Innovative Repairs in Coke Drums

Coking.com
Calgary, Alberta
Canada

Agenda

- Reasons Coke Drums Crack
- Locations of Cracks
- Various Repair Methods
- (3) Examples of Innovative Repair Methods
- Test Results from Refinery Vaildating use of OL for Repair of Bulges
- Test Results for Using OLP in Coke Drums
- Joint Industry Project

Coke Drums

- API Survey of 54 Drums
  - 61% Bulging
  - 97% Circumferential Cracking
  - 78% Skirt Cracking
- Cracking occurs within 5 to 7 years
- 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

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

Example 1

Repair of ID Corrosion

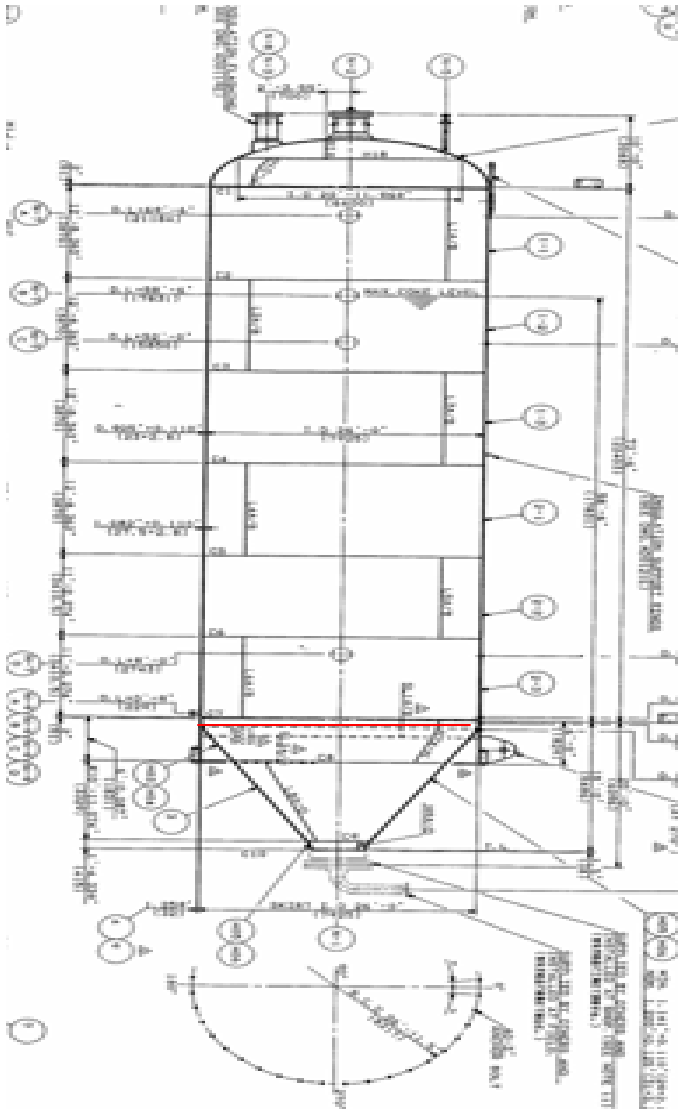
Rough Draft
Waiting on info and pictures to complete

- Customer was experiencing cracking and delamination of explosion bonded clad in 1999
- WSI removed cladding and applied overlay tying back into explosion bonded clad
- In 2008 Customer was experiencing delamination of explosion bonded cladding around Overlay
- WSI removed delaminated clad and applied Overlay

Example 2

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:

