



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**

Status Of Integrated Waste Treatment Unit

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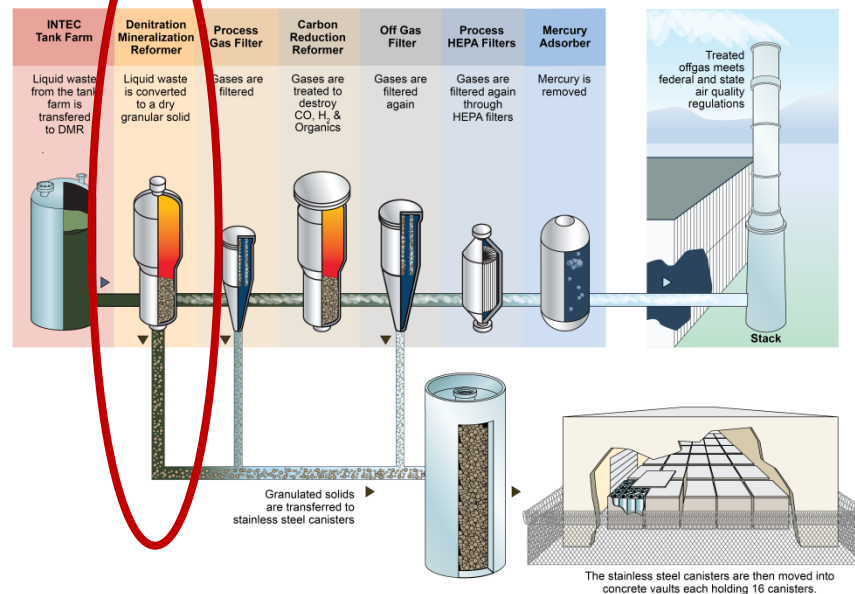
October 26, 2017

IWTU Background

- There are about 900,000 gallons of liquid radioactive waste stored in three stainless steel underground tanks at the Idaho Nuclear Technology and Engineering Center.
- The Integrated Waste Treatment Unit (IWTU) was constructed to treat the waste, but design and mechanical issues have prevented the beginning of waste treatment.

Fluor
IDAHO

Simplified IWTU Process Flow



IWTU Overview / Objectives

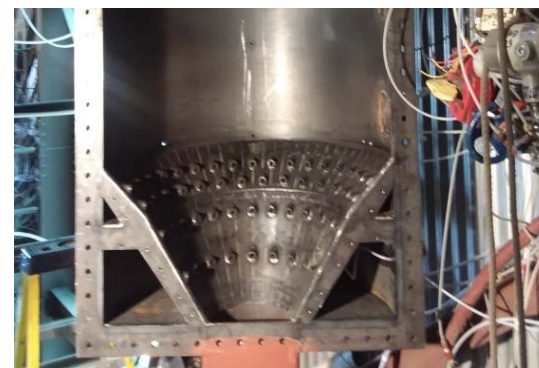
- IWTU is a 53,000 sq. ft. facility designed to treat 900,000 gallons of Sodium Bearing Waste (SBW) using the Fluidized Bed Steam Reforming process.
- The process will convert SBW into a solid, granular, carbonate product for on-site storage pending final disposition.
- IWTU construction completed in 2011 and CD-4 achieved in 2012.
- Process instabilities and equipment issues identified during non-radiological testing operations to date have delayed the transition to radiological operations.
- Instabilities are associated with the primary reaction vessel, the Denitration Mineralization Reformer (DMR), and include particle size control, difficulties maintaining fluidizing conditions and scale formation within the DMR.



