Hanford, Washington
Waste Treatment Plant

Treating and Vitrifying the Worst Mixed Nuclear and Chemical Waste in the History of the World

By Bob Stevens

(Straight from the Horse's Mouth)

Project Engineering Manager (Retired)

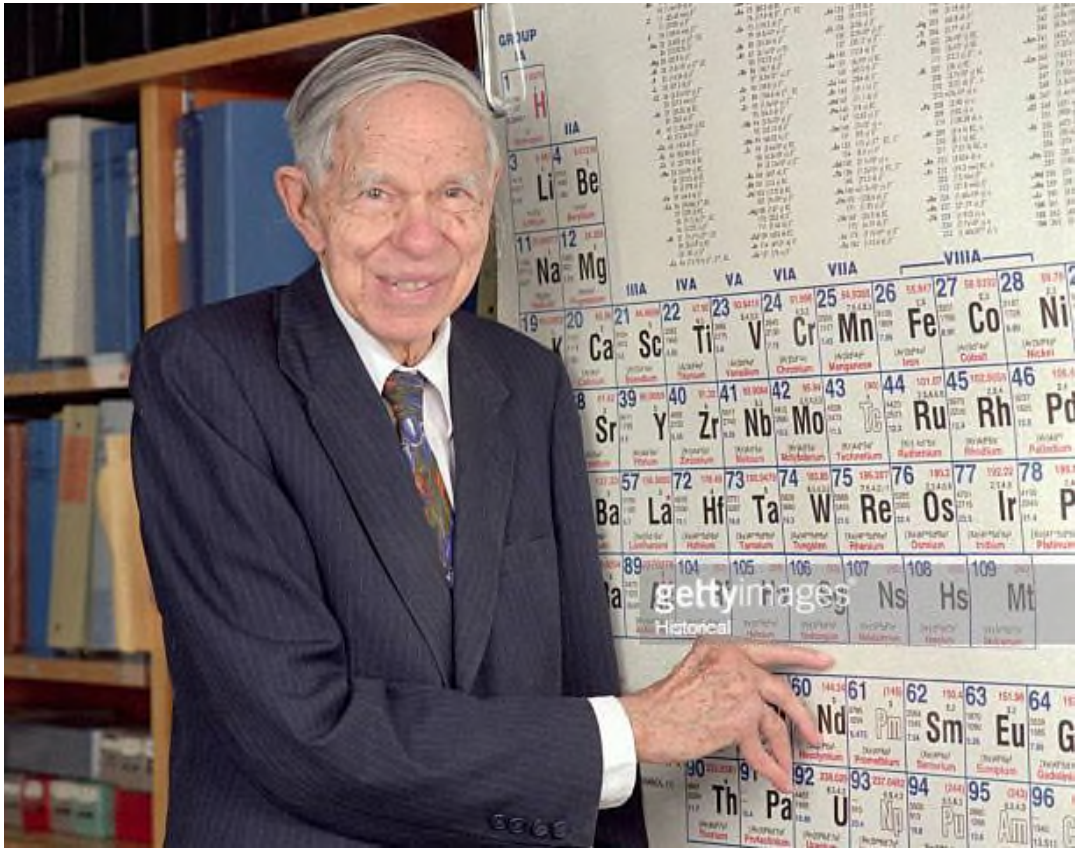
Bechtel Corporation – 06/28/2022

Key Notes

- **Hanford Site – North of Richland, WA**
- **Entire Cleanup – Likened to Putting a Man on the Moon**
- **WTP - $4.3 Billion in 2001 → $17 Billion Today**
- **WTP - 2001 → Glass in 2007 → 2036**
  - **Direct Feed LAW 2025**
    - **WHY?**

Where is Hanford Area, WA?

