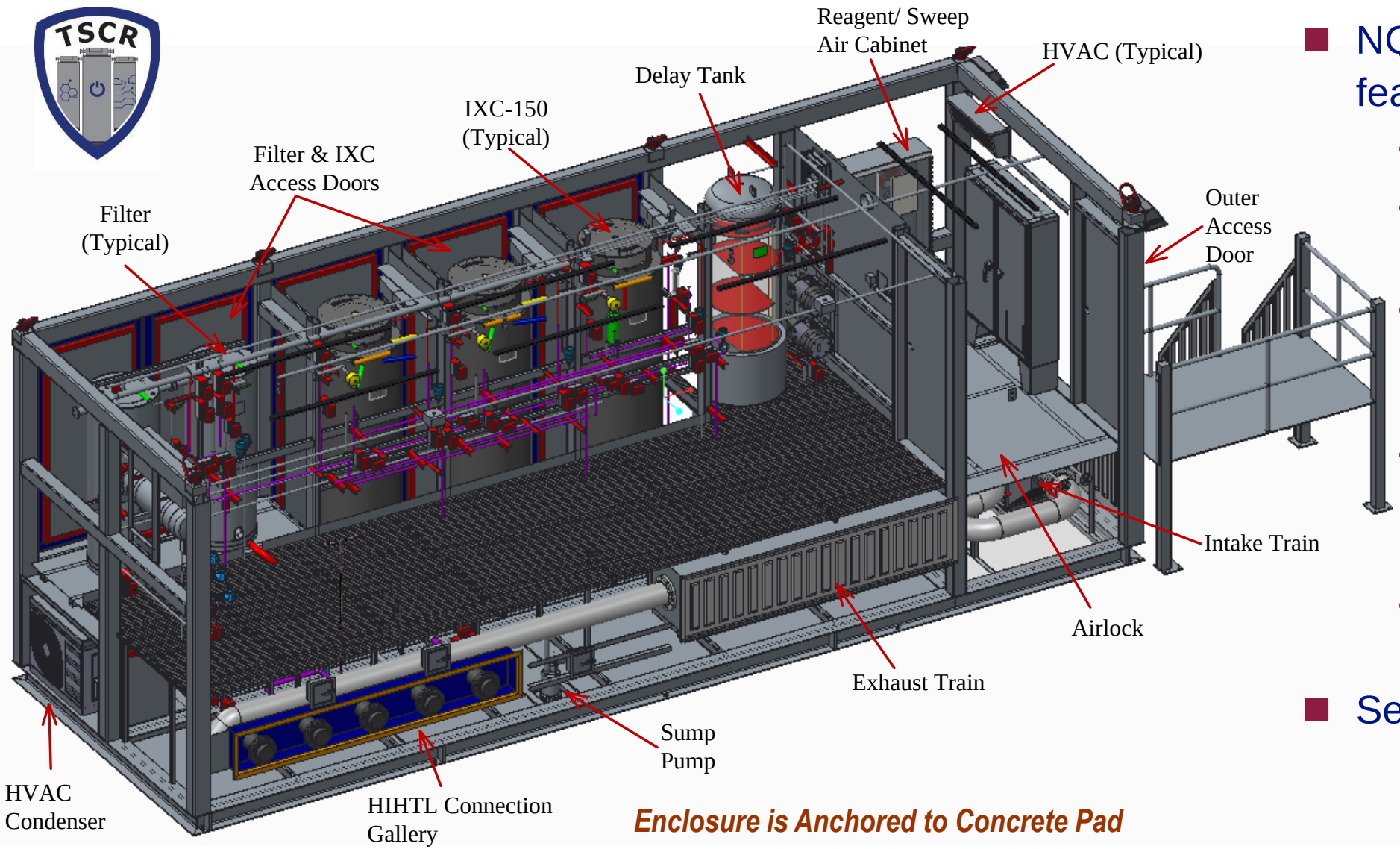
IXC-150

- Design for Crystalline Silicotitanate (CST) media
- High Cs-137 Capacity
  - ✓ 141,600 Ci
- Robust Structural Design
  - ✓ Design Pressure: 400 psig (ASME Section VIII)
  - ✓ Survives 36” vertical drop
- IX Column Internals
  - ✓ Support effective flow distribution as well as bulk dewatering/ drying
  - ✓ Good CST compatibility(1)
- Quickly replaceable
- Integral Self-Shielding
  - ✓ Reduces dose rates to < 5 mrem/hr
- Cooling Core
  - ✓ Aids in heat dissipation
  - ✓ **Mitigates IXC boiling under liquid filled static conditions - (580 W Decay Heat)**
- Simplified Contact Handling
  - ✓ Compatible with forklift or overhead hoist
- Passively Safe Storage
  - ✓ > 50-yr interim storage

IXC-150 on TSCR Forklift

(1) *AVANTech and UOP have partnered for more than 7 years to deploy over 200,000 kilograms (53,000-gal) of UOP CST adsorbents in systems designed and manufactured by AVANTech.*

