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RESULT

Managing Weld Stresses for Advantage in Coker Engineered Repairs

Pedro Amador (VP&Chief Technology Officer WSI)

Coking and Cat Cracking Conference

New Delhi, India - October 2013

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Topics

Industry experience

- Managed stress repair history
- Machine welding enablers
- Temperbead welding
- Refinery example

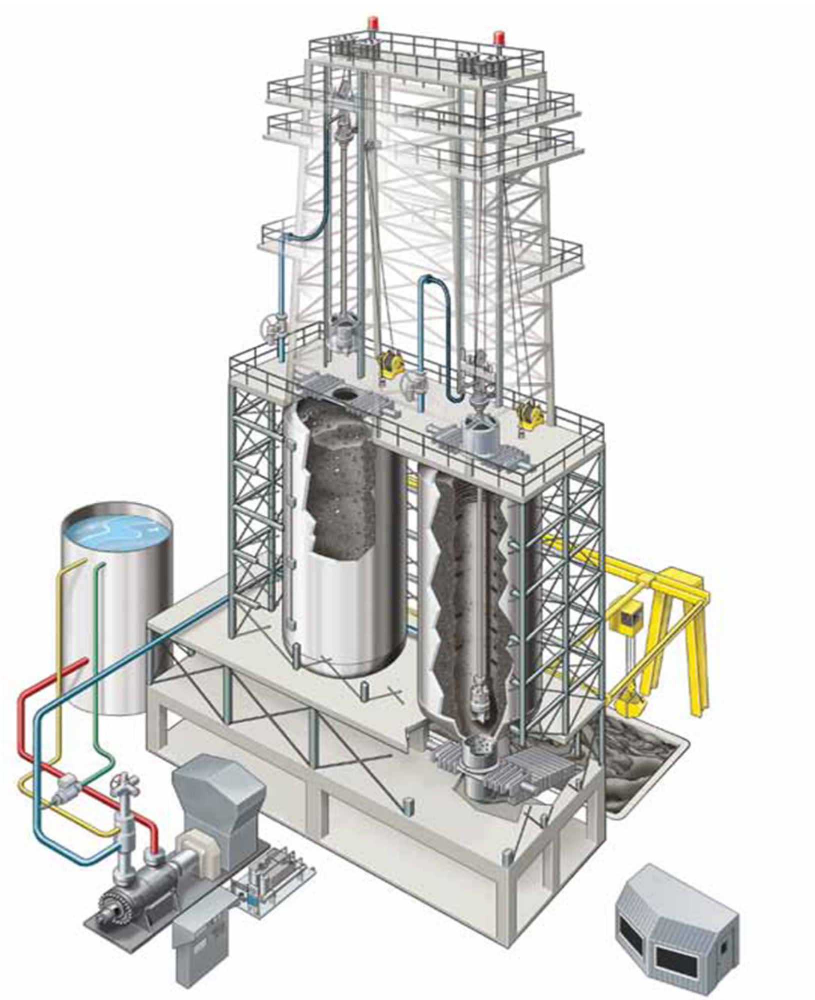
Case study MiRo

Bulge repair example

- Bulge repair design
- Defining a repair strategy
- Executing in the field

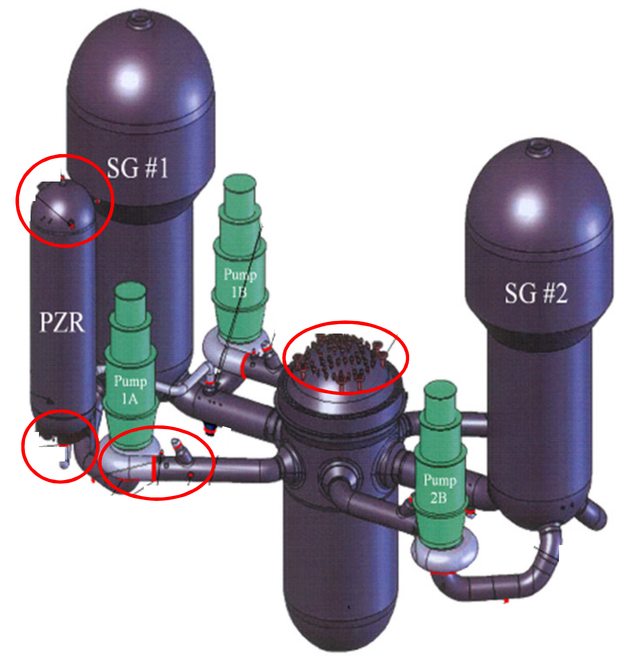
Summary

Contact



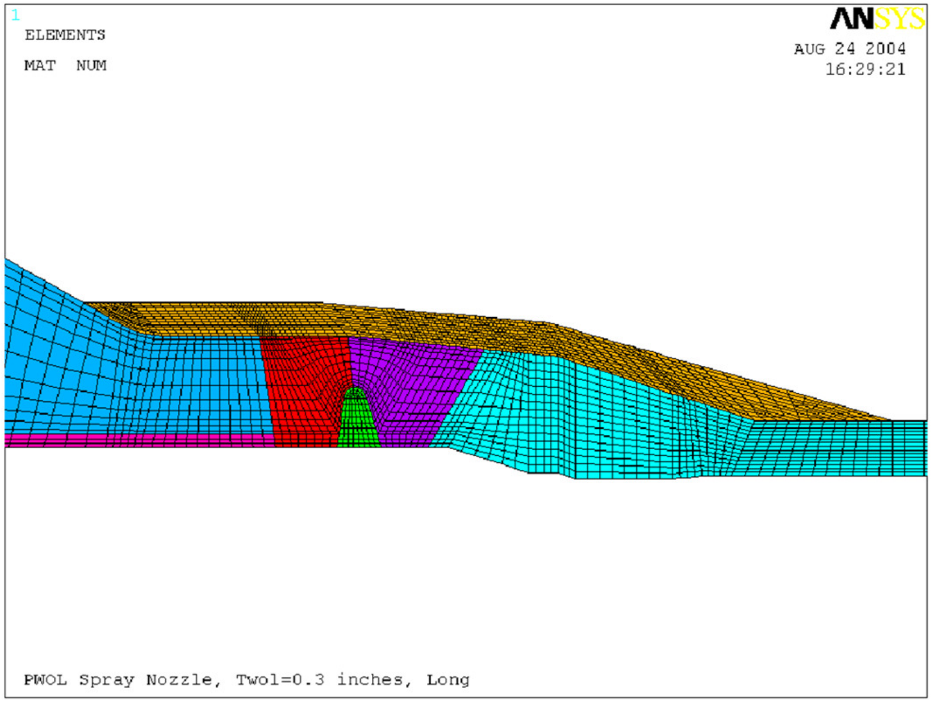
Initial uses of managed stress weld repairs in the nuclear industry

