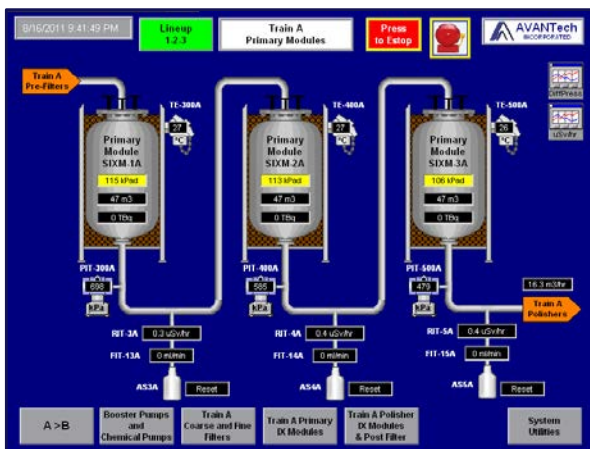


# Fukushima Liquid Waste Treatment

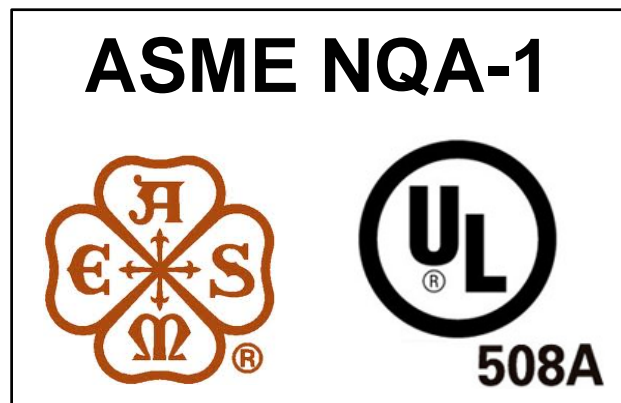
James L. Braun  
jbraun@avantechinc.com

43<sup>rd</sup> Waste Management Conference ▪ WM2017

## Process Design & Automation



## Standards & Certifications



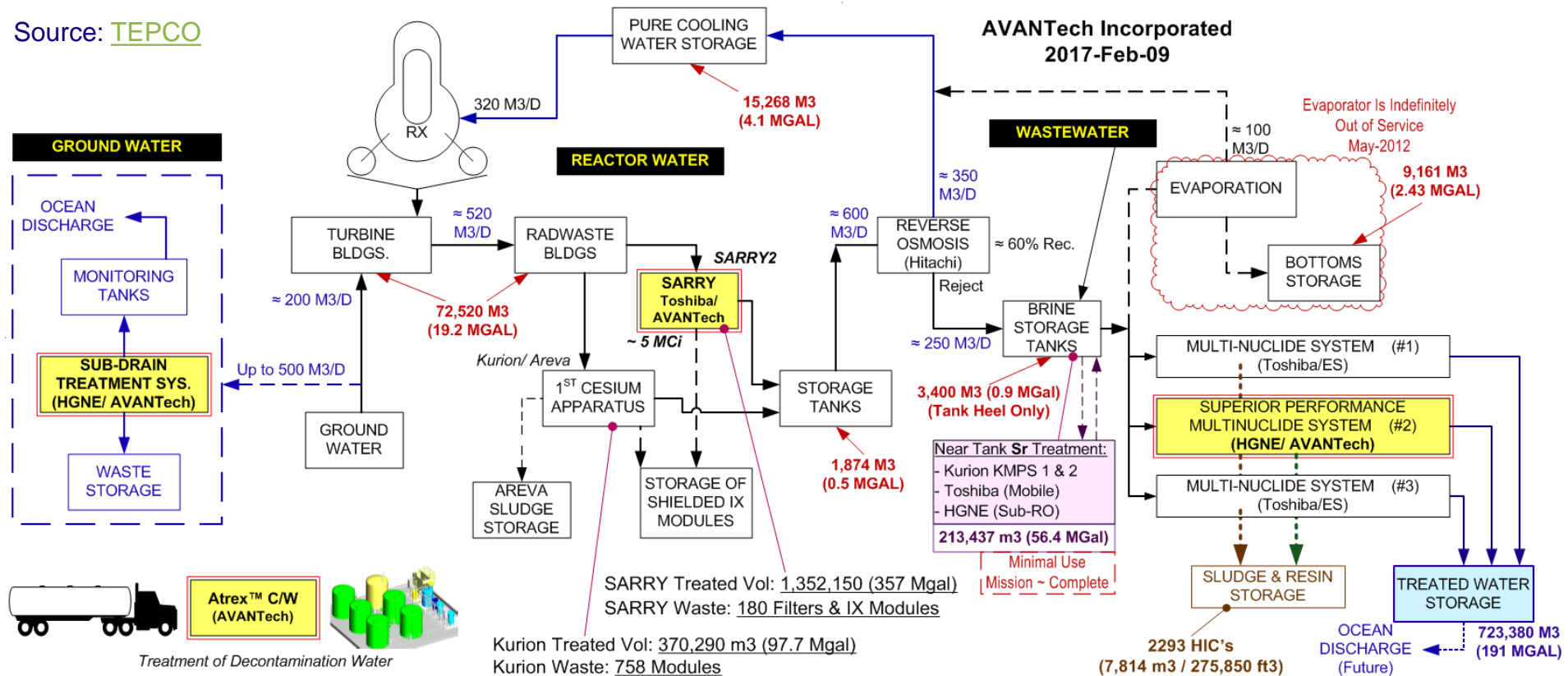
## Manufacturing Excellence





# Liquid Waste Treatment Systems

Source: [TEPCO](#)



## Groundwater

- ✓ Subdrain vessels
- ✓ Subdrain A replacement

## Reactor Cooling Water

- ✓ 1<sup>st</sup> Cs Apparatus (Kurion/Areva)
- ✓ 2<sup>nd</sup> Cs apparatus (SARRY)

## Sr Treatment

- ✓ Multiple systems

## Reverse Osmosis Units

## Contaminated Water (Brine)

- ✓ Multi-nuclide 1
- ✓ Multi-nuclide 2