SHOW and TELL



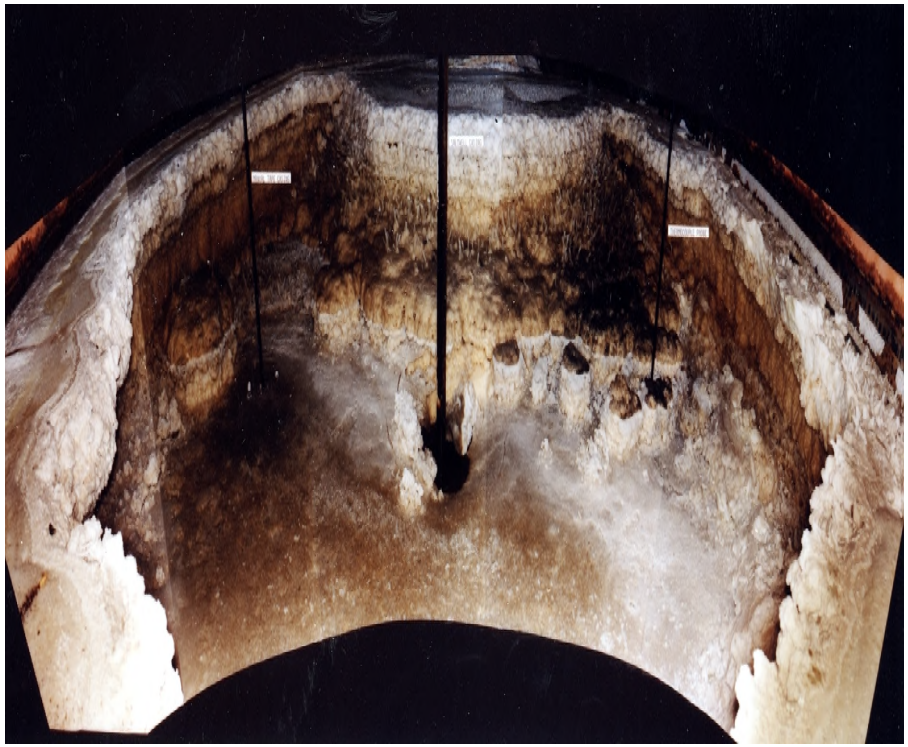
WTP In Foreground
Looking West

- Left – Mt. Adams
- Right – Mt. Rainer
- Hanford – Half the size of the state of Rhode Island

Columbia River

- The last free-flowing stretch
- North and East edge of Hanford
- Cooling Water Supply
- Grand Coolie Dam - Power

Tank Waste – 56 Million Gallons – 177 Tanks



The Project:

Currently: ***56 Million Gallons - Mixed Nuclear & Chemical Waste In 177 Underground Storage Tanks***

- ***1944 to 1987, Leaking Rusting Carbon Steel Tanks***

The Goal: ***Build a One-of-a-Kind Plant – Treat, Separate, Vitrify***

– To HLW and LAW Vitrification (Big Glass Logs)

- Safe Long-Term Storage as Stable Solids

No Confidential nor Secret Information

Safety is NO Accident

Perspective on Size

- **53** Process Flow Diagrams (PFD)

- **1800** Piping and Instrument Diagrams (P&ID)
  - (Not Including Direct Feed LAW ~ 25 more)

- **$1 Billion in R&D** (Research and Technology)
  - Concurrently with Design (and Construction)

The Waste Treatment Plant

- **PTF = Pre-Treatment Facility** – Separate – HLW & LAW – Remove Water
- **HLW = High Level Waste** – Remove Remaining Water – Vitrify
- **LAW = Low Activity Waste** – Remove Remaining Water – Vitrify
- **LAB = Laboratory** – Testing Nuclear Waste Samples
- **BOF = Balance of Facilities** – Steam, Air, Water, etc.