- Highly stressed nozzle to pipe connections
- Corrosive environment created SCC conditions
- Common in BWR and PWR designs



Residual stress model: pressurizer spray nozzle

- Structural WOL process patented
- Residual stresses from welding used to generate compressive stresses
- Added strength of deposit provides a redundant repair
- Over 1,000 nuclear applications performed



Small nozzle structural overlay in pressurizer vessel

Welding beneficial stresses

Welding stresses

- Inevitable with full fusion bond
- Accurately be managed through parameter control
- Homogeneous

Basis / key contributors

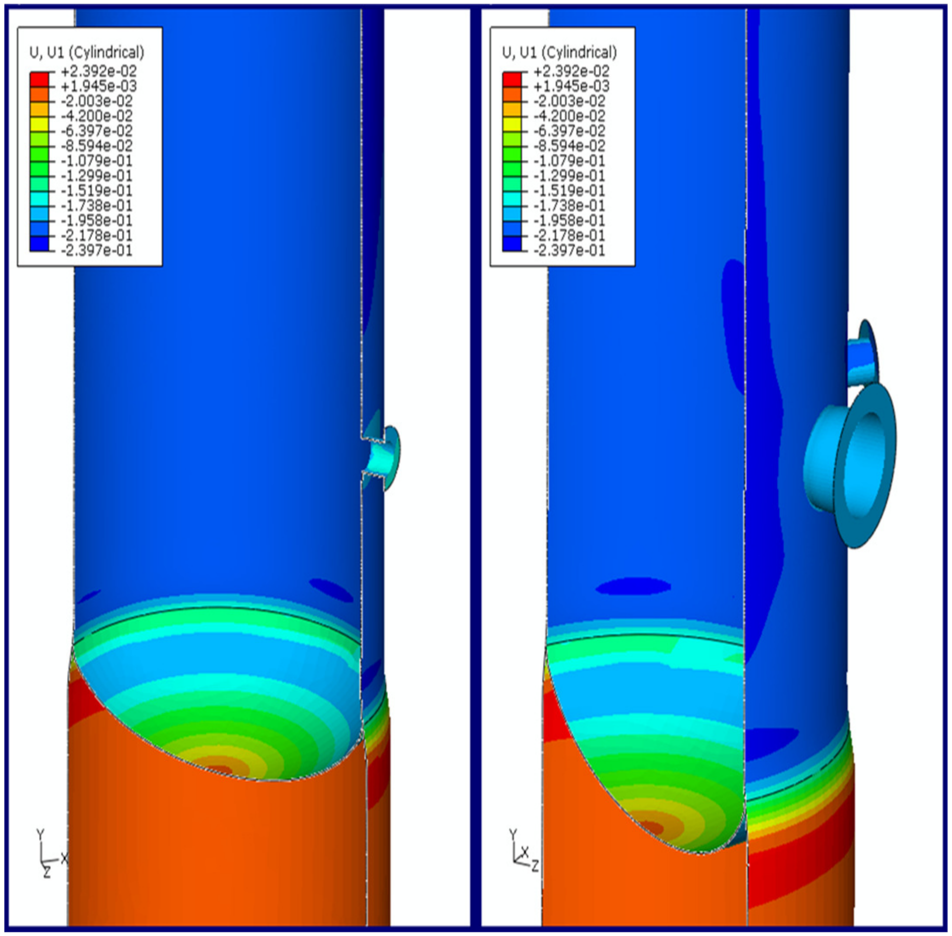
- Accurate heat input
- High dimensional quality

