



Innovative Coke Drum Repairs

Coking.Com Conference



Welding Services Inc.

Agenda

- Reasons Coke Drums Crack
- Locations of Cracking
- Who is WSI
- Examples of Innovative Repair Methods
 - Repair/Restore Corrosion with Automated Weld Overlay
 - Skirt to Shell Weld Repair utilizing Temperbead
 - Skirt to Shell Weld Repair On-line
 - Bulge Repair with Temperbead
 - Coker Pipe Welding using Orbital Welding
- Conclusion



Coke Drums

- Why are they cracking and/or bulging
 - Operating on shorter cycles
 - Running different feedstocks
 - Weren't designed for low cycle fatigue or compressive strength of coke
- API Survey of 54 Drums
 - 61% Bulging
 - 97% Circumferential Cracking
 - 78% Skirt Cracking
- Cracking occurs within 5 to 7 years



Typical Coke Drum Failures

- Cracking
 - Circumferential seam
 - Skirt to Shell welds
 - Shell cracks
- Bulging
 - Circumferential Seams
 - Shell Course
- ID Corrosion
 - Delamination/wear of cladding



**Many skirts are cracking within
5 years of operation**

WSI: Who We Are

Unique Competency Set

Applied Welding Technology

Mechanical Repair Design

Global Field Operations

Project Execution Excellence

Broad Services Offering

Erosion/Corrosion Field Services

Field Orbital Welding Services

Shop Erosion/Corrosion Services

Nuclear Repair Services

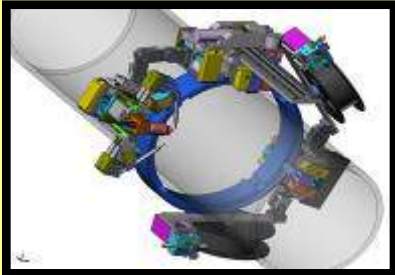
Serving a Broad Global Energy Customer Base

Creating Mechanical Integrity.



WSI Technical Leadership Technology and Engineering

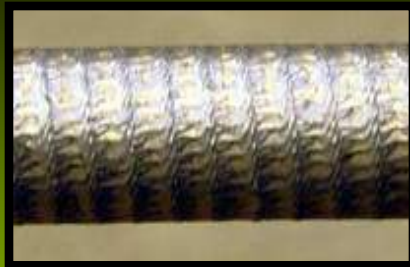
Tooling Engineering



- Mechanical Systems
- High Definition Video
- Controls
- OEM Modifications

- FEA Modeling
- Integrated 3D CAD
- Controls Simulation

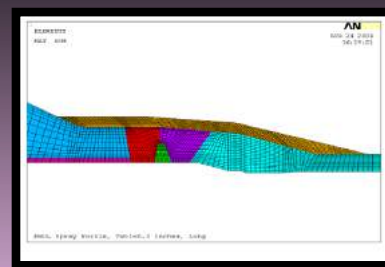
Materials & Welding



- Codes & Standards
- Welding Processes
- Corrosion Coatings
- Metallurgy

- 300+ Traveler Library
- Mockup/Training Center
- 1050+ Welder Certifications

Project Engineering



- Solution Design
- Application Eng.
- Field Engineering
- Process Procedures

- 600+ Procedures
- Temperbead, E/C, etc.
- Level 3 NDE Capability

Operations Support



- Fleet Maintenance
- Mobilization Staging
- Site Technicians
- System Testing

- 180 Automatic Systems
- 75 Semi-Auto Systems
- 40 Remote Vision Sets

Applied Engineering Excellence

WSI Proprietary



Coker Weld Overlay Project

Refinery in Southern California



Welding Services Inc.

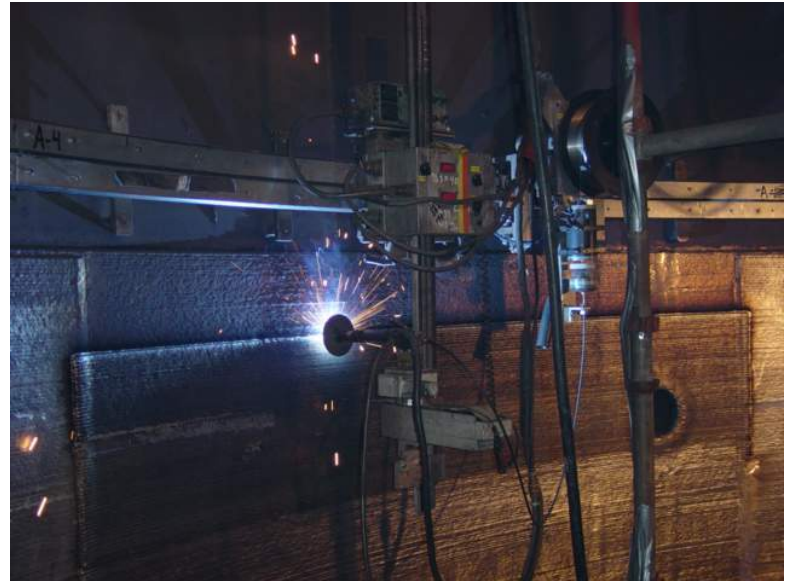
Project Overview

- T/A to Retro fit (4) four Coke Drums to accept new Delta Valves
- Coke Drum Material: SA387, Grade C, 1 ¼ Cr ½ Mo, 1" thick
- Perform repairs to existing 410 explosion bonded cladding by applying over 1200Ft² of Inconel 82 Overlay in cone section above bottom nozzle
- Schedule: 10 days for all four drums total completion