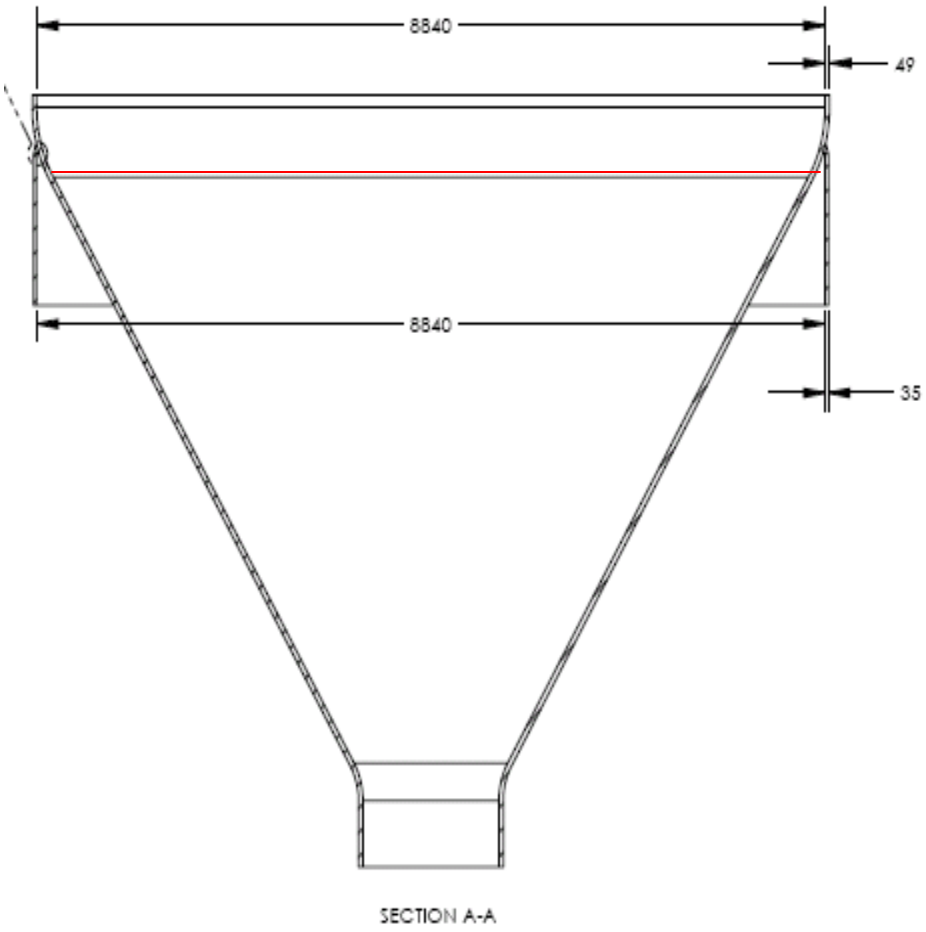
- Utilizing 8 Automated Weld Systems
- Machined and Re-Welded Circ Seam using Temperbead WPS
- Post Soak used, eliminated PWHT
- UT Shear Wave acceptable
- 5 day Schedule for the welding of both Coke Drums
- Savings $$$
  - Customer avoided 10 days of Downtime
- ***Recently inspected after 660 cycles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

