TAKING SAFETY TO THE MAX : ELIMINATING HYDROBLASTING RISK THROUGH INNOVATIVE DESIGN, AUTOMATION AND PROCESS

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ABSTRACT

Concerns about the safety risks associated with hydroblasting are not new, but there is a renewed emphasis globally on reducing the human cost associated with the technique. Each year, there are numerous injuries and deaths associated with both manual and semi-automated hydroblasting techniques. A failure of a hose, fitting, or human error can cause devastating injuries or death.

When Tech Sonic LP decided to branch out into the cleaning services business with the formation of Clean As New Gulf Coast, we decided to put safety at the top of our priority list. Safety was a focus in the design and continues to be in the operation of the new state-of-the-art facility. By inventing new hydroblasting operating systems, making design choices and investments which directly eliminate risk, and optimizing our entire process for safety, we have created the world's first completely "hands-off" cleaning facility which still uses many of the standard hydroblasting methods alongside the Tech Sonic Cleaning technology. This presentation will describe the design mandate, process and results, and highlight how we have virtually eliminated risk from the cleaning operations.

INTRODUCTION

Since 2009, Tech Sonic LP has been using proprietary and patented (EP2516074, CA2359149, CA2413899, CA2412432, CA2785203, CN102939171A, RU2548084, SP181886, MX/a/2012/007462, ZA2012/05199, JP2012/545031, PCT/CA2010/002016) large-scale ultrasonic cleaning bath technology, chemistry and processes to clean large industrial equipment, with a focus on heat exchangers. The Tech Sonic Cleaning technique supplements the traditionally applied hydroblasting methods to produce near-perfect cleaning results for many types of equipment that are not possible to thoroughly clean by hydroblasting alone.

In addition to providing superior cleaning results, the cleaning process provides other significant benefits such as a drastic reduction in the amount of water consumed in cleaning and an even larger reduction in the amount of hydroblasting required[1].

In 2018, Tech Sonic LP embarked on a plan to design, build and operate state-of-the-art off-site cleaning facilities in North America and Europe, forming the company Clean As New Gulf Coast. Our goal is to create facilities that are specifically designed around the optimal use of the Tech Sonic Cleaning technology and the best available hydroblasting equipment available to maximize performance and throughput. Figure 1 shows an aerial view of the new facility.

It was clear from our consultation with the market that safety is a major concern for both the users of hydroblasting and the companies that employ contractors to perform the work. In 2018, the Waterjet Technology Association (WJTA) in partnership with the Stichting Industriele Reiniging (SIR) and Système de Certification Compétence et Conformité (S3C) announced a global initiative (GICC) to promote safety in waterjetting with the formation of a global standards committee1 to help address this concern[2].

Figure 1. The new cleaning facility in Baytown Texas.

HYDROBLASTING INJURY

Hydroblasting accidents are a cause of injuries and deaths worldwide. Improvements in technology, particularly the introduction of semi- and fully-automated systems have improved the safety of the technique in recent years, but the proliferation of the technology globally and the lack of standards for operation and reporting mean that injuries continue and that most injuries are likely not reported other than locally.

The bulk of injuries are to the extremities but even such injuries can be fatal. Injuries to the abdomen, neck, chest or head are less frequent, but significantly more deadly[3].

Hydroblasting injuries are particularly heinous, often showing little external evidence of extensive internal damage[4]. The tiniest exposure to a high-pressure waterjet, which leaves a small entrance

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wound can cause massive internal damage as the volume and momentum of fluid injected expands within the body cavity.

DESIGN MANDATE

As we began to design the new cleaning facilities, our goals were to engineer the equipment and process to:

1. Provide the best possible cleaning results in
2. the least amount of time while
3. using as little water as possible and
4. providing a risk-free work environment.

Our focus on safety has been paramount in the design. We understood that the hydroblasting and rinsing activities which are critical in the cleaning process represent the major risk in operations. We are determined to reduce the associated risk to as close to zero as possible and do so by considering the specific associated risks and engineering our systems and processes to eliminate them.