Customer Challenge

- (2) Large projects occurring in Coker (Installing Delta Valve's and Overlay work)
- Schedule: 10 days
- Reducing Cost
- Improving Quality
- Reducing Safety Instances



Project Planning

- Provided T/A Planner to evaluate other contractors schedule and coordinate activities and scopes
- Developed detailed ventilation plan so other contractor personnel can continue to work while WSI performed our scope
- Provided crew of 8 In-direct personnel for entire project and 8 weld operators per coke drum working two shifts
- All work performed under WSI “R” stamp and QA program



WSI Solution

- Utilized 4 **Unifuse** PLC controlled Automated Weld Systems per drum
- Met customer's 10 day schedule
- Took on additional scope during the T/A
- Safety: Zero lost time accidents
- Customer stated: "WSI was the best company out 22 on this T/A...First Class Crew"



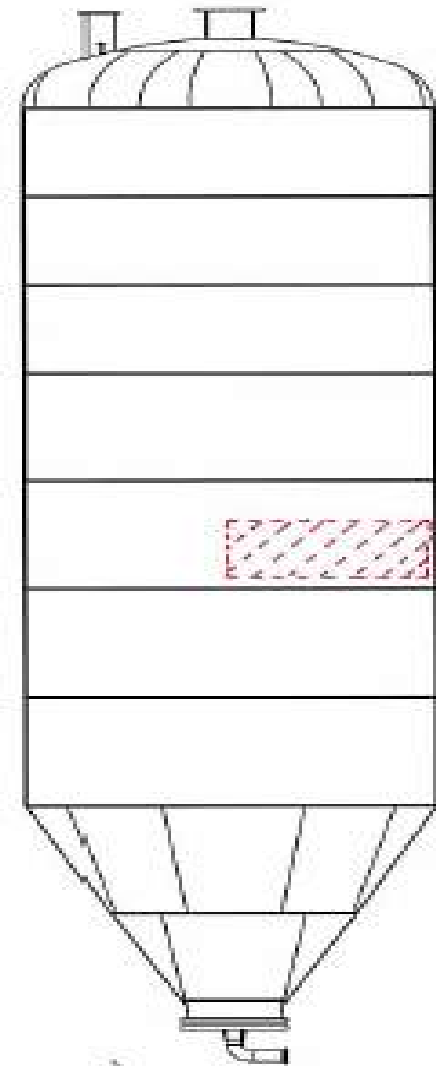
Bulge Repair of Coke Drum Utilizing Temperbead

Refinery in Canada



Bulging Coke Drum

- 8 Coke Drums
- Material: SA 263 Grade C
- Wall Thickness: .875
- Diameter: Ranging from 26 to 32 Ft.
- Size: Ranging from 66 to 94 Ft.
- One of the Cokers was experiencing bulging due to fire in drum



Bulge Severity and Growth

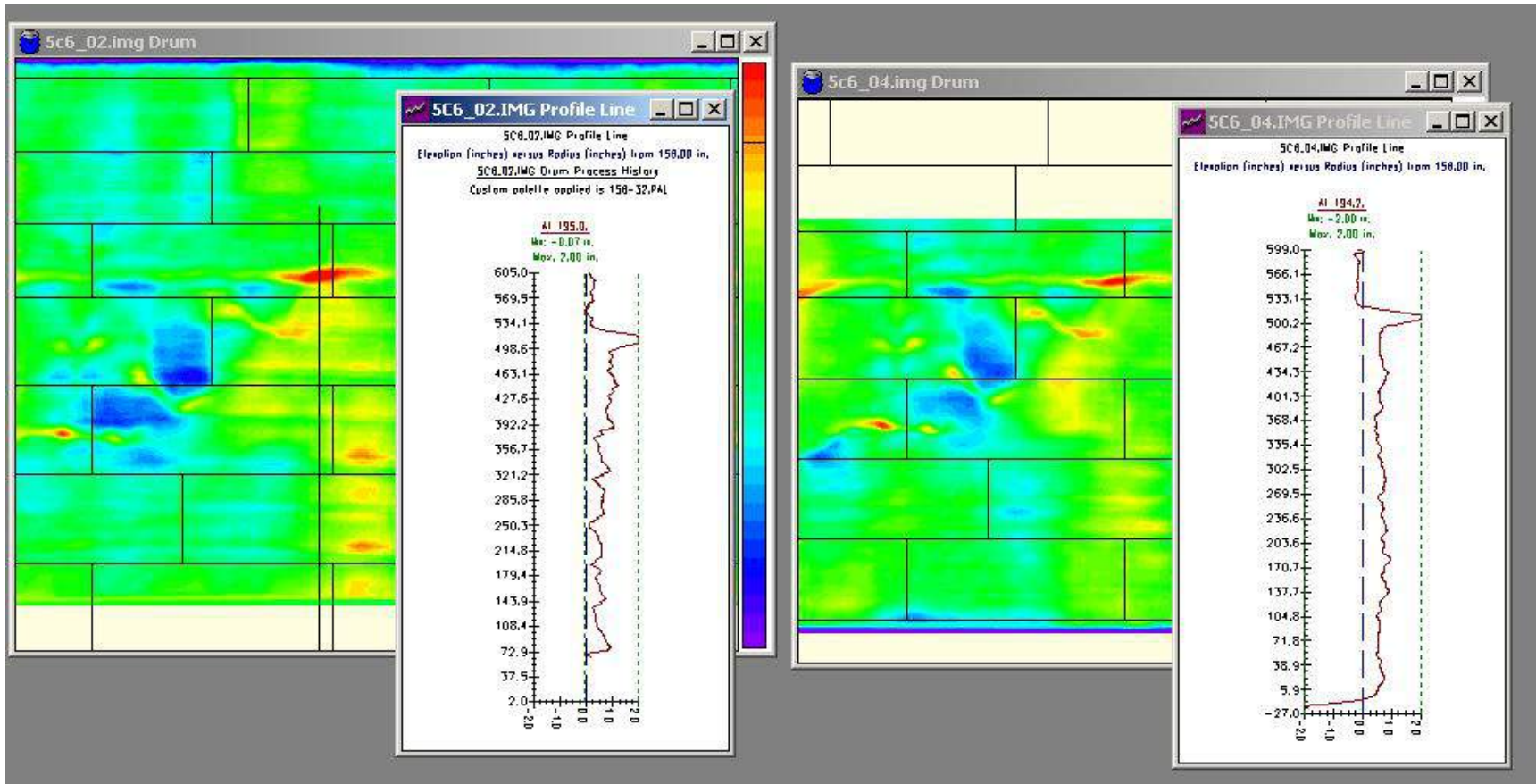
- Customer used Stress Engineering's BIF to evaluate bulge severity of the drum surface.
- Results were intended as a guide to rank bulges for inspection priority as a function of their likelihood to encourage cracking.
- BIF factor correlates the geometric bulging patterns of past cracking histories, developed from examining other coke drums, to the bulges on Suncor's coke drum.

