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Fig. 1: Waterjetting robot in operation. At most, it had to bear the weight of the 100-foot vacuum hose. Courtesy of the author

Remote Waterjetting Offers Inconspicuous Coatings Removal on LNG Tank

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NEWS FROM THE FIELD

From June through December of 2001, a large regional distributor of natural gas on the East Coast, a contractor, and a coatings manufacturer teamed together to strip and repaint the exterior of a 14,000,000-gallon (53,200,000-liter) Liquefied Natural Gas (LNG) double-walled tank. The tank stands 125 ft (38 m) tall and has a diameter of 180 ft (55 m).

The task was to remove 85,000 sq ft (7,650 sq m) of a 12- to 18-mil (300- to 450-micrometer) coating system from the previously blasted carbon steel surface. The double-walled tank has an internal temperature of -260 F (-162 C). The sheer size of the tank, combined with the use of a remote crawler at 125 ft (38 m) in the air, made this project unique.

Every contractor and owner want to complete a project as quickly as possible, as safely as possible, and with as little waste as possible. Accomplishing all three goals is difficult. However, using pressurized water cleaning that did its job inconspicuously, the team achieved these goals.

Project Planning

The existing paint on the LNG tank was about 15 years old. By the time the project started, light rust breakthrough covered about 80-90% of the surface. To be conservative, the utility company decided to blast and repaint the tank to achieve a service life of 20 years.

Safety Considerations

LNG tanks are double walled, similar to a double-hull tanker, with a pressurized interior tank. To avoid the danger of explosions, the utility company could not allow any welding or burning on the exterior of the outer tank.

Operations

The utility company had to keep operating during this time and maintain service to its over 200,000 commercial, industrial, and residential customers. To prevent damage to operating equipment, no abrasives or dust could reach the pumps, motor, or fans.

Environmental Concerns and Public Relations

The tank is located in a sensitive environmental area near water and not too distant from highways and public spaces. In addition, the tank is visible because of its height. The utility placed primary importance on the health and safety of its employees and the community. The company did not want to create environmental problems or arouse public comment or fears while the tank was being cleaned and repainted.

Project Requirements

The Paint System

The contractor was to remove a multi-coat paint system (12 mils; 300 micrometers) and apply a three-coat paint system consisting of two coats of epoxy and one coat of polyurethane. This coating system was to be applied at four mils (100 micrometers) per coat (12 mils or 300 micrometers total).

Selection of Surface Preparation Method

The selection of ultra-high-pressure (UHP) waterjetting was not necessarily the utility company's first consideration. The end user wanted to minimize the amount of hand work and had no tolerance for "hot work," such as welding. When the utility company approached the commercial paint contractors in the region, all contractors thought that they had to weld fittings on the exterior tank so that they could attach the containment for the abrasive dust and solids. By itself, this safety consideration precluded dry blasting techniques.

With the issues given above and with the experience of the coatings manufacturer with waterjetting as a surface preparation for its products, the utility company decided that it would use UHP waterjetting rather than abrasive blasting.

The surface preparation was specified as NACE No. 5/SSPC SP-12/WJ-2 with light flash rust. In this region, contractors who perform ship maintenance work have waterjetting experience. On the basis of six years of successful projects, the paint manufacturer arranged the introduction of a contractor known for marine work to the utility company.

Selection of Contractor

The contractor is a certified Department of Defense contractor who specializes in removing nonskid coatings from floors, flight decks, and helicopter pads of ships. Certification from the Department of Defense means that a contractor has met all requirements to bid on DOD bid lettings.

The company has been blasting and painting since 1962. It started using waterjetting in 1995 on Military Sealift Command (MSC) ships. The contractor approached the tank project in a manner similar to that of a ship hull project.

Surfaces and Configuration

Tank Height

One area of concern was the height of the tank. How would the contractor get the equipment to the work area and alleviate the weight of the hoses?

Because of its height (125 ft [38 m]), the tank had three, six-inch (15-centimeter) stiffeners around the exterior. Each stiffener protrudes 8 in. (200 mm) from the surface of the tank. The vertical side, the underside of the band, and the top of the band (estimated 2,800 sq ft; 252 sq m) would all have to be cleaned.

Interfering Areas

Some areas had to be tackled with open manual waterjetting. The inaccessible areas were the straps, bands, stairs, penetrations, stanchions, and pumping station. These areas made up approximately 25–30% of the total area to be painted.