- ✓ Multi-nuclide 3



# Emergency Response: The AVANTech Technical Approach



Strategic Alliance with  
AVANTech



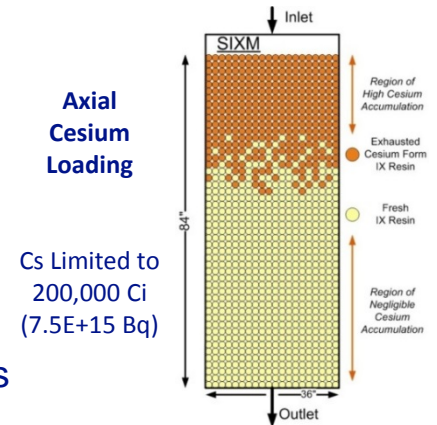
## ■ Important Underpinning

- ✓ CST testing at DOE sites
- ✓ Comprehensive CST evaluation
  - Thermal
  - Radiological
  - Material stability

## Safely Managing 200,000 Curies of Radioactive Material

## Challenge 1 – Cesium Removal

- Engineered Zeolite
  - ✓ Primary ion exchange
  - ✓ Good axial distribution
- Crystalline Silicotitanate
  - ✓ Polishing ion exchange
  - ✓ Distribution coefficient ( $K_d$ ) > 20,000
  - ✓ Complete activity removal in a single pass



## Challenge 2 – Shielding



### Integral Shielding

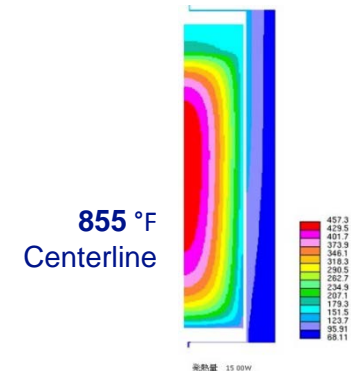
≈ 6" Pb equiv.