BIF	Internal Cracking Likelihood
$\geq +2$	Severe
+1.5 to +2	Very High
+1 to +1.5	High
+0.75 to +1	Medium
0 to +0.75	Low

- Of the eight drums reviewed, 1 Drum was identified with the most severe bulging at 2 Locations. We name them Bulge A & Bulge B.



Compare 2002 and 2004 Bulges



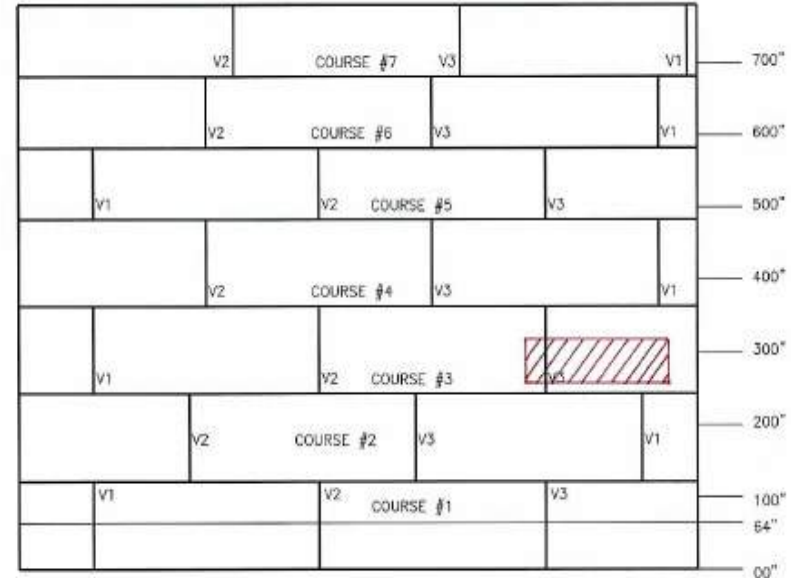
FEA Performed

- Stress Engineering performed FEA to validate overlay as “fix” for the problem
- Calculated expected life on the bulge was 8,277 cycles (before repair)
- Weld overlay reduces the stress on the bulge
 - Bulge peak hoop stress was reduced by 43% and 49% respectively on weld ID and OD
 - Bulge peak axial stress was reduced by 43% and 49% respectively on weld ID and OD
- The life of the repaired bulge is controlled by the hoop stress at the taper
 - The calculated expected life on bulge is 29,259 cycles (after overlay)
 - The calculated expected life at the overlay taper is 16,463 cycles (conservative calculation)
- Increased Life Expectancy of Coke Drum by over 3X



Bulge Overlay

- Bulged area overlaid: 21' x 6'
- Applied Alloy 625, .375" thick (2 layers), overlay utilizing temperbead utilizing (2) PLC controlled Unifuse Weld Systems
- Temperbead eliminated the need for PWHT
- Post Soak of 450° for 2 hours to eliminate any potential for hydrogen