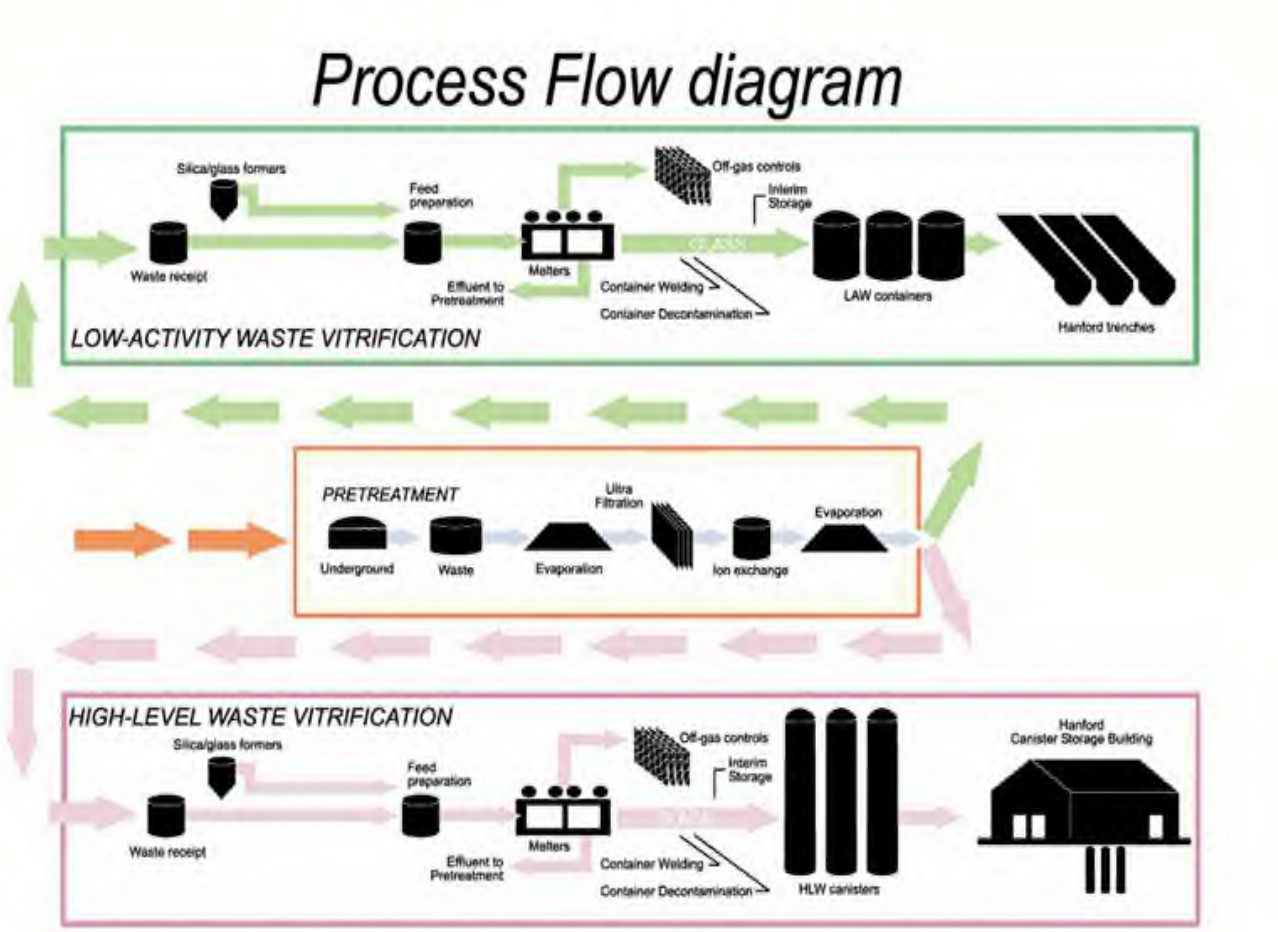
- **Tank Side Cesium Removal** - $130 Million Adder – Batch Filtration & Batch Ion Exchange – Late Add – "**Direct Feed LAW**" to start in 2025

From the Air – PTF – Lab – HLW – LAW - BOF


AUG 8 2004

Whys? Examples – Cost and Schedule

- Bid Scope – Carbon Steel vs. 316L Stainless
- Technetium-99 Ion Exchange Removal
- Conjecture – 40% increase Seismic – Stop Work – 1,000 Calculations
- Pulse Jet Mixing – Pilot Size vs. Half Scale Test
- $1 Billion of Research & Development (Technology) – Enough? More?
- White Papers and What If Studies Galore
- Corrective Action Reports (CARs)
  - Non-Full Penetration Pipe But Welds (Other Project)
  - CANCELLED vs. CANCELED – Procedure – 480 Eng'g Hours (160 of Mine!)


Process Flow diagram
Silica/glass formers
Feed preparation
Off-gas controls
Interim Storage
Waste receipt
Effluent to Pretreatment
Melters
Container Welding
Container Decontamination
LAW containers
Hanford trenches
LOW-ACTIVITY WASTE VITRIFICATION
PRETREATMENT
Ultra Filtration
Evaporation
Underground
Waste
Evaporation
Ion exchange
HIGH-LEVEL WASTE VITRIFICATION
Silica/glass formers
Feed preparation
Off-gas controls
Interim Storage
Waste receipt
Effluent to Pretreatment
Melters
Container Welding
Container Decontamination
HLW canisters
Hanford Canister Storage Building

Pre-Treatment Facility

Head End of Process

- Highly Caustic – pH ~11 to 13

- Feed Receipt Tanks (HLW 3-5% solids and LAW <1% solids)
  - PJM (Pulse Jet Mixers (a/k/a Turkey Basters)) – Keep Solids Suspended
- Evaporation (HLW and LAW)
- Ultrafiltration (HLW to 20% solids – Non-Newtonian - 30 Pascals/ 30 cP)
- Ion Exchange (LAW to remove Cs-137+ in exchange with Na+)
  - Cs-137 is only significant water-soluble radioactive constituents
  - Regenerated with NaOH, Fed to HLW stream
  - 5 IX columns – Lead, Lag, Polishing, Standby to be next Polishing, Regeneration

Pre-Treatment Facility

- Ultrafiltration (HLW to 20% solids – Non-Newtonian)
  - 30 Pascals Shear Thinning/ 30 cP Viscosity (Bingham Plastic)

