



#### **DCU Support Skirt Repair & Life Extension**

Presented by:

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- Coke drum skirt attachment configurations vary depending on vintage and the original design
- Low Cycle Fatigue induced damage is common at this critical location
- This presentation addresses repair options for the modified crotch design which is one of the most common configurations today
- The repair method selected varies depending on the history of damage, available repair schedule window, and the owner's expectations on operating life.

#### Skirt Attachment Configurations





#### **Common Skirt Attachment Geometries**<sup>1</sup>

#### Damage Mechanism





End of Fill Cycle

#### Damage Mechanism





**1 Hour Into Quench Cycle** 

#### **Resulting Potential Crack Paths**







## Upper Knuckle Repair

#### Indications at the Upper Knuckle Weld





**Common Upper Knuckle Cracking** 



#### Process:

- 1. Excavate to remove cracks & previous repairs
- 2. Utilize temper bead technique to eliminate PWHT
- 3. Re-contour geometry to minimize stress concentrations



### Upper Knuckle Repair Process



 Additional weld metal is applied to add material for re-contouring operation to obtain improved transition geometry.



#### Upper Knuckle Repair Process



- Modified contour area is optimized to minimize stress
- Optimized Contour is applied by grinding using template created with the results of the analysis







## Window Section Replacement



- Method is common when there is significant damage or an accumulation of previous repairs
- Facilitates alloy and geometry changes from the original design
- Proper installation techniques and welding process significantly extend life of repair
- Provides good root geometry to minimize stress risers







**Skirt Bulging** 

Replacement in Progress





**Existing Skirt Removal** 





Section Alignment Fixturing



Proper Root Opening for Welding





**Skirt Section Ready for Welding** 





Welding Completed and Ready for Inspection





- Method is common when there is concentrated damage in the attachment weld
- Repair is not as robust because root geometry is less controllable
- Allows for "on-line" repairs which minimize production schedule



**Through Wall Groove Weld Cracking** 



#### **Root Geometry Concerns**

- It is common to encounter previous repairs in this location
- These repairs sometimes leave significant root misalignment
- The resulting root geometry can magnify stresses and shortens time to new crack incubation







#### **Root Geometry Concerns**



**Groove Weld Root Misalignment** 



#### **Root Geometry Concerns**



**Bevel Reconstruction** 

Reconstructed Bevel Ready for Root Pass



 After root reconstruction, automated temperbead welding is used to fill and cap the groove





 Sometimes customized weld heads are required when there are structural obstructions



Low Profile Weld Head and Track Assembly



 PAUT is used to inspect all welding upon completion.





## **Selection of Welding Process**

# Joint Design & Alignment Sensitivity



#### **Field Friendly Joint Design**

- Simple Bevel on Existing Material
- J-Prep on Replacement Plate
- Allows Machine Welded Root
- Full Penetration Weld With Acceptable Root Geometry

Frontside



Backside





## **High Quality Welding Process**



AZZ / WSI GTAW Hot Pulse Wire: .035" Inconel 625 240 IPM @ 32hz pulsing

Shot at 2,000 FPS with playback at 30 FPS





# Joint Design & Alignment Sensitivity







# Sensitivity to Root Gap Variations









# Automated "Hot Pulse" process from WSI used for all panel welding

- Welding Process Delivers Volumetric Quality with goo Root Profile
- GTAW Weld Deposit provides significantly better mechanical properties than SMAW and GMAW deposits







# **Thank You**

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