TSCR Process Enclosure



Enclosure is Anchored to Concrete Pad

- NQA-1 safety significant features:
  - Spray leak knockdown
  - Containment of media & waste from H_2 detonation
  - Protects safety-significant components within enclosure during NPH
  - Enclosure has guides & restraints that protect it from forklift damage
  - Lockable to prevent inadvertent entry
- Seismic Category 2

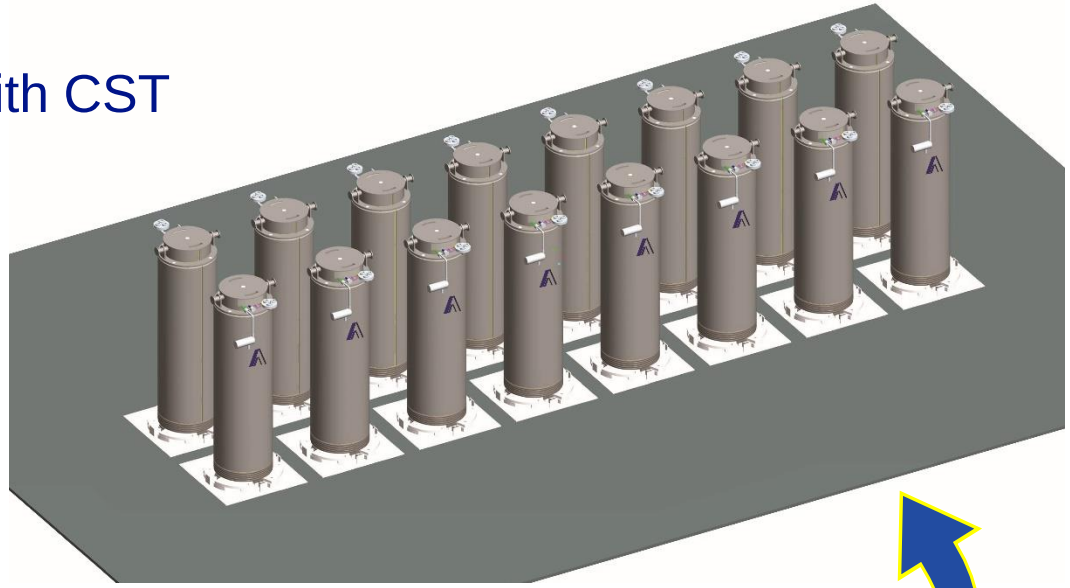
IXC Handling and Storage

- TSCR Forklift Used for:
  - ✓ Unloading of freshly loaded Ion Exchange Columns (IXC-150's)
  - ✓ Insertion and removal of Filters and IXC-150's
  - ✓ Movement of IXC-150's to Interim Storage Pad
- Features
  - ✓ Mast Height Restrictor
    - Maintains IXC-150 height within 36-in of ground level
  - ✓ Wet Chemical fire suppression system
- Mimics handling at Fukushima
  - ✓ Eliminates need for cranes and onsite use of transport trailers

