Reducing Stranded Maintenance Costs For Cross-under Piping Repairs Through Effective Utilization of the WSI CUPUS System Approach

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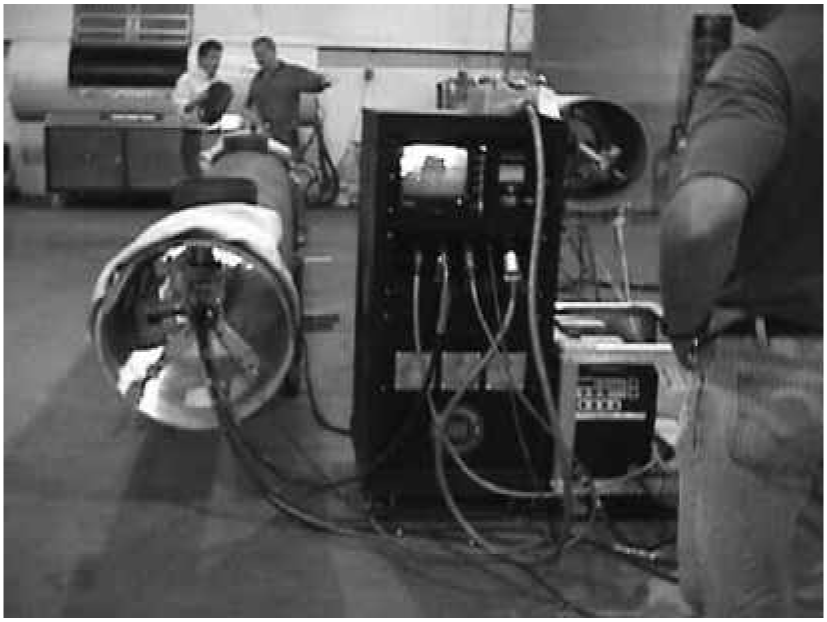
Abstract

A majority of the Nuclear Power Facilities owners are faced with the issue of monitoring and repairing damaged carbon steel crossunder piping of the wet steam piping off of the turbine. Owners have adopted aggressive erosion/corrosion programs, which require the owner to perform 100% inspection of the system.(5) The goal is to access the integrity of the piping. Upon completion of a visual and UT inspection of questionable damage, evaluation and repairs take place. Once a minimum wall thickness violation is identified, repair work begins in attempt to maintain minimum wall thickness. Often these areas of min wall violation are random through out the piping system. This random damage is sometimes known as Tiger Striping. In most cases Tiger stripping becomes a problem that continuously degrades the integrity of the material surface of the piping and becomes difficult to manage through localized patch repairs.(1)

The utility is now at the mercy of what is in need of repair. The repair work is usually UN-planned, costly, timely and could become the driving reason for outage extension. Traditional repairs for this type of damage have been SMAW build up with carbon steel. This has provided minimal protection against Flow Accelerated corrosion and owners have found themselves repairing the exact same locations the following outage. Another alternative was to build up the base material using SMAW stainless steels to prevent future repairs. This has actually resulted in development of Stainless steel islands within the piping system. These islands were actually produced by the Flow accelerated corrosion transferring itself to the susceptible carbon steel and accelerating its useful life expectancy.(2) Hence, creating a continuous circle of inspection and repair, which becomes unmanageable for the owner.

Plant owners find themselves expending limited finances and resources just to maintain piping integrity. Costs associated with monitoring and repairing crossunder piping have started small but eventually climb into spending 300k – 600k per outage. These costs do not provide a permanent solution because of wear rates of carbon steel. These cost are continuously rising along with scheduling impacts due to the shorter outages. As an alternative to continual inspection and repairs or replacing the carbon steel piping with stainless steels, WSI offers the application of a corrosive resistant overlay applied to the inside diameter of the pipe. This overlay is applied using WSI new GMAW CUPUS system. As part of the WSI turnkey repair program WSI applies a permanent 304L-finished product which protects the piping system for the life of the plant. The application of this material is 360 degree in the pipe and can be isolated to areas of high erosion or can be applied to the total piping system. This can be applied as a single outage application or scheduled over several outages.

The advantages of the CUPUS system over traditional repair approaches are immense. Typical repair approaches were accomplished manually with SMAW or GTAW. These processes were short-term repairs and in some cases developed increased erosion islands that worsened the situation. The repairs are also very time consuming and safety of working in a confined space enhances the difficulty of managing the problem. Since the development of the CUPUS and introduction of the new MINI CUPUS system, utilities are able to repair broad areas in a fraction of the time previously required. The new CUPUS system allows speed and repeatability of a minimum cladding thickness that minimizes distortion. Other benefits include its ability to be operated remotely using video welding systems eliminating the need to keep personnel in the piping system.