Manway Plug Fit-up



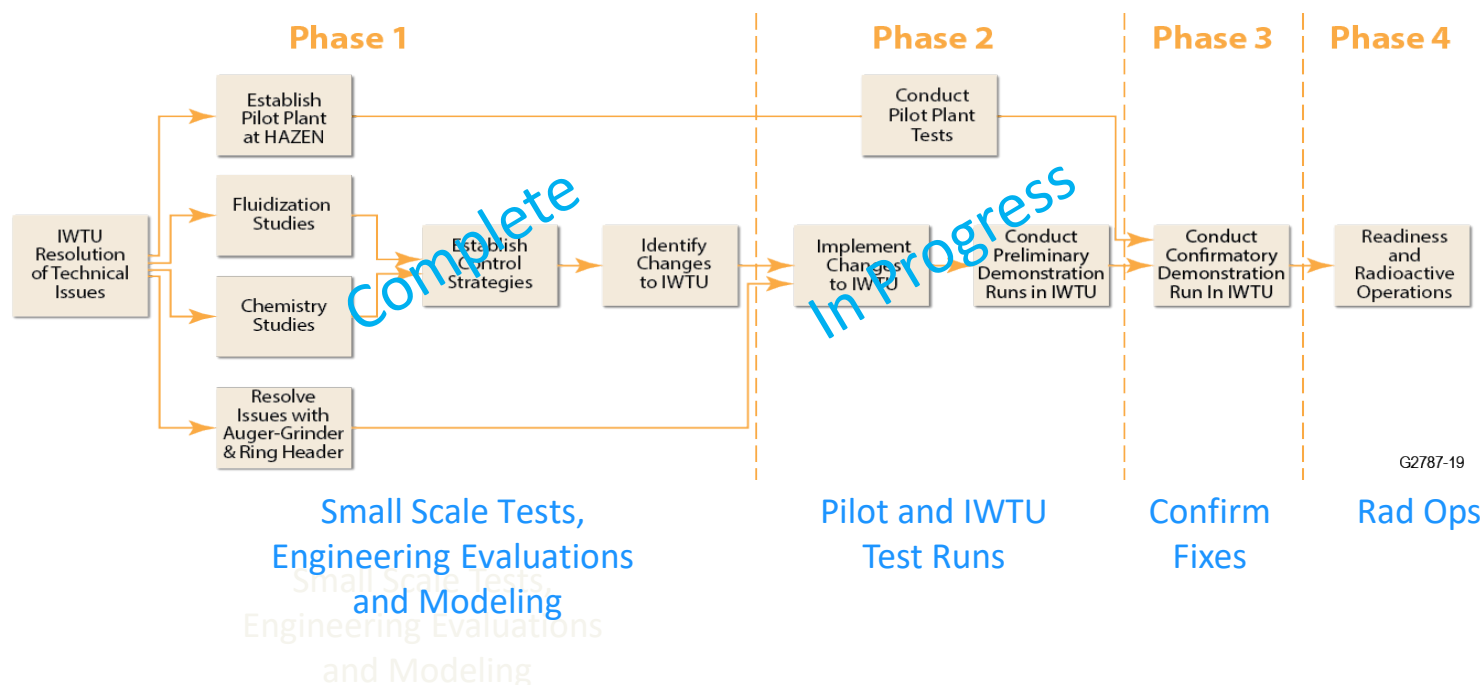
PSRI Baseline Test



PSRI Prototype Test Rig

Approach to Address Remaining Issues

- Fluor Idaho has established a systematic, mechanistic based approach involving 4 phases to address issues with the IWTU
- A team of specialists was assembled to work with IWTU staff, including experts in fluidized bed technology that have solved similar problems in industry
- Fluor established a Technical Review Group consisting of subject matter experts from National Labs, industry and academia to provide input and advice
- Fluor has enlisted the Particulate Solid Research Inc. (PSRI) to assist in the testing and evaluation of fluidized bed improvements.



Summary Status of the 5 Main Issues

Issue: Wall Scaling

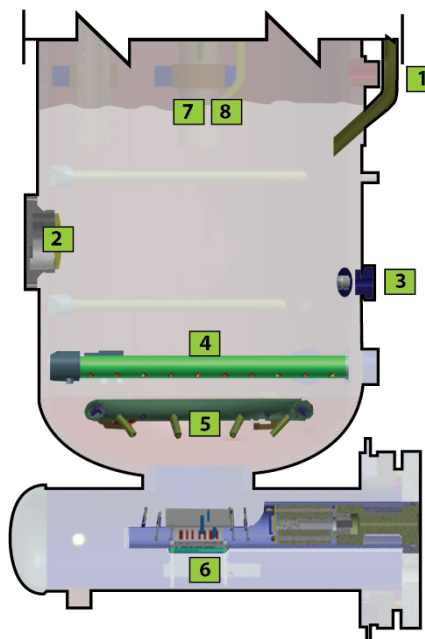
Status: Impact has been reduced. Improved understanding of wall scale formation and control mechanisms.

Wall Scale	
Observation	Wall Scale
Impact	Build-up of Scale Deposits
Root Cause	Slow Conversion of Feed
Solution	Reduce the Feed Rate Use all Three Waste Feed Injectors Increase DMR Operating Temp Increased DMR Bed Depth
3	7 8

Formation of Sandcastles	
Observation	Sandcastles / Agglomerations
Impact	Temperature and Fluidization Instabilities
Root Cause	Slow Conversion of Waste Feed Insufficient Fluidization Insufficient Particle Size Control
Solution	Refine Fluidization Strategy Modify Fluidizing Gas Rails Implement Sizing Control Requires Manway Access Insure sufficient CO ₂
1 2 3 4	5

Issue: Formation of Sandcastles

Status: Sandcastle formation mechanisms understood. Implementing changes in IWTU.



