

PROCEEDINGS PAPER:

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Innovative Inspection and Repair of Pipelines Over Water

Abstract

Inspecting and repairing pipelines that are located over water presents a unique challenge. Access and working conditions are usually poor. Wind and waves can damage staging, making it hard to maintain and potentially unsafe. Proper application and curing of coating is difficult when abrasive blasting is prohibited and conditions are often wet. Moisture makes getting good quality weld repairs a challenge, plus residual hydrocarbon inside lines presents a potential safety hazard during welding and cutting operations. Finally, common inspection techniques can miss the very localized corrosion that can occur in such environments, and this makes finding and repairing all potential leak locations an extremely difficult task. This paper discusses some unique and innovative approaches that have been used at the ConocoPhillips San Francisco refinery to overcome these challenges.

Facility Description and Background

The ConocoPhillips Marine Terminal in Rodeo, California is a “T-Type” Wharf located near the southern shore of San Pablo Bay approximately one-mile west of the Highway 80 Carquinez Bridge. The terminal was placed in service in 1955.

The terminal currently has 16 active hydrocarbon lines handling a variety of commodities including crude oil, fuel oil, diesel, jet fuel and gasoline. The total length of hydrocarbon piping is about 7 miles.

Though the terminal piping has a long history of inspections and repairs, an aggressive inspection and repair program was started in 2000. The enhanced inspection and repair program was deemed necessary for the following reasons:

- Environmental restrictions on grit blasting and other aggressive surface cleaning techniques had made it increasingly difficult to utilize coating systems that could provide adequate protection against external corrosion.
- Older lines, especially in splash zones, were continuing to corrode despite past maintenance preventative measures.

- The San Francisco refinery had developed a zero tolerance philosophy for even the smallest pinhole leaks in hydrocarbon services, especially for lines over water.

The challenge for this renewed effort was how to efficiently and effectively inspect and repair miles of over water hydrocarbon lines that are: 1) hard to access 2) have poor working conditions 3) pose safety hazards for welding and cutting operations and, 4) where abrasive or water blasting to better enable inspection and re-coating is prohibited.

Inspection Techniques

Early on, it was felt that using a combination of hydrotesting and long range ultrasonics would effectively identify areas most at risk of a near term leak. Concern areas identified by these techniques would be targeted for direct access first, inspected up close, and repaired as needed. As it turns out, neither hydrotesting or long range ultrasonics can effectively find localized deep pitting, the most common failure mode for over water piping. Conventional ultrasonics and radiography also cannot be counted on to accurately assess highly localized external corrosion. To date, close up visual inspection and pit gauging remains the most reliable method to assess localized corrosion and minimize the risk of pinhole leaks. Line sections are replaced or repaired when pit depths and lengths exceed the limits stipulated in ASME B31G “Manual for Determining the Remaining Strength of Corroded Pipelines”. From our viewpoint, hydrotesting and long range ultrasonics should be considered rough screening tools only. However, these techniques may have more value for inspecting lines with more broad corrosion damage than what we’ve typically experienced at our marine terminal.

Access: Staging or Rope Access Technicians

Given that direct access and close-up visual inspection and pit gauging was deemed the only truly reliable inspection technique, we were left with the dilemma of how to “close-up” inspect miles of hydrocarbon piping in a timely manner using staging. Our track record for timely inspection and repair using staging was not good. Staging was often damaged or destroyed by wind and waves despite our best tie down efforts. This led to numerous delays, especially during the winter months. Starting in 2003, we began using rope access technicians for inspection and repair work on marine terminal lines and have found them to be very effective for this purpose. Though rope access technicians still require reasonably good weather to work, we found that our inspections and repairs progressed much faster than possible with staging.

Coating Repair Options

Being limited on cleaning techniques and dealing with often-wet conditions limits our coating options. However, technology for surface and moisture tolerant coatings continues

to improve and we are currently having reasonable success with two types of coating systems:

- Petrolatum tapes and
- Surface tolerant aluminum filled epoxy mastic primers with a top coat of white, moisture curable urethane

Petrolatum tapes are easier to apply initially but typically require more maintenance than epoxy/urethane systems to remain effective. An advantage of urethanes is that bright colors can be used and initiating rust blooms are more easily spotted than on petrolatum taped piping. For both coating systems, we are limited to hand tool cleaning (e.g. needle gunning) for surface preparation.

Piping Repair Options

Historically, corroded line sections have been repaired by complete replacement or sleeving, depending on the extent of corrosion damage. Both options require welding, always a challenge from a safety standpoint at an active refinery terminal with lines that are difficult to fully drain of hydrocarbon. In 2003, we began using engineered fiberglass wraps on line sections with modest external pitting corrosion. These wraps are engineered to withstand the full relief pressure of the line. Each wrap location is carefully noted and will be re-inspected at least annually to ensure there's no deterioration in the wrap's condition.

Conclusions

- Rope access technicians can be an efficient and effective tool for inspecting and repairing pipelines over water.
- Close-up visual inspection and pit gauging is the most reliable method to assess localized corrosion and minimize the risk of pinhole leaks. Long range ultrasonics, hydrotesting, conventional ultrasonics and X-ray can all play a role in a comprehensive piping assessment program, but these are not the most reliable tools for finding and assessing highly localized external corrosion.
- Petrolatum tapes or surface tolerant/ moisture curable, epoxy/urethane coating systems appear to be the best options for corrosion protection for lines over water (where conditions may be wet, and aggressive cleaning options like grit blasting are prohibited for environmental reasons). *Note: we are also using Teflon coated bolting for flanges in splash zones.*

- Engineered fiberglass wraps are a relatively new and promising repair option for over water line sections with external corrosion. Using such wraps eliminates the safety hazards associated with cutting and welding on hydrocarbon lines.