Forklift & Yoke for TSCR Filter & IXC-150

IXC-150 Handling

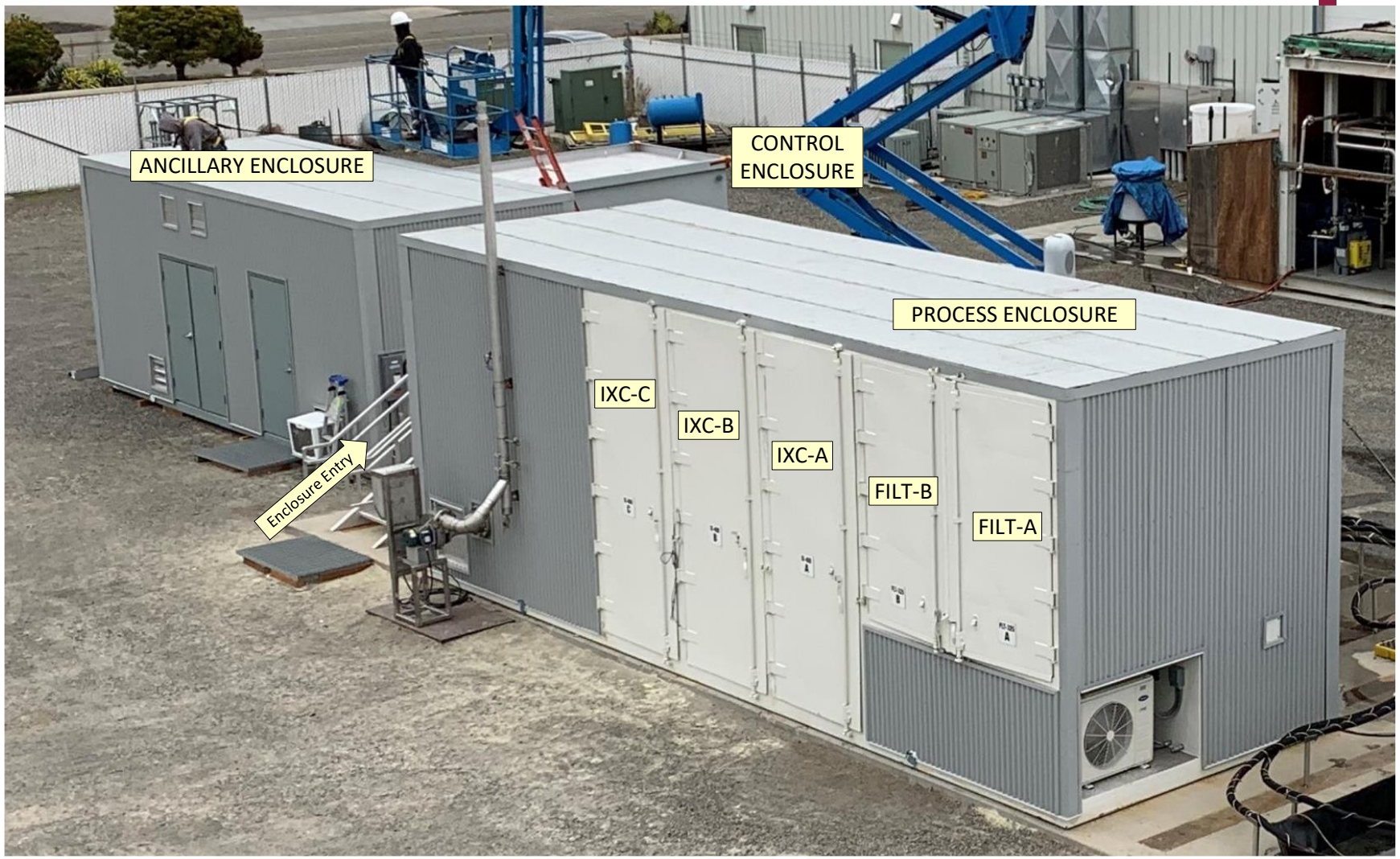
- **Transporter:** Delivers new IXC-150 loaded with CST
  - ✓ CST washed, loaded and rinsed by AVANTech *(at Richland facility)*
- **Forklift:** All onsite IXC handling and movement