Results

- Predictable mechanical properties

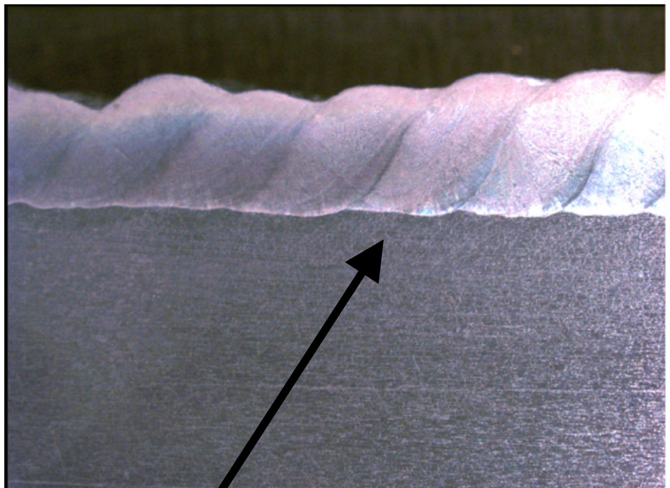
Machine-applied predictability

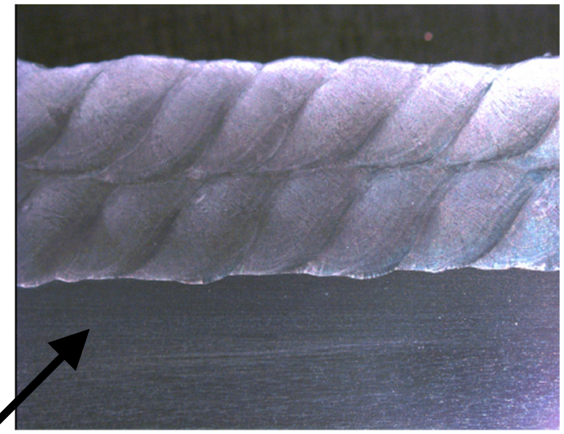
- Allows accurate modeling and repair design

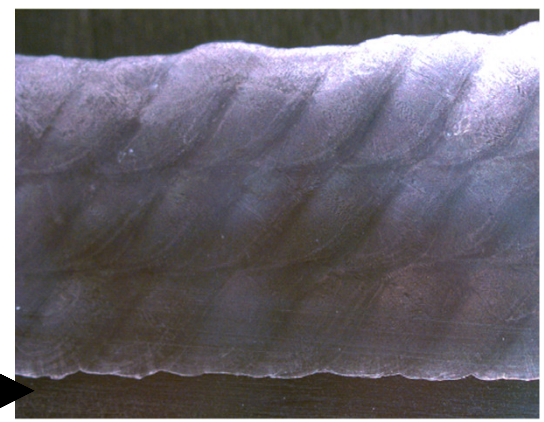


Industry experience

Temperbead Welding







HAZ created by 1st weld layer

HAZ is tempered by deposition of successive layers

Predictive analysis drives FCCU repair plan

Pressure Vessel Example

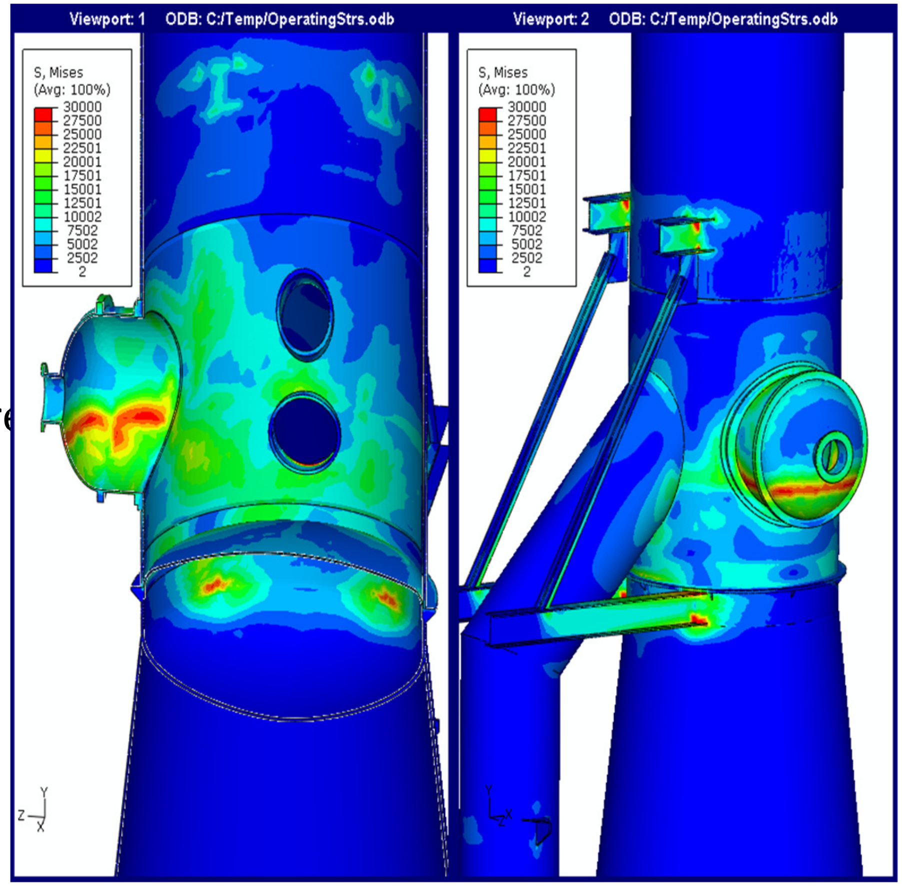
- FCCU stripper/reactor
- High temperature creep failure
- 5 Year life extension required