THE MAJOR SOURCES OF RISK

The major risks associated with hydroblasting are:

1. Human Behaviour and Error
    a. Accidental direction of the waterjet towards oneself or another worker
    b. Accidental movement by a worker into the path of a waterjet
    c. Flying debris from a waterjetting activity
    d. Improper use of equipment leading to an equipment failure and dangerous waterjet release
2. Equipment failure
    a. Hose failure
    b. Fitting failure
    c. Loss of control of the jet
    d. Overpressure leading to failure
    e. Catastrophic failure
3. Environment
    a. Noise
    b. Heat/Humidity as a contributor to accidents
    c. Air Quality

ELIMINATING THE HUMAN ELEMENT

Automation is the most obvious method to eliminate the risk to a human operator. We have taken a similar approach in the design of our facility, but our solution to the risks associated with Human Behaviour and Error has been to completely remove humans from the equipment and work areas.

In our facility, all hydroblasting activity occurs within a secure section of the building. Operators of the equipment are in a different part of the building, behind reinforced glass with oversight, and using remotely controlled hydroblasting equipment, operated with the assistance of high definition video cameras. Electronic process controls are implemented through an Operational Management System (OMS – includes data management, part management, workflow auditing, process controls, SCADA) which prevent the hydroblasting equipment from being energized unless the area is cleared of all personnel and is locked-down.

In addition to the access and operational controls, the OMS audits 100% of all hydroblasting operations and all operational parameters, including the operator, time, water volume, pressure, activity and video surveillance.

Access to the high-pressure pumps is similarly controlled, with three pumps located each in its own enclosed space and electronically controlled to ensure that no personnel are in the space during operation.

ELIMINATING THE RISK ASSOCIATED WITH EQUIPMENT FAILURE

There is no process or technology which can completely eliminate the risk of equipment failure, so the best approach is to expect such failures and design to deal with them safely. We have taken the approach that even though we have designed the facility and process to remove humans from the hydroblasting areas, the system is further designed to ignore that fact, and to assume that there are workers in the area who would be at risk in the event of a failure, and is thus subsequently designed to eliminate that risk.

Hoses present a risk to injury through failure, which can produce unexpected waterjets through tiny cracks or pinhole leaks, or at worst an uncontrolled jet at the end of a broken hose. Hoses also present a trip hazard, and the presence of hoses on the floor means that the hoses are exposed to detrimental conditions (wear, UV light, mechanical damage, etc.) on a constant basis. We have addressed this reality by ensuring that all high-pressure hoses are 100% underground in concrete lined conduits and/or secure metal conduits at all times.

The risk presented by the failure of fittings is mitigated by ensuring that all fittings are enclosed and secured in such a way as to prevent injury in the case of a failure. The pump monitoring facility of the OMS applies here as well to instantly detect a fitting failure and shut down the pumps.

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Figure 2 shows an operator's view of the remote hydroblasting of the shell side of a heat exchanger bundle. In addition to being able to see the operation from a vantage point above the equipment, operators have several remote camera views which allow very detailed viewpoints.

Figure 2. Automated and remotely operated shell-side rinsing of a heat exchanger as viewed from the control room

All sources of a waterjet in the facility are robotic and therefore secured. Lances are similarly robotic and flexible lances are enclosed at all times in rigid sheath tubing or shields (when wound).

All pumps are electronically controlled, and the OMS system ensures that no pump can ever be operated under conditions that are not suitable for the downstream equipment. The OMS also enforces routine maintenance and inspection of the pumps, and tracks and monitors all pump performance data for diagnostic and predictive maintenance.

Finally, the risk of catastrophic failures is mitigated by ensuring that all equipment is regularly maintained and inspected (as enforced by the OMS) and that equipment is segregated into separate working areas – each hydroblasting system is in its own bay, each pump is in its own enclosed space.