- *IXC-150*
- *Forklift with Yoke*
- *Truck with Transporter*

Factory Acceptance Testing (FAT) – Richland, WA

- Verify/ Validate
  - ✓ System operation
    - Control logic
    - Pressures, flows, etc.
    - IXC carousel rotation
    - Filter backwashing
  - ✓ Transient Recovery
  - ✓ CST Recovery
- Train operators
  - ✓ Procedure refinement
- Train craftsmen
  - ✓ IXC replacement
  - ✓ Forklift operations



TSCR Arrangement for FAT at AVANTech's Richland Facility

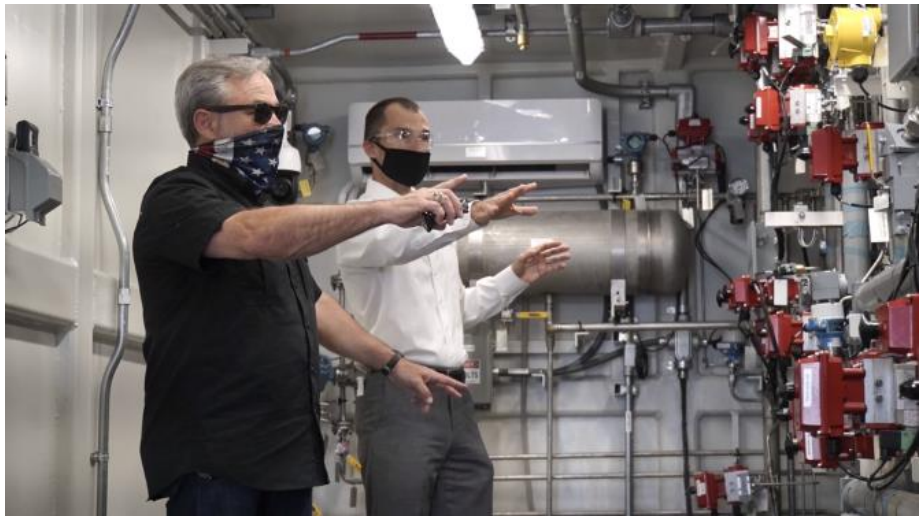
Results from Lab, Pilot and Factory Testing

- CST will effectively remove Cs from Hanford Tank Waste.
- TSCR filter technology will enable uninterrupted/ continuous operation (24/7).
- H_2 is effectively managed by sweep air, IXC vent assemblies and specific administrative controls (SAC).
- The TSCR forklift & yoke has proven to be an effective method of filter and IXC handling.
  (Same technique as used by AVANTech at Fukushima)
  - ✓ Eliminates rigging
  - ✓ Maintains IXC-150's close to the ground
  - ✓ Forklift used for all handling/ movement operations, thus eliminating need for separate crane, trailer, etc.
- FAT has shown that a modular treatment system is an operationally viable method of tank waste treatment.

TSCR HMI-Control Station

TSCR Mobilization and Delivery

- Pre-Ship Inspection by Sec. Brouillette



- Mobilization from AVANTech

- Process Enclosure Offload at AP Farm

- TSCR Delivery to AP Farm

Technology to Meet Nuclear Challenges!

AVANTech Facility – Columbia, SC

- ✓ Engineering Excellence
- ✓ Process Innovation
- ✓ Advanced Manufacturing
- ✓ NQA-1 Quality
- ✓ Qualified Personnel

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AVANTech Facility – Richland, WA