MINI-CUPUS Remote Operation

Overall, the new GMAW pulse spray system allows a cost effective, high quality finished product that can be adopted under shorter outage constraints. Many utilities have begun to adopt the WSI Cupus system to eliminate the crossunder piping stranded repair costs.

Implementation

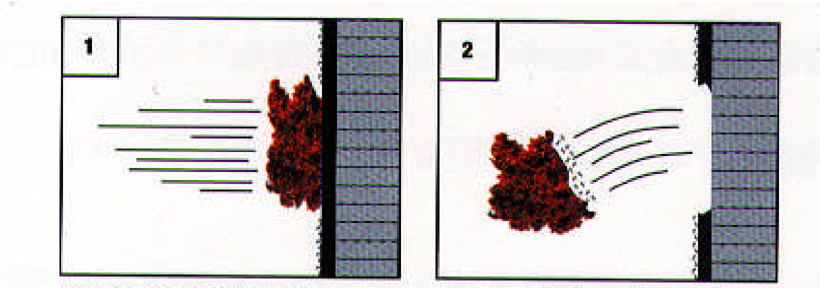
The initial step for the Cross-under Piping maintenance program is surface preparation of the material to be overlaid. Typically the approach of many utilities is to perform weld overlay of areas which are approaching minimal wall conditions. In this scenario the approach is to clean the surface to a near white metal finish by abrasive removal of material. This is most often accomplished by manually grinding the isolated areas. The surface is then coated with an anti oxidant material to preserve the finish until the overlay can be applied.

In the case where large areas or sections are to be repaired, manually grinding is very time consuming and not production oriented. To accommodate the schedule concerns abrasive blasting has proven to be the preferred method to prepare large areas for repair. This method has been successfully utilized at several locations for surface preparation. There are several drawbacks to this approach.

- Blasting helmets and equipment is bulky and uncomfortable for the operators while working in the enclosed piping systems.
- Debris in the piping is difficult to clean up and Foreign Material Exclusion is a concern due to the small size of the debris.
- Airflow through the pipe will allow dust to exit the system and become airborne on the turbine floor.
- Handling of blasting media produces airborne and uncontrolled debris in the turbine building.
- Waste material created by the blasting process has to be disposed.

One of the major concerns for the utilities is the introduction of dust and debris into the turbine building in areas that must maintain a high level of cleanliness. Often these areas have open systems including the turbines and generators that should not be exposed to these conditions. In an effort to provide a better working environment and to minimize the atmospheric conditions created by the blasting media several alternatives were investigated.

The products offered by Sponge-Jet, Inc. were chosen as a preferred solution. Sponge Jet's Blasting System offers clean, dry, low dust, reusable surface preparation. The media used for blasting is an open-celled, polyurethane particles impregnated with abrasives know as Sponge Media™. The pliant nature of Sponge Media allows its particles to flatten on impact, exposing the abrasive on the surface to be blasted. After leaving the surface, Sponge Media constricts, pulling and entrapping most of what would normally have become airborne contaminants.



Sponge Jet Material Removal System

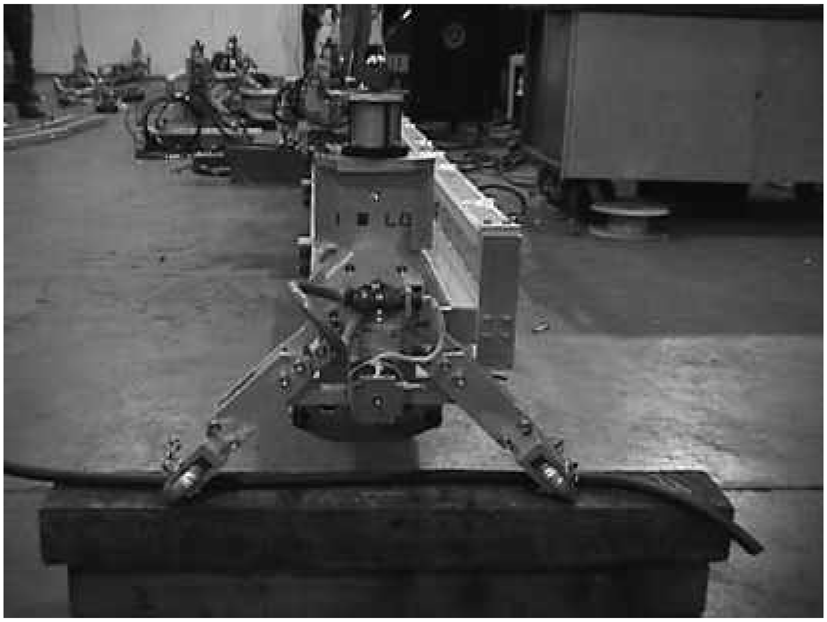
Utilization of this technology has proven very successful. Minimizing the dust was the primary objective and the client observed not only was the dust minimized in the open system but also the dust generated in the open turbine building was also greatly reduced.