- Mildly Radioactive Water Disposal – to Existing Process Disposal
- Pulse Jet Mixer Ventilation System – Scrubber, Filter, HEPA Filter
- Tank Ventilation System – Scrubber, Filter, HEPA Filter

- Gantry Crane
- Remote Manipulators
- HVAC Cascade – HEPA Filters

Pre-Treatment Facility

- Materials - 316L Stainless Steel – NQA-1

- Black Cells – Highly Radioactive - No one can ever access. No Mechanical Parts / Nothing Serviceable
- Hot Cells- Highly Radioactive – Must Service – Pumps, etc. – Remote Cranes

- 2 Football Fields Wide x 2 Football Fields Long (end to end)
- 119 Foot – Top of Concrete Slab to Roof
- Walls – 4 Foot thick Poured Concrete – Radiation
- Floor – 8 Foot thick Poured Concrete – Seismic


Z-45/25J
TEREX
CAUTION
OCT 7 2000

High Level Waste Facility

- Feed Receipt Vessels
- Glass Formers (Engineered Sand)
- Feed Preparation

- 2 Melters – 2100 F – 2 Feet Dia – 14.5 Feet High - 4 Tons – Shape – Neutron Flux – Avoid Criticality
- Container Handling
- Container Welding
- Container Decontamination

High Level Waste Vitrification Facility

- 400 Foot Long x 275 Foot Wide x 95 Feet High
- Similar Walls & Floor to PTF
- Similar Ventilation and Mildly Radioactivity Waste, Etc.

- 88,000 Cubic Yards of Concrete (10,000 Redi-Mix Trucks)
- 12,000 Tons of Structural Steel
- 1.1 Million Pounds of HVAC Ductwork
- 165,000 Linear Feet of Piping
- 1.6 Million Linear Feet of Electrical Cable

- CANISTERS TO THE NATIONAL NUCLEAR WASTE REPOSITORY - 10,000 Years

Low Activity Waste Vitrification Facility

- Feed Receipt Vessels
- Glass Formers (Engineered Sand)
- Feed Preparation

- 2 Melters – 2100 F – 4 Feet Dia – 7 Feet High - 7 Tons – No Criticality Concerns
- Container Handling
- Container Welding
- Container Decontamination

Low Activity Waste Vitrification Facility

- 300 Foot Long x 275 Foot Wide x 90 Feet High
- Thinner Walls & Floor – Smaller Radiation & Non Seismic
- Similar Ventilation and Mildly Radioactivity Waste, Etc.

- 29,000 Cubic Yards of Concrete (3,000 Redi-Mix Trucks)
- 6,000 Tons of Structural Steel
- 1.0 Million Pounds of HVAC Ductwork
- 100,000 Linear Feet of Piping
- 800,000 Linear Feet of Electrical Cable
- CANISTERS TO ON SITE TRENCHES – 40 Years

LAW Vitrification Canisters Turn Table

Analytical Laboratory

- Gloveboxes and Shielding Pipes to Analyze 3,000 samples per year
- 320 Foot Long x 180 Foot Wide x 45 Feet High
- Thinner Walls & Floor – Smaller Radiation & Non Seismic
- Similar Ventilation and Mildly Radioactivity Waste, etc.

- 12,000 Cubic Yards of Concrete (1,300 Redi-Mix Trucks)
- 1,800 Tons of Structural Steel
- 300,000 Pounds of HVAC Ductwork
- 35,000 Linear Feet of Piping
- 170,000 Linear Feet of Electrical Cable

Balance of Facilities

- Steam, Cooling Water, Chilled Water, Effluent Management, Potable Water, Fire Water, Communications, Electrical Sub, etc.
- 14 Buildings and 53 Separate Systems

- Chilled Water could cool 25,000 houses
- Electrical Power could power 2,500 homes
- Compressed Air could fill the Goodyear Blimp in 3 minutes
- Fuel Storage – fill tanks of 12,000 cars
- Steam Plant could heat 3,000 houses

Tank Side Cesium Removal (Direct Feed LAW)

- NEW ADDITION – Allows LAW to start before PTF and HLW Resolutions

- Disposable Filtration
- Disposable Cesium Ion Exchange Columns
- $130 Million

Commissioning

- First – (Initially just DFLAW and LAW) in Water Runs – **NOW**
- Second – Cold Commissioning (e.g. Non-Radioactive Isotopes of Cs)
- Third – Hot Commissioning with real waste
- LAW Control Room UP AND RUNNING (next slide)


EXIT

DOE WTP Overview – 3 minute video

Focused at the End on the LAW – (Direct Feed LAW) - Now

- https://youtu.be/BROG2CHJidg