Start Up

Labor

This region of the country has workers experienced in waterjetting who move from one contractor to another as projects start and finish. The contractor easily located experienced jetters, but the trick was finding people who would go up 120 ft (36 m) in a man lift that was subject to a lot of motion at the full height.

Equipment

The contractor purchased a new remote crawler, but elected to rent all other equipment. The equipment staged on the site included the remote crawler; four UHP waterjetting pumps; eight hand lances; guns; assorted hoses; a vacuum truck; one 20-yard (18-meter) vacuum box; 3 manlifts operating at 60 ft (18 m), 80 ft (24 m), and 120 ft (36 m); one 250 cfm (71 cmm) air compressor; and one paint sprayer.

Orientation and Learning Curve

During the first couple of weeks, the contractor experienced an intense learning curve typical of any large project. Safety training, staging of equipment, and teaching workers the practices of the contractor and the utility company were the first priorities. The manufacturer of the remote crawler worked very closely with the contractor to provide equipment training, review preventive maintenance practices, and answer typical questions as the crew bonded together as a team.

One of the biggest issues was how to support the weight of the hose at the 120-foot (36-meter) height. The problem took approximately one week to figure out. In the end, the vacuum hose and waterjetting hose were winched up to the band and hung on the band so that the hose weight was minimized for the crawler. The contractor rigged a rigid, 6-inch (15-centimeter) plastic pipe going up the vertical side of the tank as a permanent fixture for the attachment of the flexible vacuum hose that went to the crawler. At most, the crawler had to bear the weight of 100 ft (30 m) of the 4-inch (10-centimeter) flexible vacuum

The contractor was to remove a Carboline paint system (12 mils) and apply an Ameron 3 coat paint system- two coats of epoxy and one coat of polyurethane. This coating system was applied at four mils (100 micron) per coat (12 mils or 300 micron total). The local Ameron representative, Jerry Davis and Terry New, are very familiar with waterjetting

Fig. 2: Absence of water from the crawler as it worked vertically
Figs. 2–4 courtesy of NLB Corporation

line (Fig. 1).

There was very efficient vacuum movement. The hose and crawler were secured to the side of the tank. The rigid vacuum system could be moved around the tank. The tank was positioned on pilings, allowing the rigid vacuum pipe to be run under the tank to a stationary vacuum collection system on the ground.

Operation and Production

Discussion

Within two weeks, the orientation period was completed. Everyone—the contractor, owner, engineer, third party NACE inspector, and coatings manufacturer—wanted a top quality product. Everyone cooperated, and everything went well. The site is visible, but remote. Unless someone were watching the tank daily, he or she could not tell that anything was going on. A cloud of dust was not visible. Structural steel was not erected. The work was quite unnoticeable. The remote crawler and manual waterjetting got the job done without being obtrusive.

Production Rates

The contractor waterjetted an estimated 4 to 5 hours of the day, with 3 to 5 hours per day spent moving lines, inspecting, and performing other housekeeping chores.

The remote crawler tackled most of the surface. The crawler was operated with a vacuum attachment for control of airborne particulates and water. Full-scale containment was not needed. Figure 2 shows the absence of water from the crawler. Typically on the interfering areas, one manual lance, equipped with a five-jet nozzle, was used per pump. The production rate varied from 56 to 108 sq ft (5 to 10 sq m) per hour on the lance.

The bands and stiffeners limited the work area and divided it into sections. Starting at the top of the tank and working down, the crawler would work vertically between the bands while workers performed manual waterjetting (Figs. 2 and 3). Then the

Fig. 3: Manual blasting was used 2 feet above and below the band.

contractor would prime the area and move the equipment. The NACE-certified inspector checked the entire cleaned and primed surface.

Four people were working together—two on handguns located away from each other, one running the crawler, and one person acting as observer and safety back-up person. The pump operator was raised to half the height of the tank, about 60 feet (18 m) in the air in a manlift so that he could see what the crawler was doing.