### Loaded Wt.:

≈ 23 mt (50,000 lbs)

## Challenge 3 – Heat Generation

- Passive Cooling
- Contact Handled
- Long Term Storage





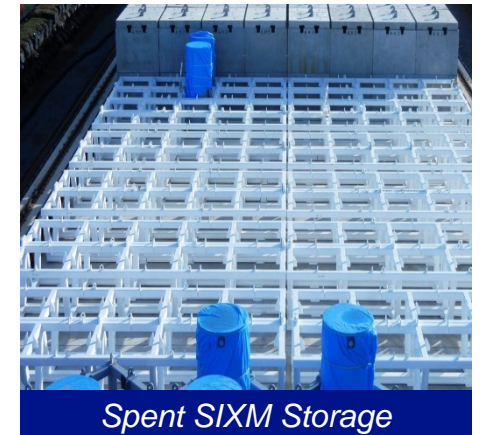
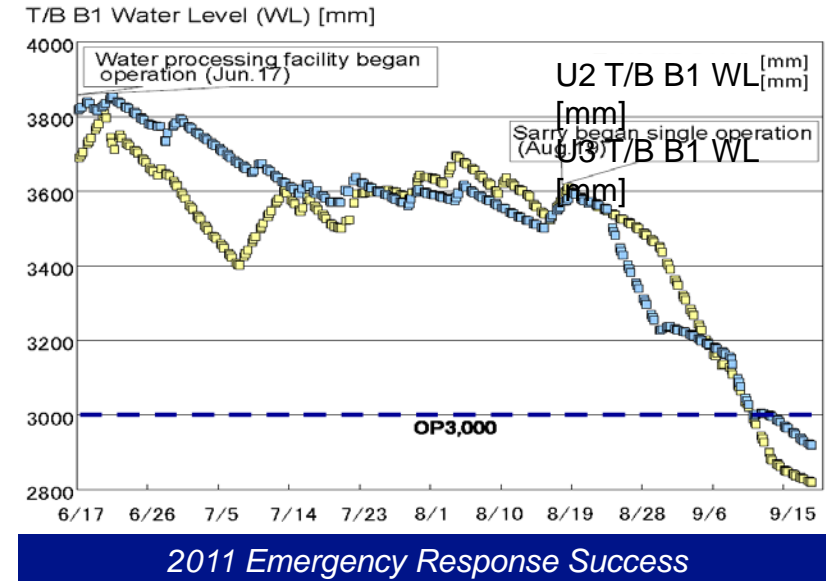
# Rx Coolant – SARRY Performance Parameters

## ■ SARRY (Simplified System)

- ✓ Treatment Capacity: 88 gpm/train
- ✓ Cs Decon Factor:  $>1.0E+06$
- ✓ Design Cs Loading: 261,000 Ci
- ✓ Actual Cs Loading:  $>150,000$  Ci
- ✓ Contact Dose:  $<50$  mrem/h
- ✓ Decay Heat Limit: 2,860 W