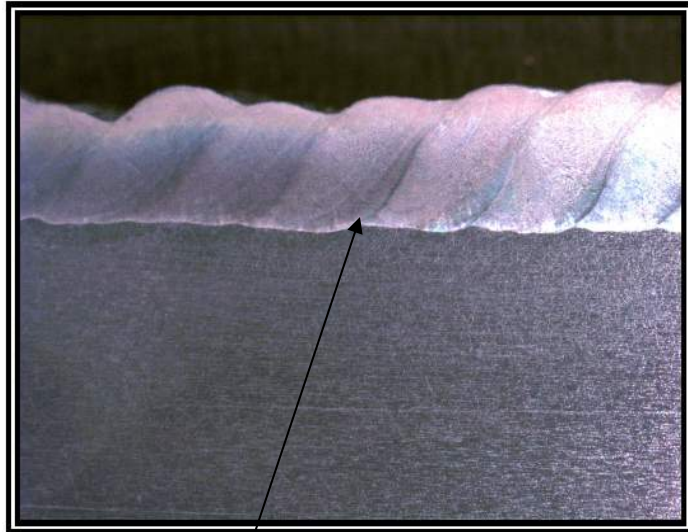


NORTH - 0 DEGREES
 EAST - 90 DEGREES
 SOUTH - 180 DEGREES
 WEST - 270 DEGREES

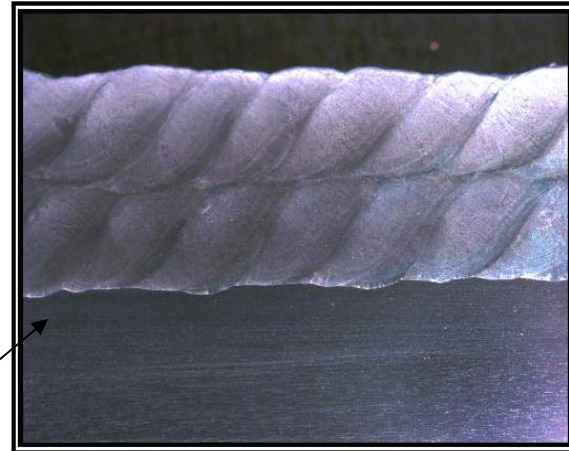
 WELD OVERLAY AREA
 * HEIGHT AREA (265
 * LENGTH AREA (0° -



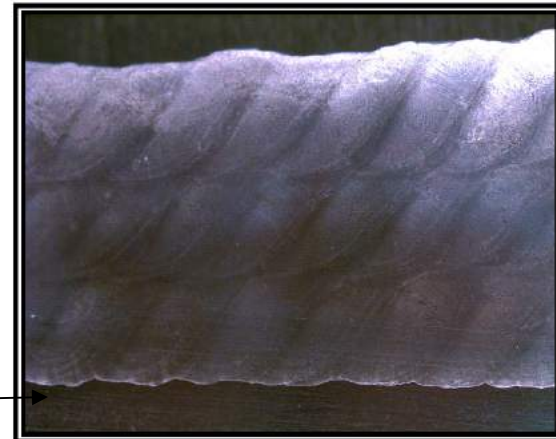
Temperbead Welding



HAZ created by 1st weld layer



HAZ is tempered by deposition of successive layers



Conclusion

- Assessment by Stress Engineering quantified remaining life of bulge, and validated overlay process
- Overlay extended life of drum (bulged area) by 3X
- Unifuse® Overlay controls enabled temperbead application and increased productivity



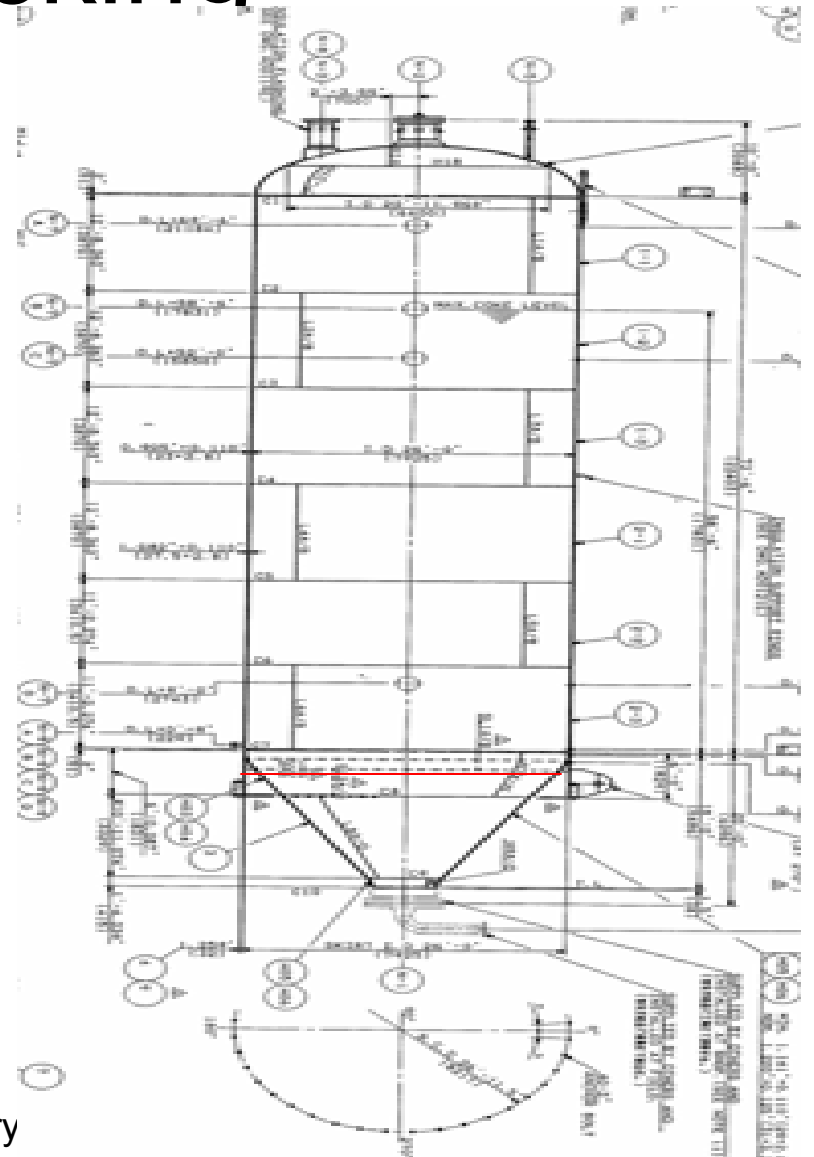
Skirt to Shell Weld Repair with Temperbead Process