ENVIRONMENTAL RISKS

The working environment plays a significant role in the health and safety of workers. The environment should be designed to eliminate direct hazards as well as reducing stress to prevent accidents. We consider the main direct environmental hazards to be noise (The processes can exceed 120dB) and a combination of heat/humidity. By removing workers from the areas in which hydroblasting is occurring and having them work remotely in a quiet, air-conditioned space, we largely eliminate the effects of noise and humidity. Furthermore, workers who are in the process area for unloading and inspection are required to wear protective gear including hearing protection with wireless two-way communication.

In the enclosed space of the cleaning operation, air quality may be of a concern and to address this issue, high volume air handlers are employed to ensure constant fresh air circulation and a clean air environment at all times. The process and waste treatment areas are constantly monitored by the OMS for air quality and noxious gases, and alarms are incorporated to ensure that no workers are exposed to any hazardous conditions which may arise. An ozone system is employed and operates automatically to clean the air in the waste storage room.

THE WORK ENVIRONMENT

The work environment plays a critical role in safety. Stress, worker fatigue, job satisfaction and happiness all are an important factor in reducing accidents and risky behaviour. Our goal is to provide a safe, enjoyable and rewarding work environment for all staff that helps build a sense of company pride and teamwork which will help foster a culture of safe work practices and concern for co-worker health and safety. The environment includes recreational, eating and indoor/outdoor entertainment facilities to help with team-building, client management and workplace happiness. In addition, we have taken steps to ensure that we are providing the best compensation, benefits and investment packages to employees.

A further unique aspect of the business model is that the initial employees of the facility were hired long before completion of the facility and participated both in the design and the actual construction of the facility.

A quiet bay for the inspection of cleaned parts by third-party contractors and clients is provided to ensure that the work quality is not affected by the noise and commotion of the cleaning activities,

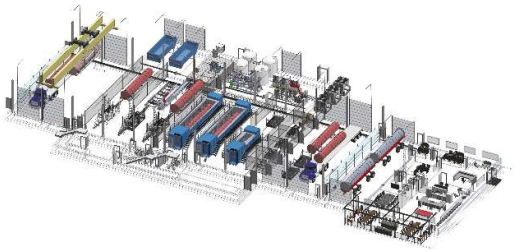

Figure 3. Overview of the facility showing the general equipment layout.

FACILITY LAYOUT

Figure 3 shows the overall facility layout and Figure 4 shows the control room. The facility is designed to support the cleaning process, with fouled equipment entering the facility in a receiving bay at one end, and cleaned equipment exiting at the other for delivery back to the client.

An overhead lifting system connects all of the various stages of the cleaning process. Each step of the process and all equipment used are controlled remotely from the control room which overlooks the entire process and audited by the OMS with

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user access controls and video surveillance of all operations.

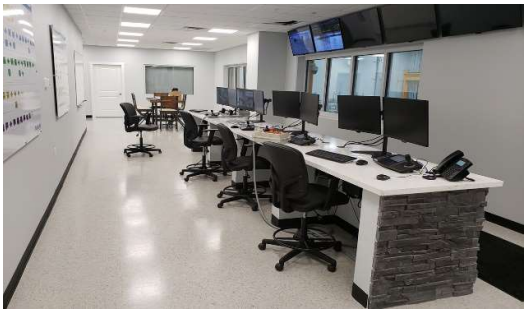

Figure 4. The control room from which all cleaning operations are monitored and all hydroblasting is conducted remotely.

CONCLUSION

We look forward to evaluating the years of effort which have gone into the optimization and design of Tech Sonic Cleaning and the new facility. The first Clean As New Gulf Coast off-site cleaning facility opened in May 2019 in Baytown Texas, and subsequent facilities are planned for North America and Europe. We believe that this facility will offer the most effective, fastest, most environmentally friendly and safest cleaning services available today.

At the time of writing, the new facility is still undergoing commissioning and is cleaning the first parts from clients.

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