An added advantage was the improved work environment for the operator utilizing the Sponge Blasting System in the enclosed pipe. He was able to replace the bulky and heavy blasting hood with an air supplied paper hood for improved comfort allowing overall increased productivity and performance.

By using the Sponge Blasting System, clean up time was also greatly reduced. The Sponge Media can be quickly vacuumed and reused 6 to 10 times thereby significantly lowering the amount of waste that was generated during this process. In addition, the Sponge Media can be incinerated if so desired.

Following the abrasive cleaning of the piping surface the surfaces are preserved utilizing a deoxalumanite coating. The surface is now prepared for the application of the weld overlay. Typically manual applications of the weld overlay is to manually apply a MIG overlay of 309L resulting in an end product of 304L(3) The production rates for this type of process is ½ to ¾ square foot per hour of production. Due to the limitations of the work areas utilization of large numbers of personnel is not only unpractical but also cost prohibitive. To provide a feasible approach the Cross Under Piping Unifuse® System (CUPUS) was developed. The system utilizes a Pulsed Spray GMAW process. Recently this system has been redefined with the introduction of the MINI-CUPUS system allowing applications in even smaller diameter piping.

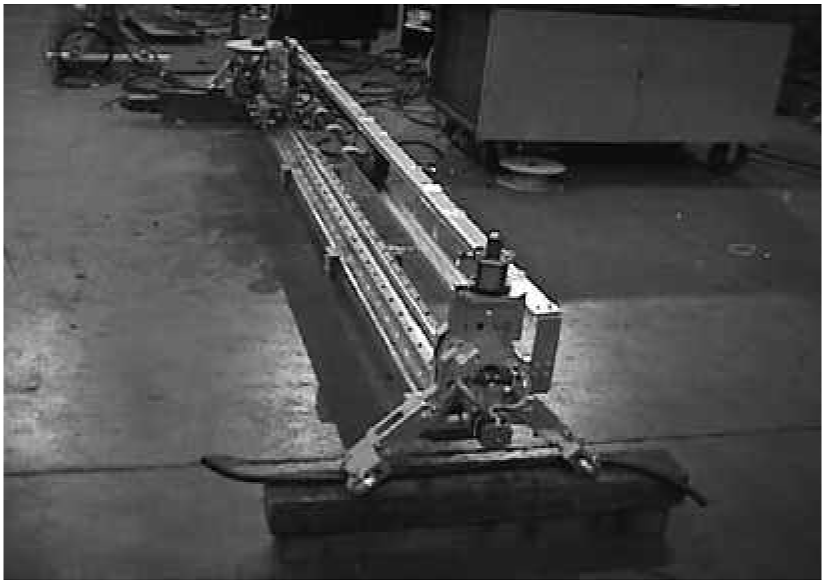
The welding procedures and welder qualifications used for this process are not treated as corrosion resistant overlay qualifications. If the weld processes are used as a groove weld qualification, credit can be taken for the structural wall build up in lieu of a carbon steel structural build up and then an application of a corrosion resistant overlay.



MINI CUPUS
Adjustable legs and locking System

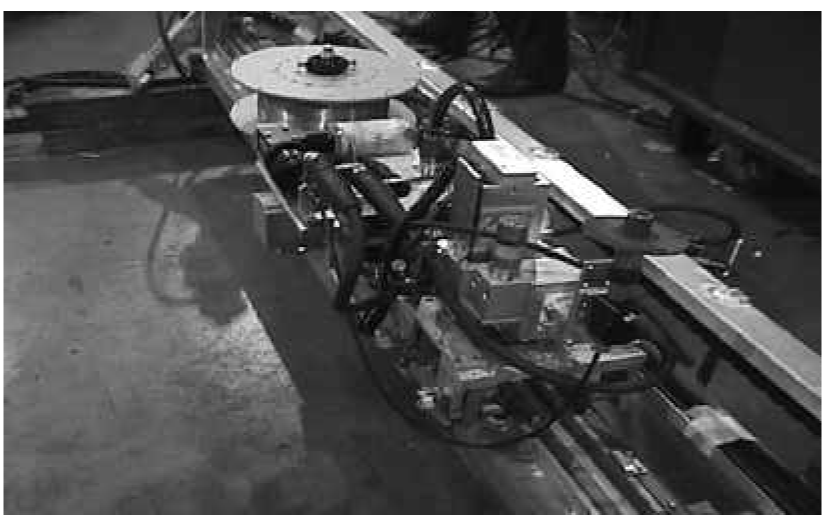
The MINI-CUPUS system takes full advantage of field application lessons learned. The system has been re-engineered to provide substantial weight savings and improved system functionality. Pulse sprayed gas metal arc welding process is employed to maximize the coverage area and production rate. Equipment system operators manage the overlay process and all critical welding parameters from a remote video console, now upgraded with advanced microprocessor based technology. Personnel exposure to radiological, chemical or other hazards is limited to the short duration consumables maintenance and install or removal of the system, which is now 60% faster than earlier systems. The system is designed to be installed and assembled in a 12" x 16" man-way. Maintenance of consumables can be performed without removal of the system.