Auger Grinder Failure	
Observation	Auger-Grinder Locked Up
Impact	Inability to Transfer Product Results in Plant Shutdown
Root Cause	Build-up on Rotating Parts Insufficient Mechanical Design Lack of Adequate Purge
Solution	Auger Grinder Root Cause Analysis Industry Expert Consultant Extensive Prototype Testing Improved Purge Gas Strategy Improve Mechanical Design Recovery Capability
6	

Issue: DMR Instabilities

Status: Mechanisms understood. DMR instabilities are due to sandcastles.

DMR Instabilities	
Observation	Temperature Excursions
Impact	Instabilities, Shutdowns
Root Cause	Defluidization Channeling of Gases Wall Scale
Solution	Refine Fluidization Strategy Modify Fluidizing Gas Rails Implement Particle Size Control
1 4 5 7	8

Ring Header Damage	
Observation	Erosion of Ring Header
Impact	Breach Would Defluidize DMR
Root Cause	Jet from Fluidizing Gas Rails
Solution	Modify Fluidizing Gas Rails Replace Ring Header Requires Manway Access
2 4 5	

Issue: Ring Header Damage

Status: DMR access approach resolved. Manway installation complete. Will replace damaged ring with Double Plenum and Cone.

Issue: Auger-Grinder Failure

Status: Resolved

Issue: Formation of Sandcastles

- Issue

- In areas of insufficient fluidization in the DMR, particles can settle or agglomerate and disrupt gas flow and mixing, resulting in temperature variations in the DMR, formation of sandcastles, further de-fluidization and other operational impacts.

- Cause

- Insufficient fluidization and mixing.
- Agglomeration of cohesive or sticky particles due to slow or incomplete waste feed conversion reactions.

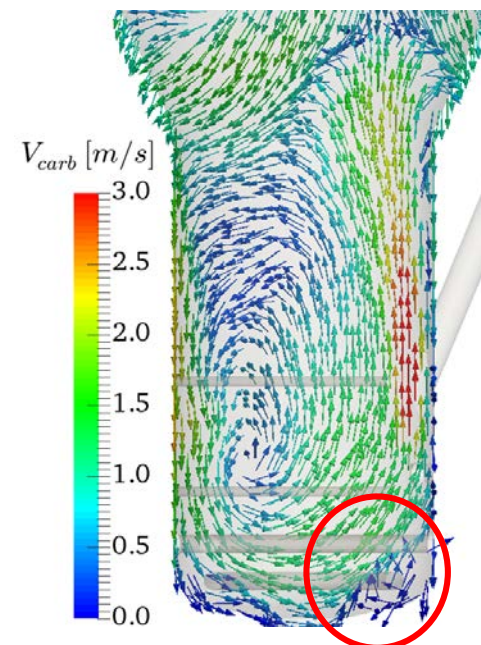
- Approach to Resolve

- Extensive work by INL to understand reaction kinetics.
- Modeling by National Energy Technology Center (NETL) to understand fluid dynamics and mixing in the DMR.
- Bench-scale, pilot plant, and cold flow testing to investigate sandcastle formation and mitigation.

- Status

- Sandcastle formation mechanisms understood.
- Replacing Fluidizing Gas Rails and Ringheader with Double Plenum and Cone configuration

Formation of Sandcastles				
Observation		Sandcastles / Agglomerations		
Impact		Temperature and Fluidization Instabilities		
Root Cause		Slow Conversion of Waste Feed Insufficient Fluidization Insufficient Particle Size Control		
Solution		Refine Fluidization Strategy Modify Fluidizing Gas Rails Implement Seeding Control Requires Manway Access		
1	2	3	4	
5				Insure sufficient CO ₂



Model showing area of weak fluidization (red circle) where sandcastles form.

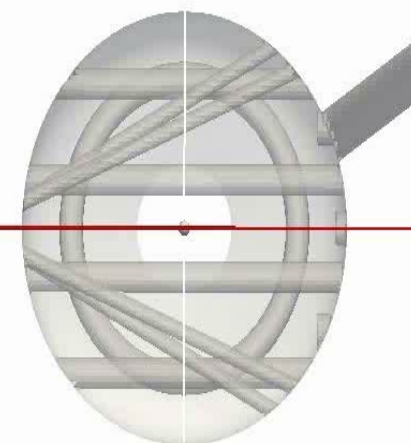
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EP_G