Anticipated Design Repair

- Model existing failure condition
- Develop "Engineered Design Repair"
  to manage stress levels below cre
  failure limits
- Perform level 3 FFS analysis

Engineered Design Repair

- Reduced scope of work
- Reduced cost for repair
- Validation of repair lifetime



FCCU Stripper/Reactor failure area

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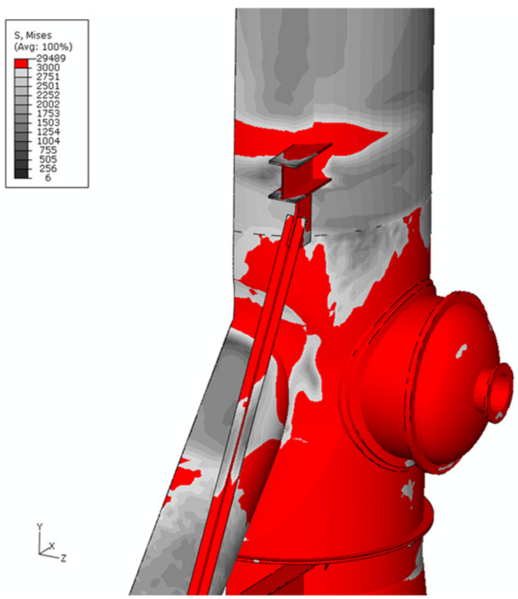
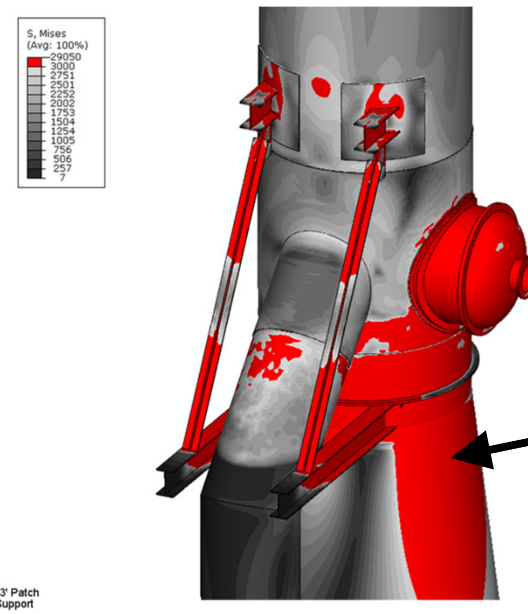
Engineered repair cycle using NPA



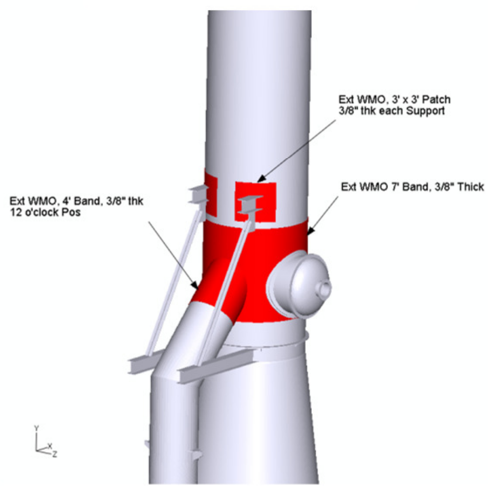
Areas exceeding creep stress limit

Estimated life of repair
Well in excess of 5 years



Regions below temperature threshold for creep

Post overlay stress gradients



Engineered structural overlay

Mineraloelraffinerie GmbH&Co (MiRo)

Bulge Repair of Delayed Coker Unit
Karlsruhe Germany, March 2012

The Delayed Coking Unit

Case study MiRo

Predictive analysis drives FCCU repair plan

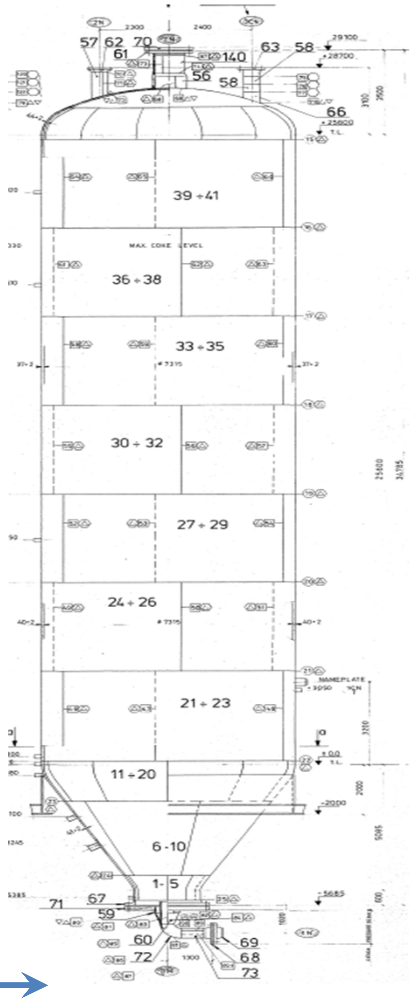
- The MiRO refinery, in Karlsruhe, has a capacity of 300,000 BBL/d
- Planned T/A in 2012
- Bulges in delayed coking unit increased rapidly, so emergent repair had to be executed
- Analytical support and “Engineered Repair” developed by Stress Engineering
- Machine welding used to implement structural improvement repair
- Temperbead process eliminates requirement for PWHT