The contractor placed tarps on the ground below the tank to collect runoff from the water blasting of the

bands. However, most of the water evaporated during blasting because the temperature of the tank was 100 F (38 C) in the sun. The handwork on the bands was done on manlifts up to 110 ft (33 m) high. The operators worked on separate bands away from

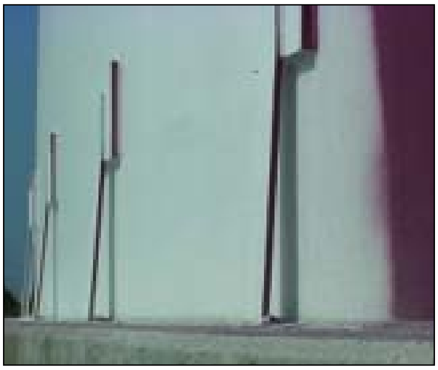

Fig. 4: Bottom straps of tanks primed (left) and topcoated (right)

each other. They manually blasted about 2 feet above the band and 2 feet below the band (Fig. 3).

A series of bottom straps from the tank to the concrete foundation pad was located about 4–5 ft (1.2–1.5 m) apart on the circumference. The straps are approximately 2 in. (5 cm) wide by 2 ft (0.6 m) tall welded to a plate at the top. The opening behind the strap was 1.5 in. (3.75 cm) at the bottom. Total removal of existing coatings was required. This was accomplished using a nozzle designed for cleaning tubes and a threaded barrel adapted to a rotating lance. Figure 4 illustrates the bottom straps, primed and finished.

The instantaneous average ranged from 5.5 linear feet per minute (1.8 m) to 13 linear feet per minute (4.3 m). This transverse rate translates into 330 to 650 sq ft/hour (30 to 59 sq m/hour). The rates include the areas cleaned, inspected, and painted, as well as downtime and movement around interfering areas during the eight-hour shift.

The contractor cleaned as much as 3,500 sq ft (315 sq m) but averaged 2,000 sq ft (180 sq m) per day on an approximately five-hour jetting time. The daily average for the crawler was 600 sq ft per shift to 1,200 sq ft per shift (60 to 120 sq m).

Other Considerations

As paint was removed, all surface defects could be observed, including the blast pattern of the original blasting (Fig. 2).

At the end of each day, the crew would solvent wipe any areas of flash rusting and apply a primer. Only a little flash rust would form in the region of manual blasting. The affected area was minimal, and flash rust was never considered a problem. Figure 1 shows the priming of the bands and the use of the crawler between the bands.

Water Collection and Disposal

The water was supplied by the utility company and reused as clean industrial water. Approximately 100,000 gallons (380,000 liters) were used on the entire project.

The contractor and the owner were concerned about general nuisance particulates in the air crossing the property line. The contractor found that the wetted paint residues from cleaning the bands simply fell to the ground and did not become airborne. Tarpaulins were placed on the ground to collect water from the manual cleaning. The effluent water from the manual blasting was passed through a filtering cloth to produce a clear stream of clean industrial water and then released to the utility company.

The water/paint slurry from the crawler was discharged into the vacuum tank where the fluid was separated from the solids. All operations took place within the secondary containment dike, about 400 ft (122 m) in diameter, around the tank.

Environmental Considerations/Waste Streams

The utility company, through the third-party inspector, performed all the air monitoring and testing of the water. Nothing of note was found. The solid waste stream consisted of the removed paint and painting materials. Ten to fifteen 55-gallon (209-liter) drums of waste were generated during the project.

Air monitoring and TCLP testing of the water for heavy metals were done routinely by the third-party NACE inspector who served as the utility company site manager. The inspector also monitored the air quality at the job site. All testing was performed by qualified personnel.

Economics

The utility company was satisfied with this approach to the problem. The pumping station remained in operation during the project. There was no interference between the contractor and on-site personnel and no effect on the daily operations or equipment.

Originally, the job was scheduled in two phases, so that the utility company could stretch out the budget and payments. Thirty days into the job, the utility company recognized how smoothly it was going. The engineer therefore authorized the preparation and painting of the whole tank within one season.

Even though the main deterrent to surface preparation by abrasive blasting was the problem of welding, economics and costs are always a consideration. With respect to costs, the utility company was extremely happy. The job cost considerably less that if it had been abrasive blast cleaned and contained.

Conclusion

According to the contractor, the remote crawler "has proven itself to be the ideal tool for this application. Troubleshooting can be easily taught on the job. The consumable parts are minimal. Clean, dry compressed air is one of the keys to minimizing downtime." Because tools of this type rely on compressed air to operate, having clean, dry compressed air eliminates a lot of problems.

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