Coker Skirt to Shell Circumferential Seam Weld Repair

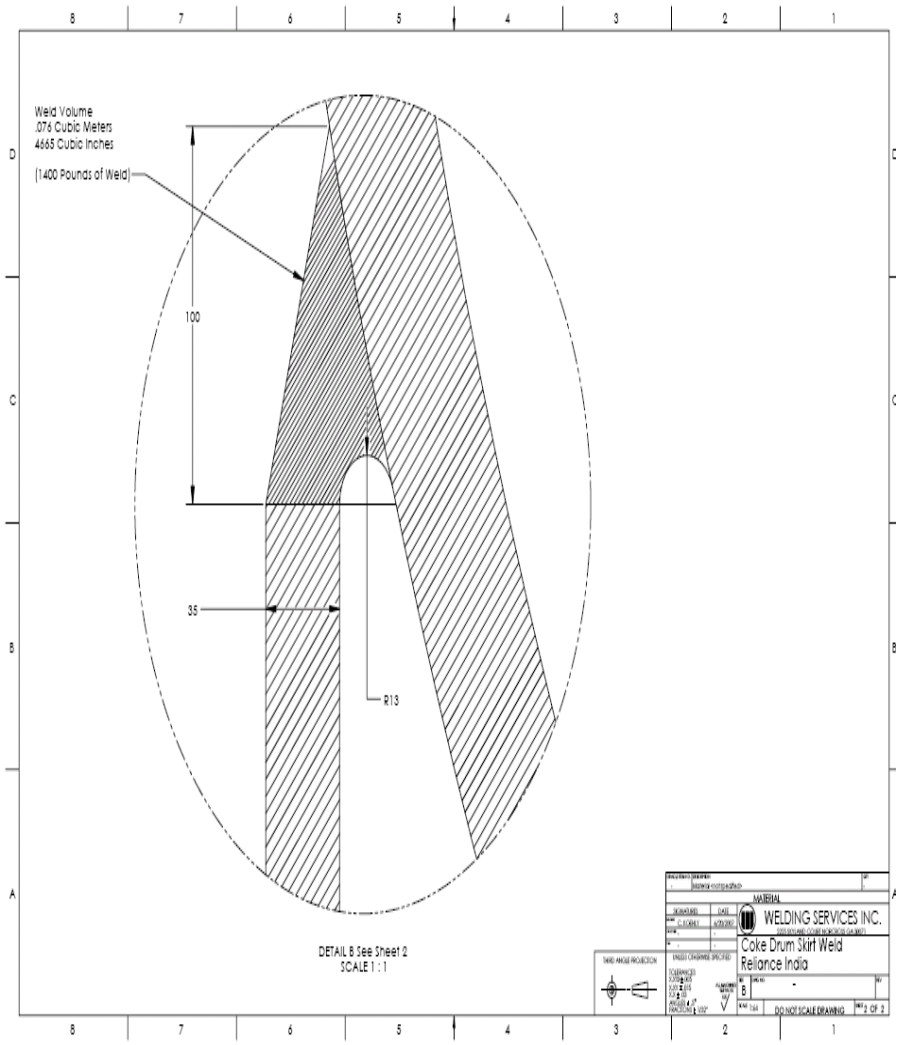
Customer's Challenge

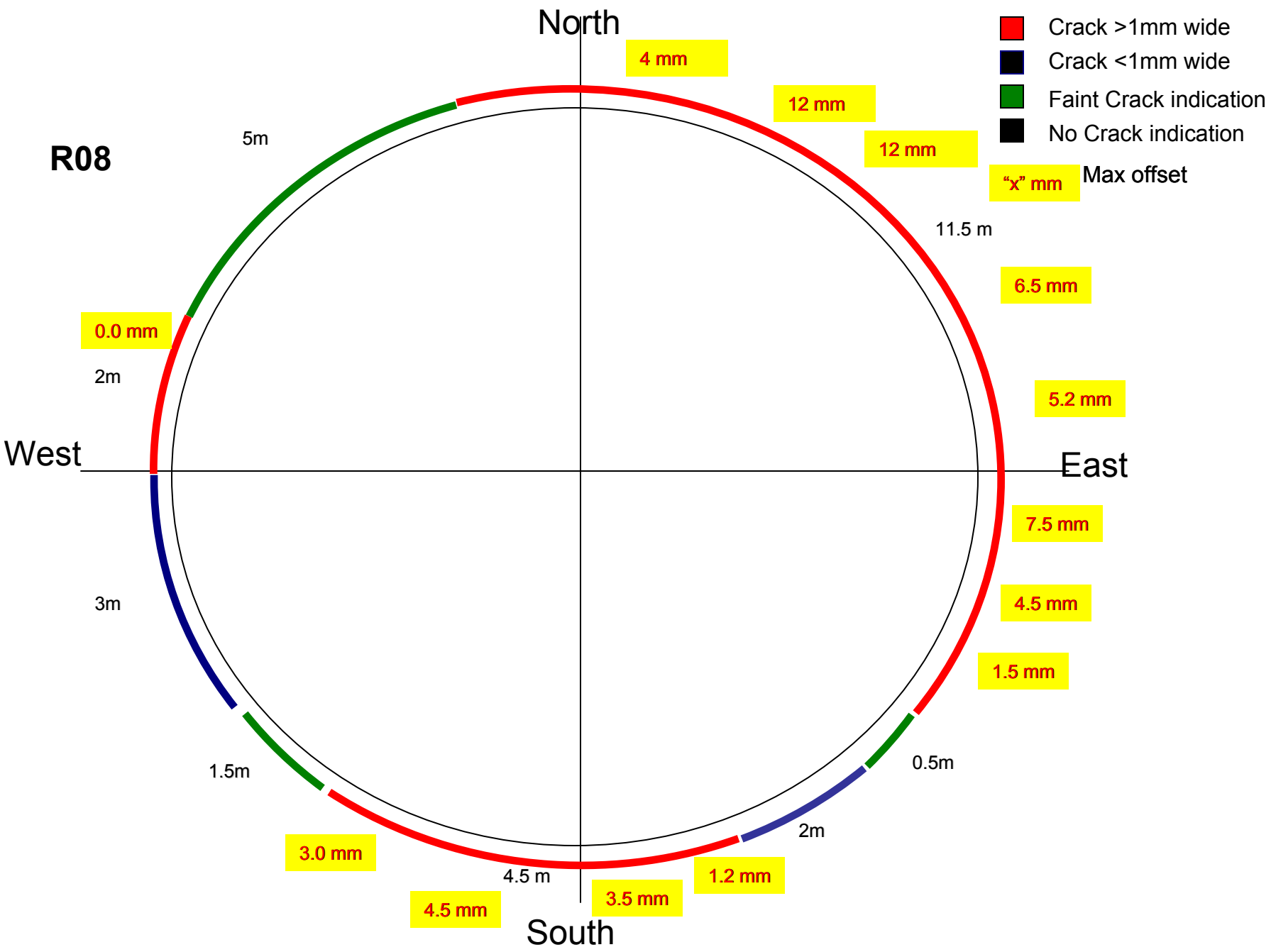
- 8 - Coke Drums (4 Trains)
- Tower details:
  - Material – SA 387 Grade 11
  - Height: 87 feet
  - Diameter: 21.7 feet
  - Original W.T.: 1.37"
- Customer was experiencing extensive cracking at skirt to shell circ seams 360 degrees all 8 drums

Circ Seam



SECTION A-A




R08
North
South
East
West
Crack >1mm wide
Crack <1mm wide
Faint Crack indication
No Crack indication
Max offset
4 mm
12 mm
12 mm
"x" mm
11.5 m
6.5 mm
5.2 mm
7.5 mm
4.5 mm
1.5 mm
0.5m
2m
1.2 mm
3.5 mm
4.5 m
3.0 mm
1.5m
3m
2m
0.0 mm
5m

Evaluation

- Cracks did not penetrate into the base material (shell wall), and customer wanted to perform repairs to cracks with little to no separation while on-line

- Safety and Risk Evaluation
  - Reviewed Refinery's Past Safety Performance
    - H2S Montoring
      - 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

Use of Overlay Plate for Fabrication of New Coke Drum

- ***Stress Engineering Services*** – Evaluation and Assessment
- Comparative Testing OLP versus Explosion Bonded Plate
  - Stress Concentration Factors
  - Mechanical Tests
  - Low/High Cycle Fatigue

Test Results

- Waiting on Completion of Test …will have within next 30 days.

Joint Industry Project

- Develop Test plan to evaluate weld overlay for Coke Drum Service
- Evaluate weld bead strength and SCF from bead contour
- Evaluate compatibility with weld cap overlay at Circ Seam
- Evaluate New Plate Fitness
- Evaluate Field Bulge Overlay
- Perform testing at SES Houston lab if details and special sensors to be used
- Or at WSI if conventional Tests performed
- Metallurgical Review by WSI and SES
- Develop Technical Papers on Results for Presentations
- Compare to Roll and Explosion Bonded