Coke Drum 001-B

Coke Drum dimensions

Coke Drum D-001B	Coke Drum D-001B
Base Material	1,25Cr, ½Mo / 13CrMo44
Estimated remaining thickness of existing clad	2mm
Nominal thickness	40.5mm + 2mm SS410
Diameter	7315mm ID

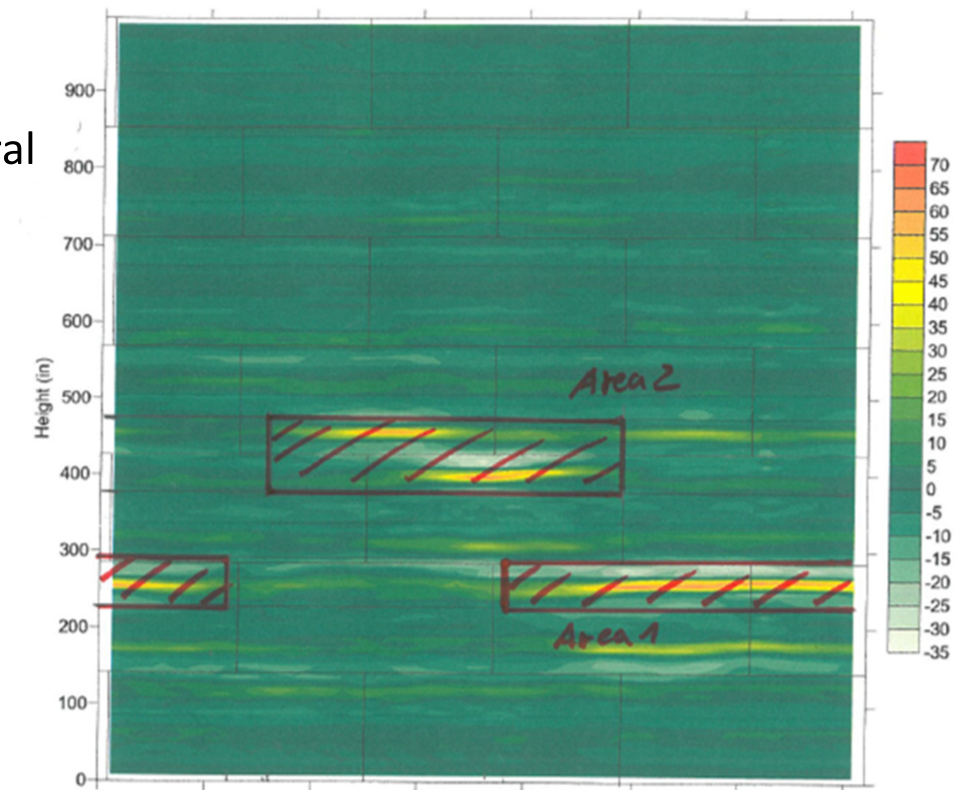
Entrance level @ 15m



Total height 35m

Engineered repair solution

- Plastic Strain Index Study performed
- 2 bulge repair areas defined
  - #1 23m2
  - #2 27m2
- Design required additional structural thickness:
  - 0.56” (14.3mm)

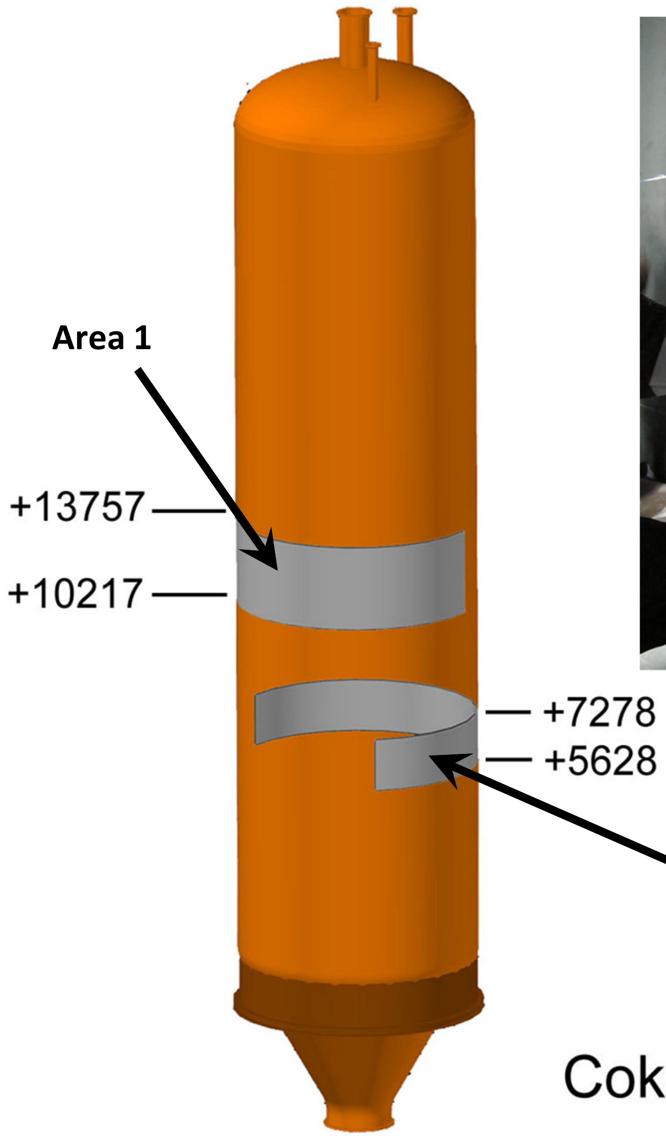


Contour plot of the Plastic Strain Index (PSI) looking from the outside of the drum