In addition to the MINI-CUPUS additional tooling also consist of the mig F head, standard CUPUS and manual applications. Through these various tooling options a project plan can be developed to maximize production through the application of the proper tooling to the proper work location. For example the mig F head is a system capable of high production capacity but only is short axial applications. The advantage is the much-improved set up time versus trying to apply the MINI-CUPUS, which is designed for the longer continuous runs. To take full advantage of the tooling options a project schedule would be developed to coordinate the overlay with the plant schedule for open access to the piping.



MINI-CUPUS ASSEMBLY

Through these various techniques productions rates as high as 2.2 square foot per hour can be achieved is certain configurations. This is comparable to the ½ to ¾ square foot per hour that may be achievable with manual applications. The discrete advantage of the automated tooling will also be seen in the available arc time. The tooling has been developed to maximize continuous arc time and eliminate down time for repositioning of equipment and consumable maintenance. The MINI CUPUS has been developed to weld a continuous run of 6 feet and 360 degrees of overlay before relocation is required. This is comparable to a manual application where the welder is working in ½ square foot areas before relocation is required. In addition the automated equipment once installed in the pipe will remain in the pipe until reconfiguration of the system or completion of the section.



MINI-CUPUS Consumable Mounting

Shrinkage and weld distortion management is another dynamic, which must be maintained through out the implementation of the project. WSI has conducted endless hours of mock-up testing to determine the optimal technique of application, which would minimize distortion. The following shrinkage measurement data was compiled in a laboratory environment to project shrinkage impact on an entire crossunder system.

Shrinkage results

Average deposit thickness of 100 mils is required to maintain minimal distortion effects upon an entire crossunder system. Maximum thickness should not exceed 125 mils over an entire crossunder system. Keeping the weld deposit with in these parameters allows most crossunder systems to be clad entirely without effecting original design criteria.

To validate the shrinkage a mock-up test was performed in conjunction with a finite element analysis. To perform the mock up test a 24-inch diameter pipe with .590 inch wall thickness was utilized. The GMAW weld was performed with the MINI-CUPUS system applying a striped overlay 6 inches wide. This overlay was repeated ever six inches over a length of 52 inches in length. Following the completion of the initial striping the unclad areas were clad completing the 52 inch full-length overlay. The following results were achieved:

Angular Location	Initial Measurements	Cooled to room temperature	Shrinkage
0 degrees (12 o’clock)	2.335	2.426	0.091
90 degrees (3 o’clock)	2.328	2.393	0.685
180 degrees (6 o’clock)	2.325	2.396	0.071
270 degrees (9 o’clock)	2.319	2.373	0.054
Average Shrinkage			0.070

The average results were compared to the results of the finite element analysis. The pipe was modeled using “Algor” analysis software and the predictive analysis was computed. The resulting predicted shrinkage from the finite element analysis was 0.072 inches, agreeing with the actual shrinkage taken from the mock up measurements.

Finished product

Upon completion of welding, final visual inspection is completed and a sample three- (3) square inch section is PT. The 304L chemistry on the finished product shall provide adequate protection of the crossunder piping for over 80 years of life. This life expectancy is based upon wear rates of stainless steel of under .001 mils per year. This assumes the end product is exposed to normal operating conditions of the wet steam system.

Project Profile:

New York Power Authority
Indian Point 3

Scope:

- 3300sqft of crossunder piping required cladding.
- 26.5” I.D., 32” I.D. 37” I.D, 42” I.D and 10” I.D piping
- Carbon steel piping equivalent to A106Grd B material. ½” and ¾” wall thickness.

Schedule:

- 32 day outage
- Working 2, 10 hour shifts, 6 days a week.

Result:

- Project completed on time. 22 days of actual welding
- 10 days of actual mobilization, inspection, set up, blasting and demobilization
- Entire crossunder system clad as per the schedule depositing over 12000# of weld wire.
- Elimination of all future stranded crossunder repairs.

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