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Visual Inspection Images

This document is prepared to demonstrate some of the capabilities of CIA's Remote Visual Inspection Service. At the same time, we hope that users of this document will be able to relate their own visual inspections with many of the conditions that we have documented.

To date we have performed inspections on close to 250 vessels and have amassed a significant database on drum performance characteristics. This database combined with our extensive visual library of recorded defects gives CIA Inspection a strong knowledge base to work from. We hope that you find this document useful and we will continue to improve and enhance its contents as we move forward with inspecting coke drums throughout the world.

The following images are typical of the images found during CIA Inspection's remote visual inspection segment of the coke drum inspection. Due to the image transfer from SVHS tape to digital media, the resolution and sensitivity of the taped images are reduced. Note that the elevation and azimuth are permanently recorded on the videotape.

Image 1

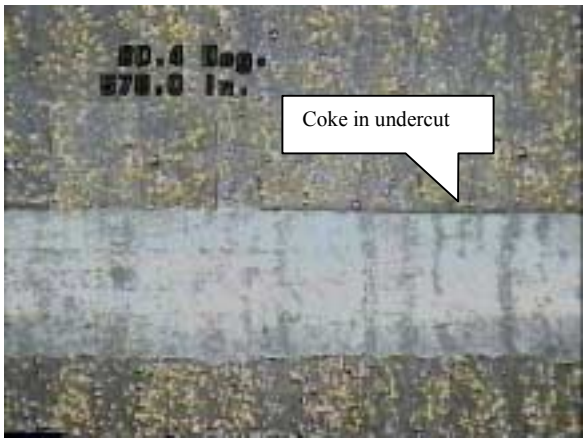
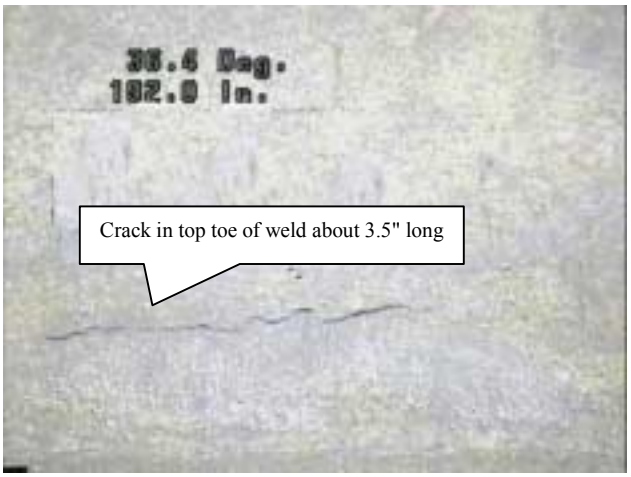


Image 1 is a flush ground weld in an eight-year-old drum. The weld metal is Inconel and the clad on the parent metal is 410 stainless steel. The weld metal clearly contrasts against the parent material. This is typical in well washed in service drums.

Note the dark line along the upper toe of the weld. This is residual coke from the wash collecting in a slight undercut. This area is adjacent to a crack site. Care has to be taken in interpreting this condition.

Image 2



This image shows a very prominent crack in the top toe of the weld and is 3.5" long. Ultrasonic evaluation determined this crack to be 0.328" deep extending at least 0.250" into the pressure boundary.

The owner is monitoring this crack ultrasonically during operation to prevent a through wall failure and to allow operation until the next turn around. This crack type indication is typical of those found at shell thickness transitions in alloy drums. They are most commonly found in the upper heat affected zone at thickness.

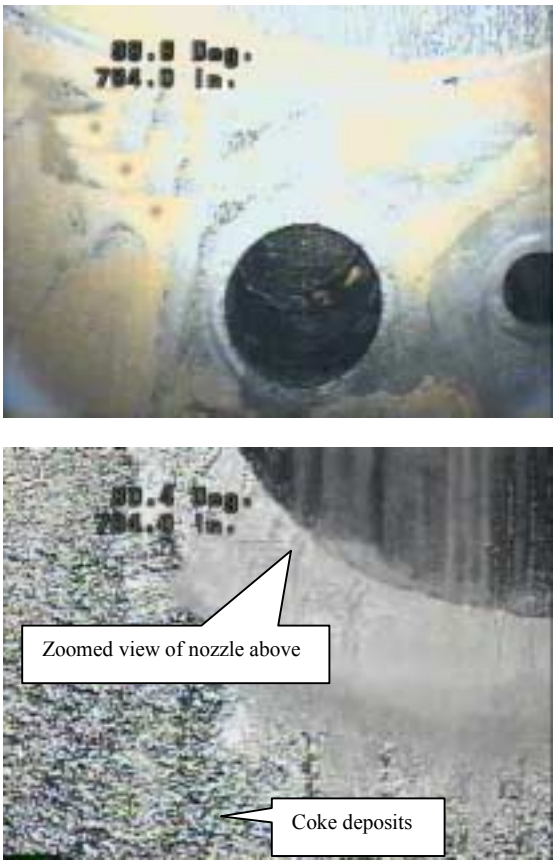
Image 3

This image shows a vertical crack extending from a cladding repair. This type of indication initiated and extended from a construction false work repair. These types of repairs are common in field erected drums.