Refinery in Northern California



Skirt Cracking

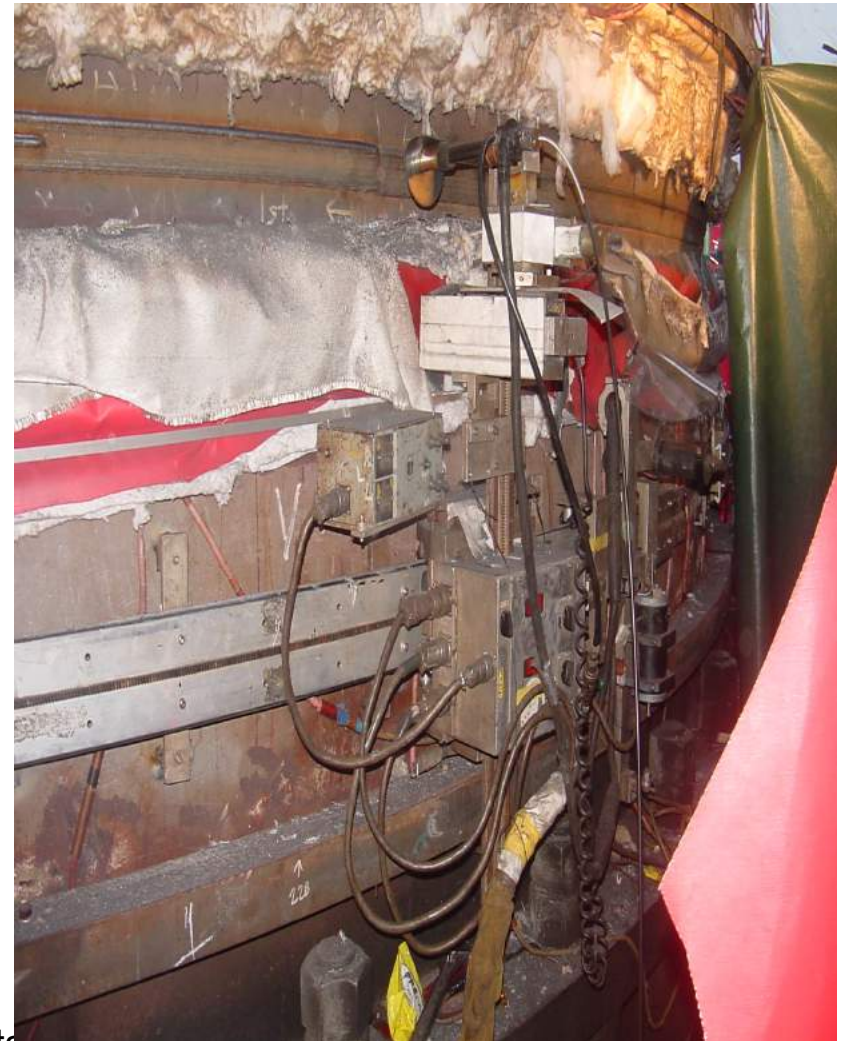
- 2 - Coke Drums
- Tower details:
 - SA-387-Grade 11 material
 - 103 foot tall
 - 26 foot ID
 - Original wall thickness 1.25"
- Turnaround inspection:
 - 2003 T/A repaired weld seams in Coker # 2
 - May 2006 found indications approximately 0.190" deep, 1" long, encompassing entire circumference of weld seam in both drums



Customer Challenge

Client options:

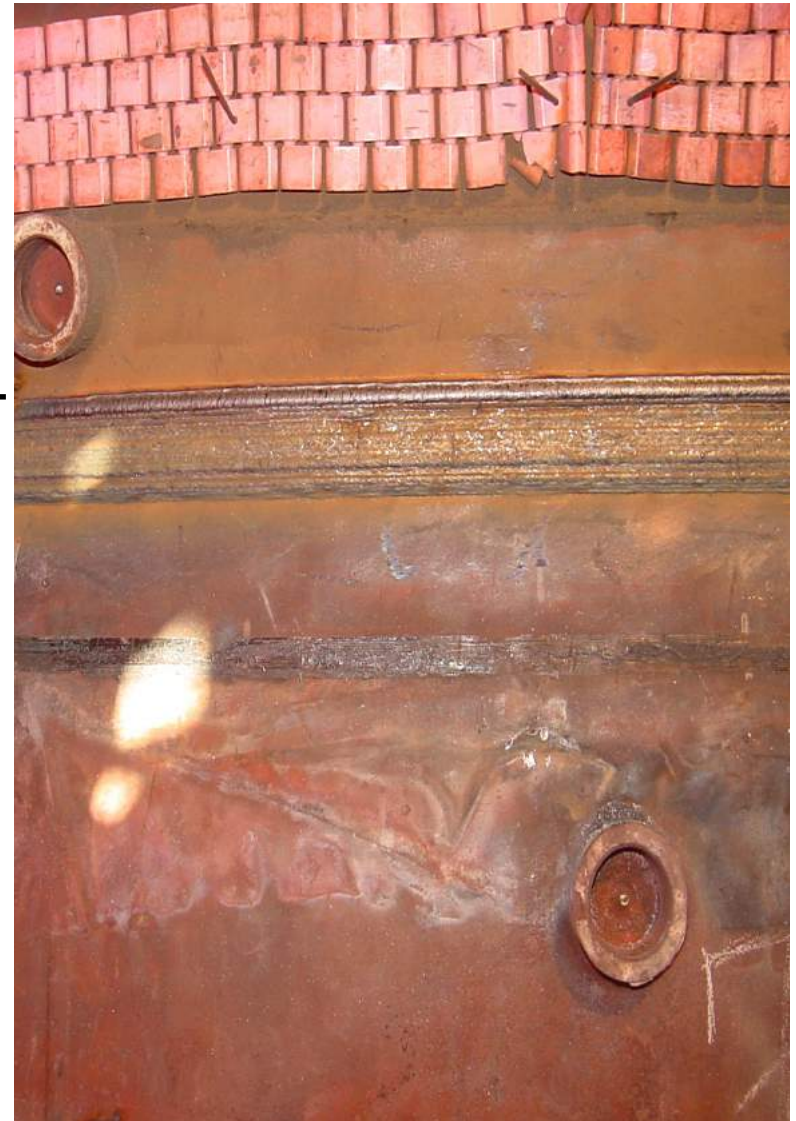
- Stick Welding:
 - Already had contracted with local general contractor to gouge and re-weld, and it was going to take 3 outages to complete.
 - 3 Outages x 5 days = 15 Days required
- Automated Welding :
 - Utilize Temper bead technique
 - Work on both Coke Drums simultaneously
 - Eliminate PWHT



WSI Approach

Engineered Repair Design:

- Utilizing 8 Automated Weld Systems
- Machined and Re-Welded Circ Seam using Temperbead WPS
- Post Soak used, eliminated PWHT
- UT Shear Wave acceptable
- 5 day Schedule for the welding of both Coke Drums
- Savings \$\$\$
 - Customer avoided 10 days of Downtime
- ***Recently inspected after 660 cycles no cracks***