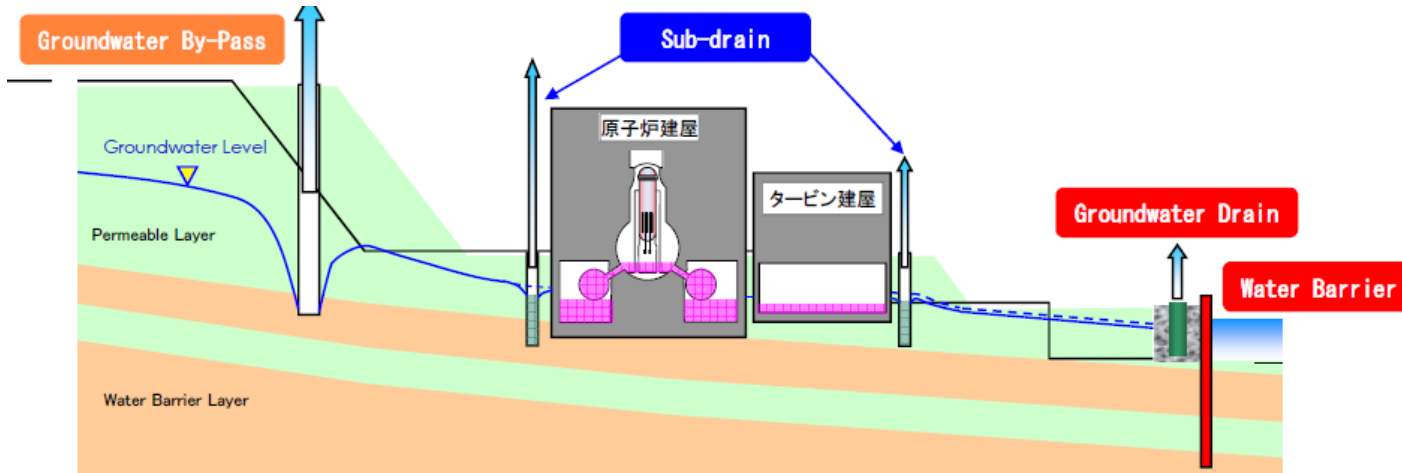
## ✓ Features

- Japanese nuclear safety compliant (TRL-9)
- Minimal facility/utility requirements
- SIXM qualified for interim storage
- No media transfers
- Contact handling
  - ◆ Raised walkways for easy access
  - ◆ No remote tools required
- Passively safe



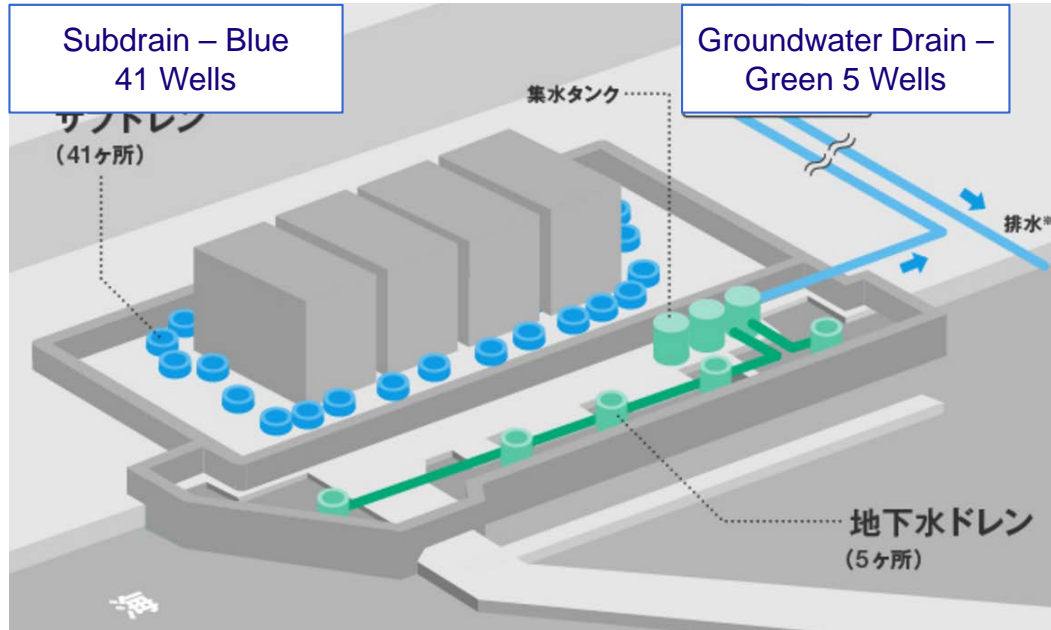


# Groundwater/Subdrain



## Groundwater Management

- Groundwater Bypass
  - ✓ Reduces level at reactor
  - ✓ Pumped directly to ocean
- Subdrain
  - ✓ Treat localized groundwater
  - ✓ Treat and release to ocean
- Groundwater Drain
  - ✓ Treated final groundwater
  - ✓ Treat and release to ocean