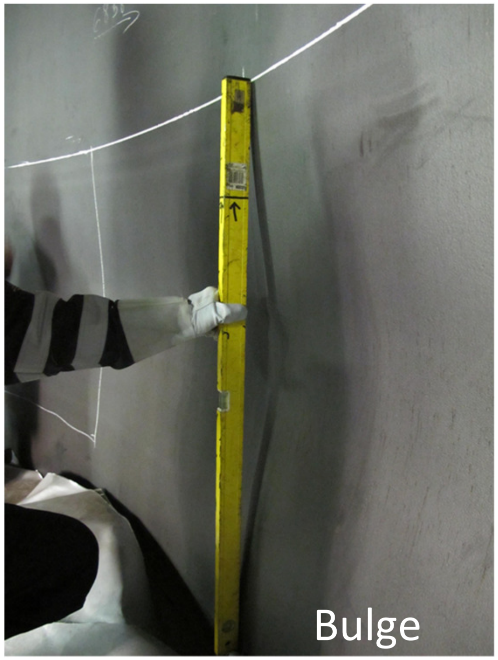
Final repair information

Coke Drum D-001B	Coke Drum D-001B
Bulge repair Area 1 (includes taper zone)	27.7m² per layer
Bulge repair Area 2 (includes taper zone)	30.6m² per layer
Filler material	Alloy 625
Overlay thickness per layer	3/16˝ (5mm)
Total Overlay one layer	**58.3m²**
Overlay three layers	**174.9m²**

Case study MiRo



Coke drum D-001 B



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Repair schedule

Task name	Duration in days	Start	Finish	Resource names
Total duration on site	21	Mon 3/5/12	Fri 4/6/12	WSI
SS & QC onsite prep	2	Mon 3/5/12	Wed 3/7/12	WSI/MiRo
Safety Induction	1	Wed 3/7/12	Thu 3/8/12	WSI/MiRo
Unload qpuipment and site set-up	2	Thu 3/8/12	Sat 3/10/12	WSI/MiRo
Total Duration inside Coke Drum	**26**	Sat 3/10/12	Thu 4/5/12	WSI
Setp-up inside vessel & inspection	**1**	Sat 3/10/12	Sun 3/11/12	WSI/MiRo
Removal of excisting liner	5	Sun 3/11/12	Fri 3/16/12	WSI
Dewwatering bin activity	1	Fri 3/16/12	Sat 3/17/12	MiRo
Grid blasting	0,5	Sat 3/17/12	Sat 3/17/12	MiRo
Inspection (base materials)	0,5	Sat 3/17/12	Mon 3/18/12	WSI/MiRo
Bulge rapair area 1&2 (overlay)	15	Sun 3/18/12	Mon 4/2/12	WSI
Taper repair	2	Mon 4/12/12	Wed 4/4/12	WSI
Final inspection	1	Wed 4/4/12	Thu 4/5/12	WSI/MiRo
Demob from site	1	Thu 4/5/12	Fri 4/6/12	WSI/MiRo