WSI Proprietary

Coker Skirt to Shell Circumferential Seam Weld Repair

Refinery in India



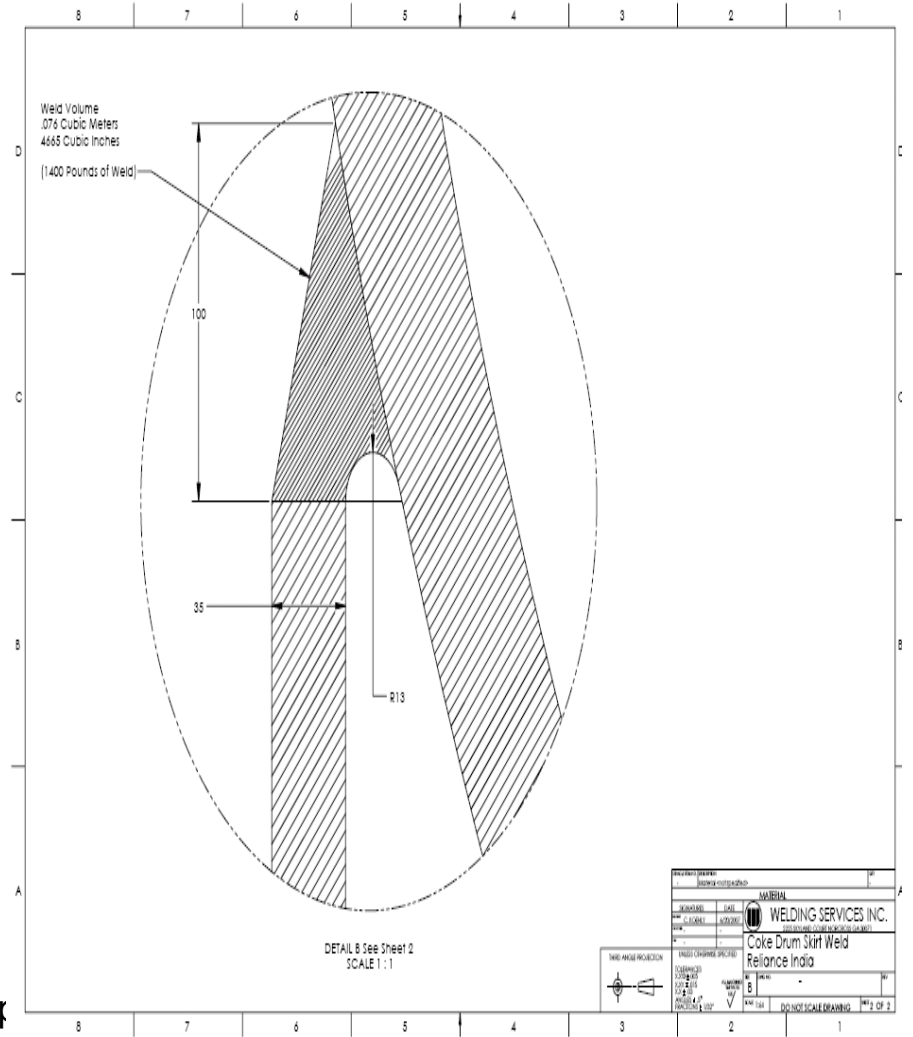
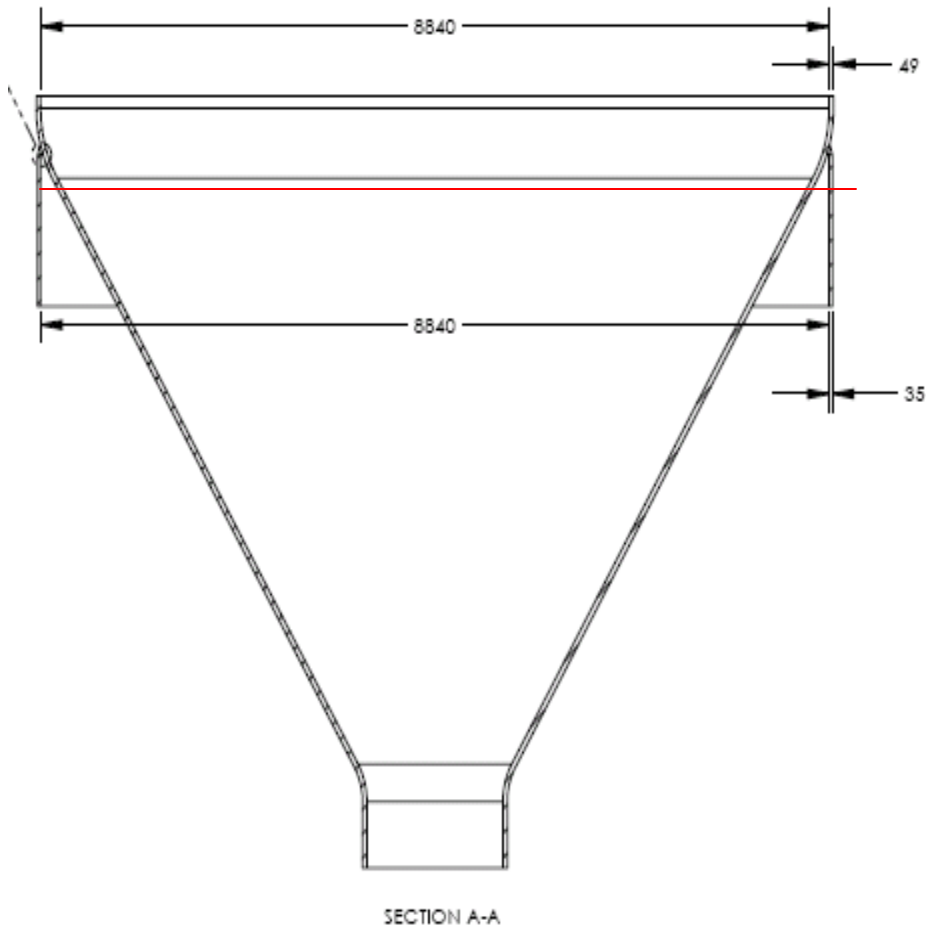
Welding Services Inc.

Customer's Challenge

- 8 - Coke Drums (4 Trains)
- Tower details:
 - Material – SA 387 Grade 11
 - Height: 87 feet
 - Diameter: 21.7 feet
 - Original W.T.: 1.37"
- Customer was experiencing extensive cracking at skirt to shell circ seams 360 degrees all 8 drums