Installed Subdrain System



# Subdrain Treatment System

- Configuration
  - ✓ Series of 4 filters and 5 ion exchangers
- Performance Parameters
  - ✓ Dual train
  - ✓ 50 m<sup>3</sup>/h (220 gpm) per train
- Targeted Radionuclides
  - ✓ Sr, Cs, Sb, activated metals
- Effluent
  - ✓ Monitored and discharged to ocean
- Treatment Technologies
  - ✓ High capacity dead-end filters
  - ✓ Colloid filters
  - ✓ Selective adsorption media



*A-Train Replacement*

**Subdrain Vessels and A-Train Replacement Delivered in 2016**



# Brine: Multi-nuclide Treatment Systems

- Multiple systems increased throughput to meet government deadline of May 2015
- ALPS and Improved ALPS
  - ✓ Applies iron and carbonate co-precipitation to remove majority of radioactivity prior to selective IX
- High Performance ALPS
  - ✓ Fully media based system (no sludge production)



*High Performance ALPS (20 IX Units)*

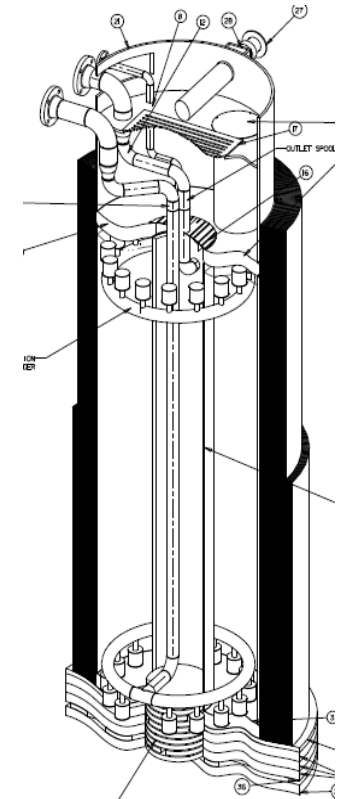
Item	Improved ALPS	High Performance ALPS	Existing ALPS
Treatment Volume	At least 250 m <sup>3</sup> /day/unit	At least 500 m <sup>3</sup> /day/unit	250 m <sup>3</sup> /day/unit
Number of Systems	3 units	1 unit	3 units
Pre-Treatment Method	Coagulating sedimentation method	Filter method	Coagulating sedimentation method
No. of Absorption Towers	18 towers	20 towers	14 towers + 2 towers
Seismic Resistance Class	Equivalent to Class B	Equivalent to Class B	Equivalent to Class B
Removal Capabilities	62 nuclides to ND level (excl. tritium)	62 nuclides to ND level (excl. tritium)	62 nuclides to ND level (excl. tritium)
Waste Generation	N/A	To the extent of 1/20 of the existing ALPS	N/A



# SIXM2: 2<sup>nd</sup> Gen. Shielded Ion Exchange Module

- Improved Heat Dissipation
  - ✓ Enables increased Cs and Sr accumulation
- Better Flow Distribution
  - ✓ Increased media utilization
  - ✓ Bi-directional flow capability
- Improved Corrosion Resistance
  - ✓ Duplex SS (2204)
  - ✓ Super Duplex SS (2507)
- Simplified Design
  - ✓ Less piping
  - ✓ Easier to manufacture
- Improved Pipe Configuration
  - ✓ No external piping
  - ✓ Fewer nozzles and improved spent media extraction port