Site preparation

Equipment Deck

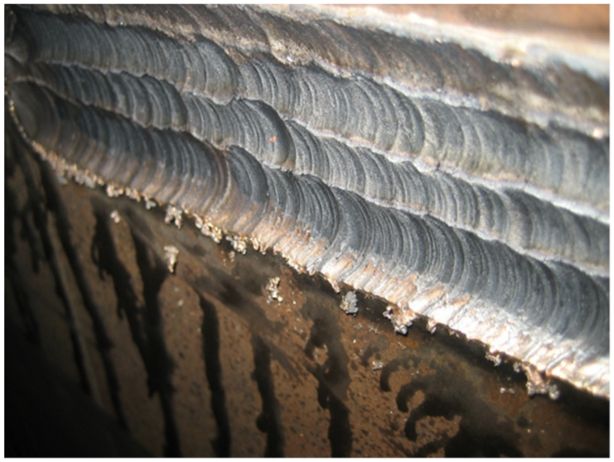
A lot of activity around the unit

Case study MiRo

Mock-up: process evaluation & training

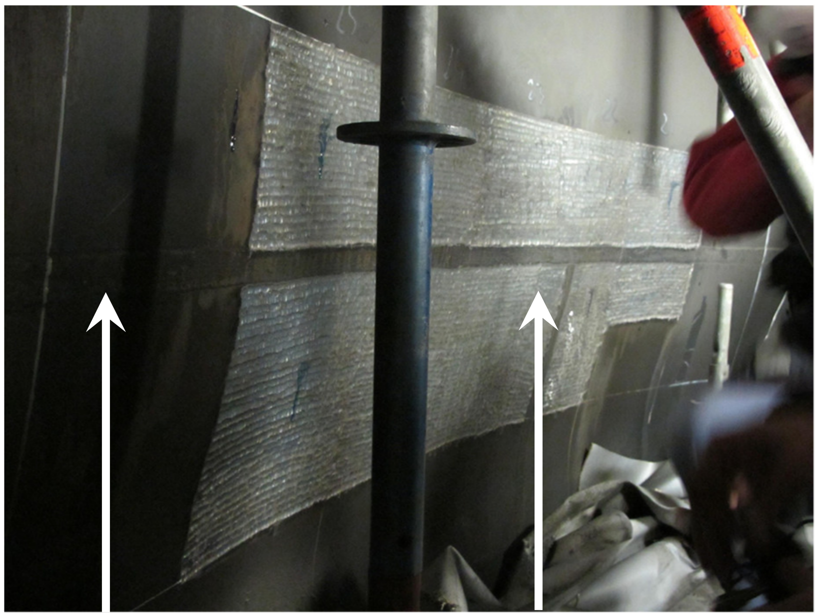
Removal of bonded cladding

Mock-up



"Skim" gouging with Carbon Electrodes
2-3mm thickness removed

Surface preparation and gouging in the field

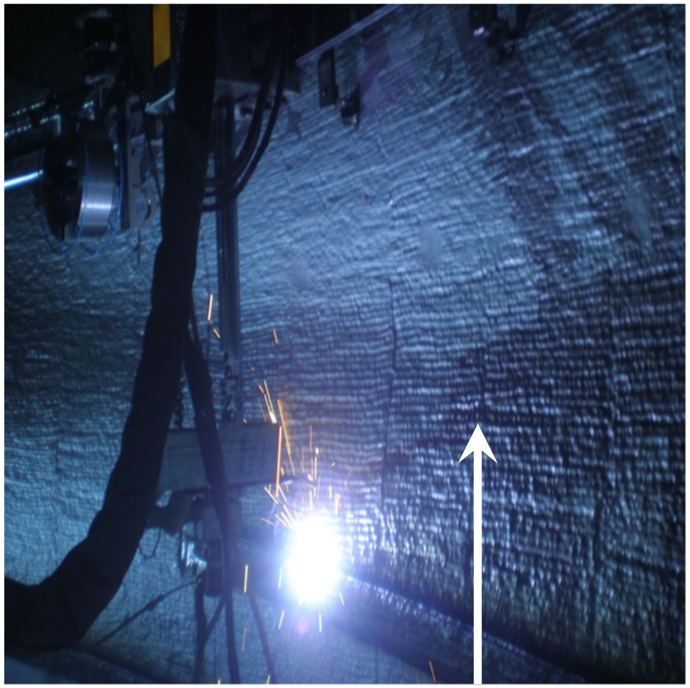


Surface "prepped" 410 cladding

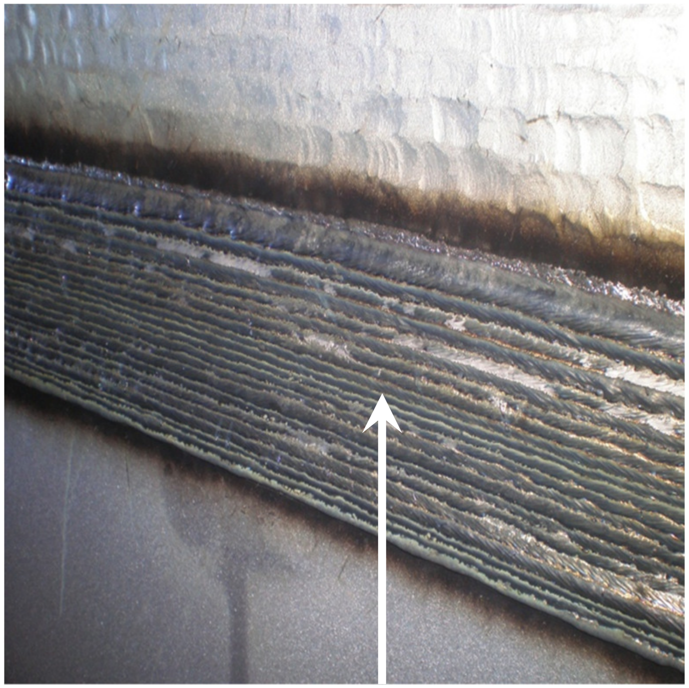
Cladding removed

Gouging in process 2 – 3 mm material removed

Application of structural overlay

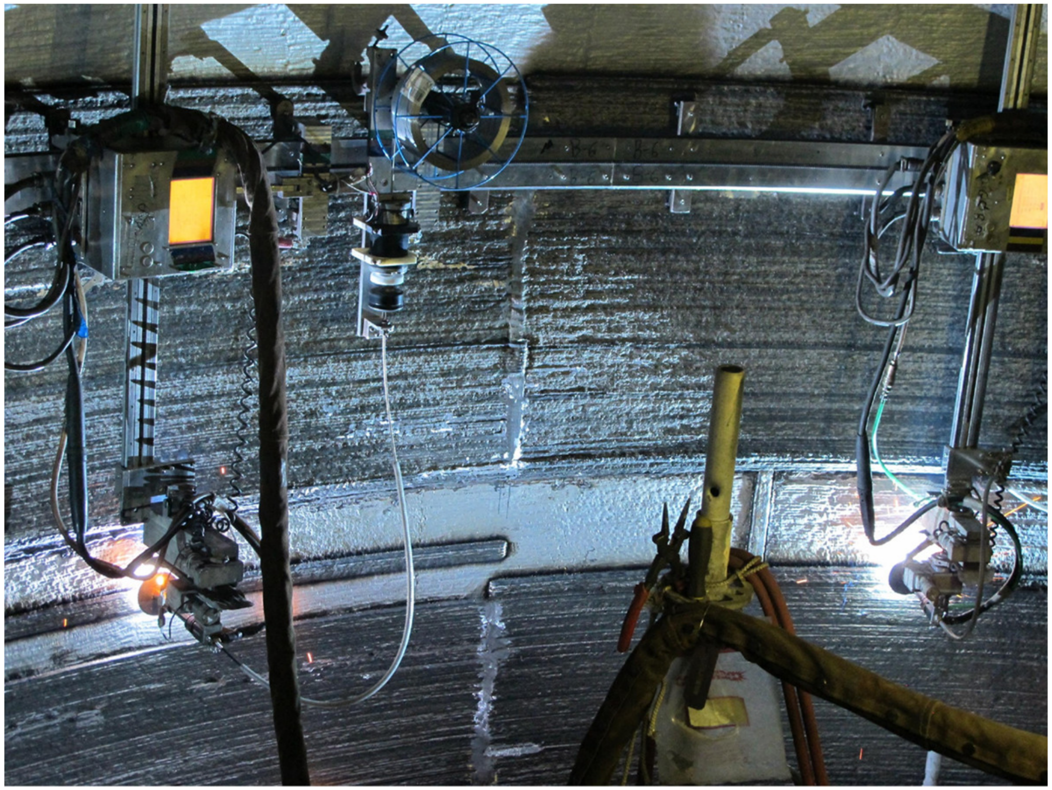


External preheat in place



Close-up of 1st layer

Repair execution

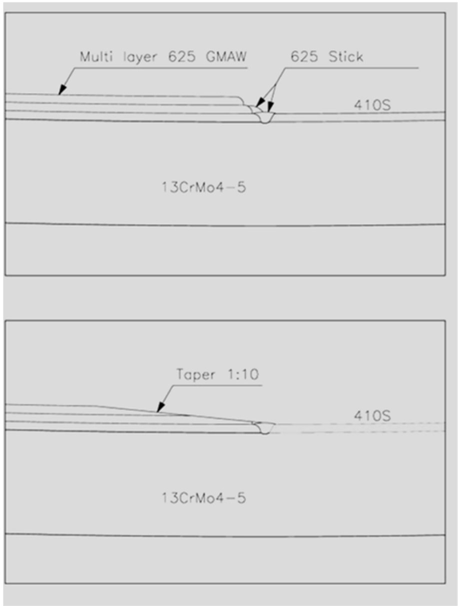