Image 4

This illustrates delamination of a fusion-bonded cladding. This condition first appears as blistering. The delaminated area will propagate to the point where the clad is fused. Delamination of spot welded liners is more extensive starting with cracking around the spot welds and eventually breaking away between the spot welds or at the liner butt welds. Spot welded liners are seen in older carbon steel drums.

Image 5



These are images of nozzles in the dome section. Nozzles can be viewed for coking and if the nozzle to shell weld is clean this area can be viewed for in-service anomalies. The dome section is difficult to clean and is generally covered with a tightly adhering layer of coke

Image 6

Thermalwells and probes can be inspected for cleanliness and condition. In the case of this image, the insert plate welds can be inspected for inservice anomalies.

Image 7

Image 7 shows a steam injector nozzle passing steam with the block valve closed. This is indicative of worn or coked valve seats. This condition can be seen remotely because feed streams do not have to be isolated for remote entry. CIA's drum profiling and video system is housed in a Class 1 Division 2 housing.

Image 8

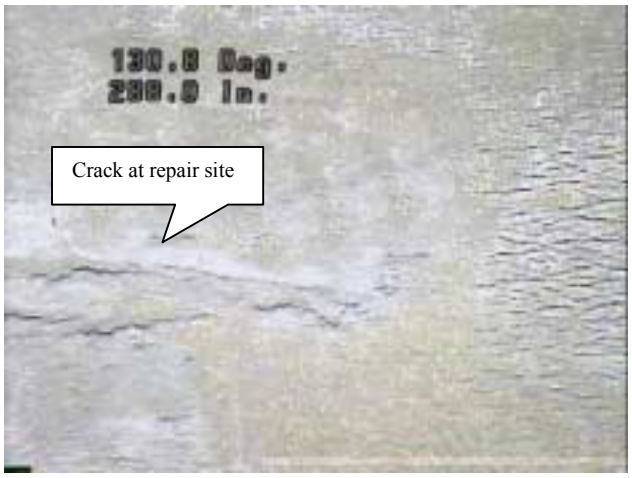


Image 8 shows cracking initiated at a repair site and propagating in the repair and the original weld. The repairs in this image are one year old. Crack initiation in these conditions could be due to non-relevant indications in the repair area, incomplete removal of the original repair indication or metallurgical alteration from excessive thermal input during the repair welding process.

Image 9

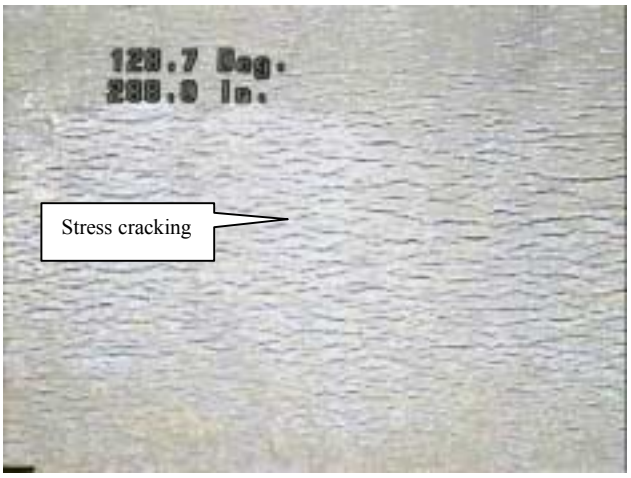


Image 9 shows surface stress cracking in mid course. This stress cracking coincides with a band of outward radial growth (bulging) that has increased by 1" to 2 ½" over the benchmark scan which was performed 18 months earlier. This radial growth was mapped using CIA's laser profiling instrument. The laser image was used during the remote video inspection to determine the relationship between the dimensional anomaly and the visual anomaly. Transverse cracking can be seen in the vertical weld in a year old repair area in the bulge.

Image 10

Image 10 is an external weld repair on a new drum post erection and before first fill. The bluing seen in this image is typical of excessive thermal input during a radiographic repair. Exceeding the weld procedure inter pass temperature causes metallurgical alteration outside of the limits of the PQR and WPS. This alteration results in a stress raiser and residual stresses beyond that of the design criteria. Video recording and laser profiling of new drums before going into service provides the user with an opportunity to identify conditions such

as these. Due to the highly cyclical nature of coke drum operations, a record of non-relevant code indications and areas of excessive thermal input and dimensional anomalies help to establish their relationship with failure initiation. It has been noted in CIA's database that there is a repair site and operational failure initiation relationship seen in subsequent scans. This information helps owners and fabricators to refine their construction and repair specifications to minimize operational failures.