## AVANTech Manufacturing Facility, Columbia, SC



*Produced 6 SIXM2s/wk during peak manufacturing*





# Location: AVANTech Equipment & Services

## ■ Hitachi-GE

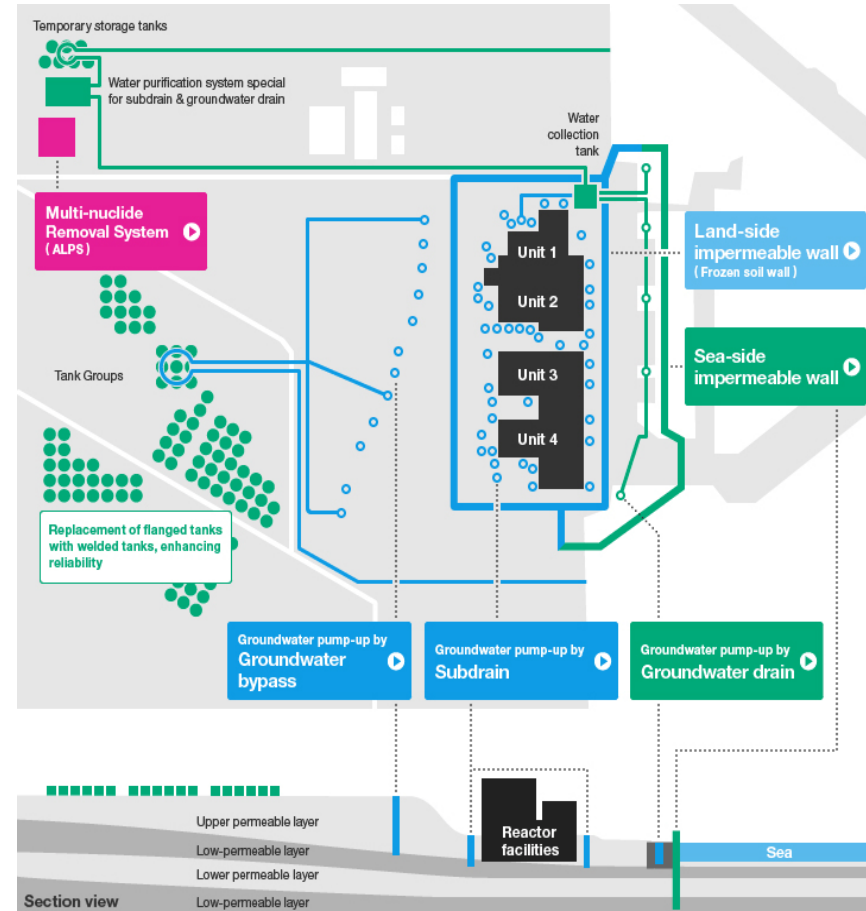
- ✓ Subdrain, SARRY-2, High Performance ALPS, Decontamination Water System



High Performance ALPS



Subdrain



## ■ Toshiba

- ✓ SARRY



SARRY



Onsite Support

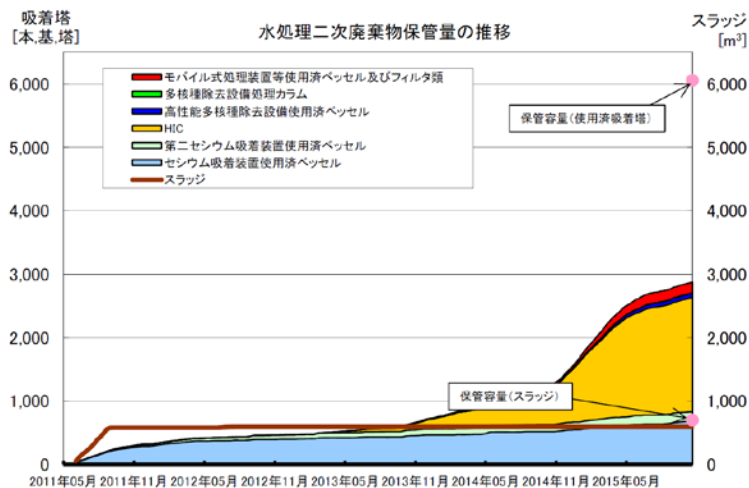


# Next Challenge – Waste Packaging

## Waste Storage Facilities 1, 2, 3, and 4



## Secondary Waste Generation



## AVANTech Technologies

- Waste Packaging
  - ✓ 300-year certified life
  - ✓ Packaging efficiency
  - ✓ Cost minimization
- Waste Stabilization
  - ✓ NRC certified
  - ✓ TCLP
  - ✓ Most efficient waste packaging

## AVANTech Goals

- ✓ Technically certified technologies
- ✓ Reduce TEPCO cost
- ✓ Simple technologies

## Technological Solutions for Challenging Problems