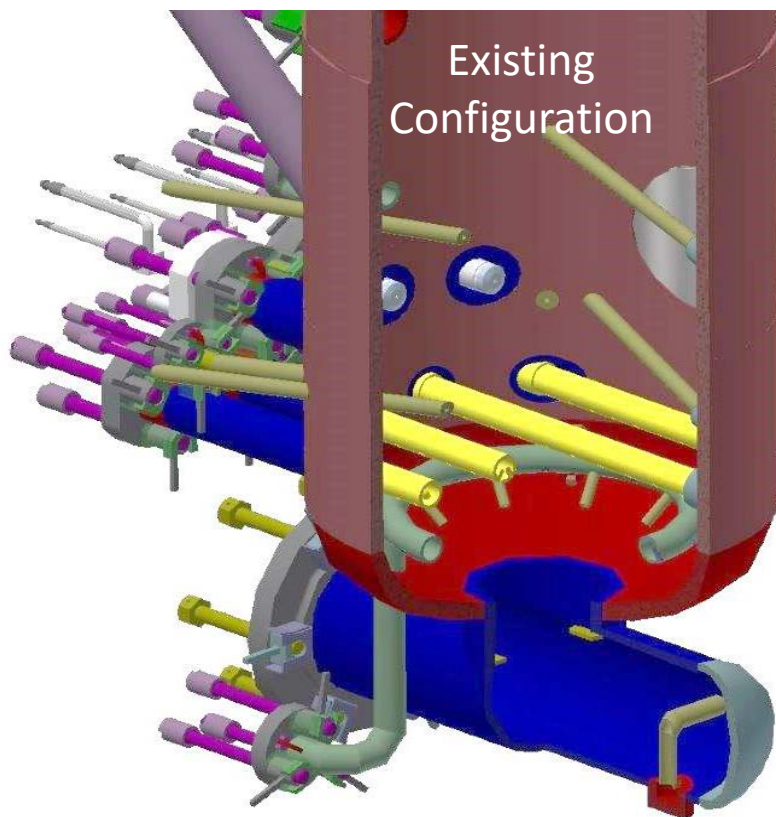


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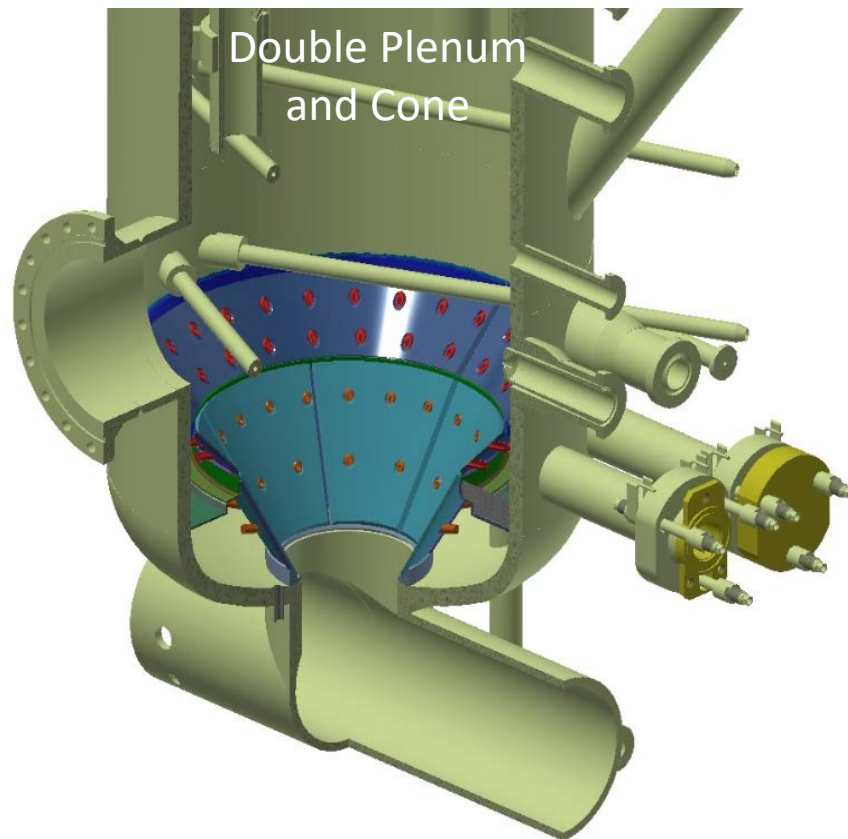
$V_{carb} [m/s]$



Double Plenum Configuration Improves Geometry and Fluidization in Bottom of DMR



- Several obstructions.
- Hemispherical bottom relatively flat with dead spots in corners.
- Ring doesn't fluidize the media in the bottom and corners.



- Few obstructions.
- Cone limits potential for hold up and dead spots.
- Fluidization gases injected directly through wall of cone.

- Complete installation of Double Plenum and Cone configuration in the DMR to address lower region fluidization
- Continue Hazen Research testing (operational control, limits)
- Outage I ongoing in preparation for next simulant run
- Conduct Component, System and Integrated testing, prior to Simulant Run 2