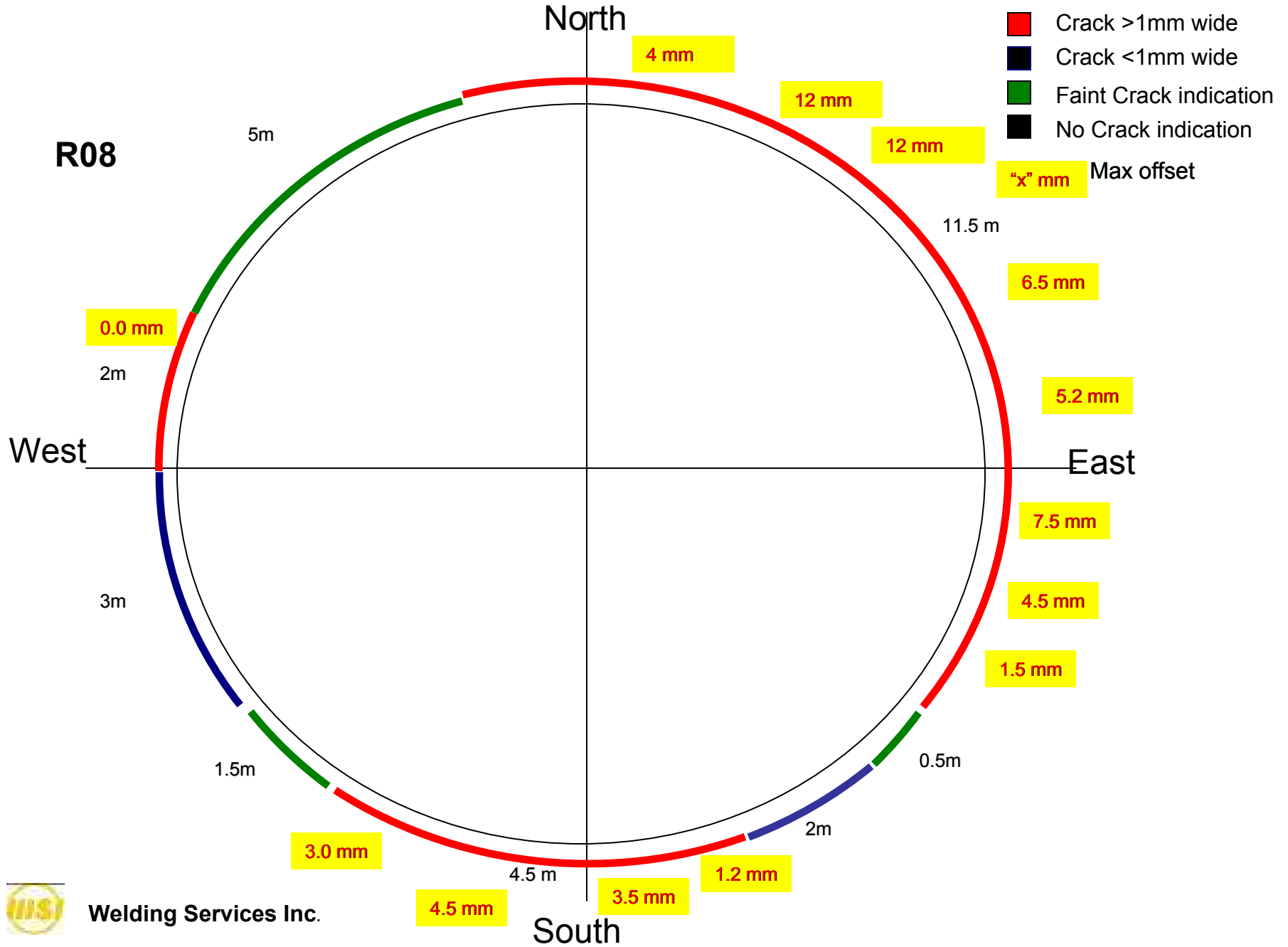


Circ Seam



WSI Proj

Crack Assessment



Evaluation

- Cracks did not penetrate into the base material (shell wall), and customer wanted to perform the repairs to cracks with little to no separation while on-line
- Safety and Risk Evaluation
 - Reviewed Refinery's Past Safety Performance
 - H2S Monitoring
 - Customers existing permanent plant monitors
 - Addition of temporary monitors strategically located
 - Structural Stability Evaluation
 - including wind load



Safety Plan

- Generation of Detailed written Safety Plan
- Focused Training of the team on the specifics on the job and the hazards to watch out for
- Generation of work traveler that incorporates the safety aspects of this evolution
- Heightened Site Safety Presence and monitoring
 - Tented cool down stations for personnel
- Vacated area during emptying of cokers



Repair Plan

- Review Crack Mapping, Structural Stability, and Work Environment
- Crack Excavation
- Pre-Heat: 250 Degrees Utilizing Resistance Heaters
- Root – GTAW Semi-Auto
- Fill – GMAW Semi-Auto
- NDE -Dye Penetrant
- Post Soak (de-gas) – 450 degrees



Schedule

- Schedule was developed with the integrated team: Operations, Maintenance, Safety, Engineering, and Corporate Executives.
- Project Team reviewed and approved the entire plan...Repair and Safety
- This was an emergent project completely mobilized within 2 weeks notification of need in India



Coker Piping Project

Refinery in Northern California



Welding Services Inc.

Project Overview

- T/A to connect new piping from capital project to existing unit
 - Installed Distillation Column and Fractionator Tower
 - Knockouts for processing heavy crudes
- Welds ranging in size from 1.5” to 36”
- Schedule: 50 days
- Goal: Zero manhour lost time.



WSI

Customer Challenge

- Reducing Schedule
- Reducing Cost
- Improving Quality
- Reducing Safety Instances
 - Lowering Headcount



WSI Solution

- Provided T/A Planner to evaluate all welding work scopes
- Developed detailed plan to weld all 5 Cr and SS piping 8"-30" 274 weld count
- Provided crew of 18 weld operators and 9 pipefitter support personnel per shift
- All work performed under WSI "R" stamp and QA program



WSI Pro

WSI Solution

- Performed 300+ welds with only 3 minor rejects in cap pass
- Reduced schedule 5 days
- Reduced Headcount by 45 Pipefitters compared to GC
- Safety: Zero lost time accidents



Conclusion

- Integrating WSI's automated welding process customers were able to:
 - Reduce downtime
 - Lower Cost
 - Lower Headcount
 - Increase longevity