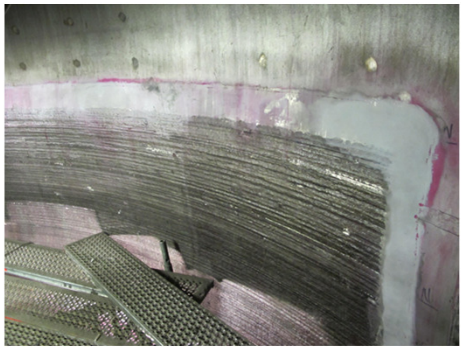
Areas 1 &2
4 machines each; total 8 machines

Repair execution

Welding 3 layers of Inconel 625
Total thickness 15mm

Deposit edge transition





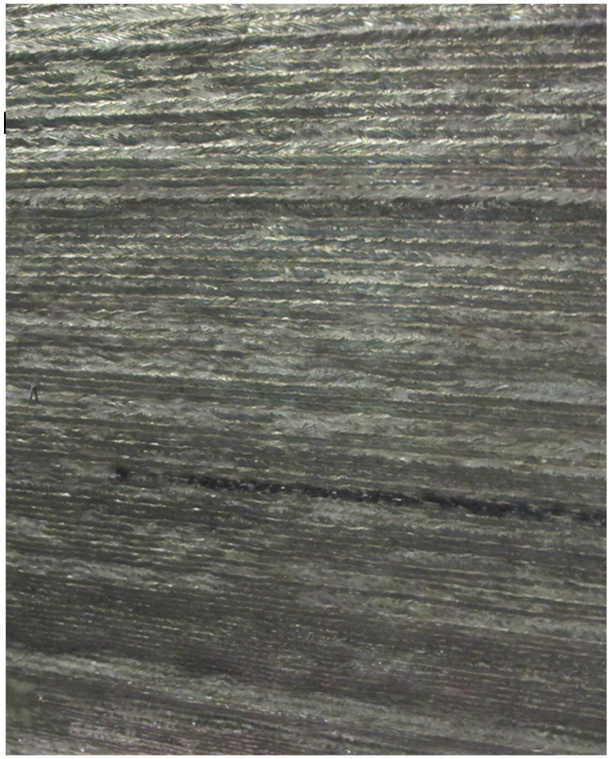
Inspection by QC MiRO, TuV and WSI

- Hardness / layer
- Liquid penetrant inspection

Summary

Results

- Two bulged areas mitigated
- Alloy 625 installed
- Engineered Repair with 3 layers of overlay
- Additional Cladding areas repaired: surface defects
- Over 40 projects of this type have been performed
  and demonstrated years of successful operatio



Contact

Contact Information

Pedro Amador
VP & Chief Technology Officer –WSI
PedroAmador@azz.com
+ 1 (678) 728-9100
Norcross, GA, USA

wsi-europe@azz.com

www.azz.com/wsi-europe