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BROWNFIELDS SYSTEM REPLACEMENT

INTRODUCTION

As part of a responsible maintenance philosophy, a client with six 665 MWe coal fired boilers, conducted extensive metallurgical surveys on its dated DIN X20CrMoV12-1 mainsteam piping.

The mainsteam system had only run approximately for half of its designed life at this point. Premature degradation of the material was indentified, as shown by wide spread premature creep exhaustion throughout the entire system. Several of the components were Class 1, which prompted the client into action.

Total replacement of the entire piping system was required as soon as possible, as the condition of the running unit was a high risk.

The client then contracted Babcock and two other contractors to individually complete a detailed design for a new mainsteam piping system. The deliverables included a detailed design, detailed construction planning, and final costing for a turnkey project.

DESCRIPTION OF THE PLANT

The mainsteam piping run in a 4-2-4 configuration, where four boiler lines feed two vertical common lines and then spilt into four lines feeding the turbine.

On the left hand side of the boiler, two 275mm controlled bore (CB) lines run horizontally from the left hand final superheater outlet header to the front off the boiler. On each line, pressure and temperature transmitters are installed along with an inline flow element to measure the steam conditions on the outlet of the boiler. Each line tees off HP bypass system towards the hot reheat line, just after the flow element and before the main steam stop valve. These two lines then drop vertically and combine into a spherical header that feeds a common line. From the first spherical header one 350mm CB line runs vertically down the boiler (firing floor). The line then turns and runs horizontally through the turbine auxiliary bay from the boiler area to the turbine area before it enters a second spherical header. The second spherical header splits up into two 275mm CB lines and runs to the left and right hand side of the HP turbine centreline and into the valve chest. The rigid turbine loops connect the valve chest to the turbine casing.

On the right hand side of the boiler, the piping follows similar routing. Figure 1 shows mainsteam routing for both sides, along with the HP bypass and hot reheat pipework routing.

The mainsteam piping was supported by PSS Grinell hangers, rated for the heavy wall thickness of the existing plant.

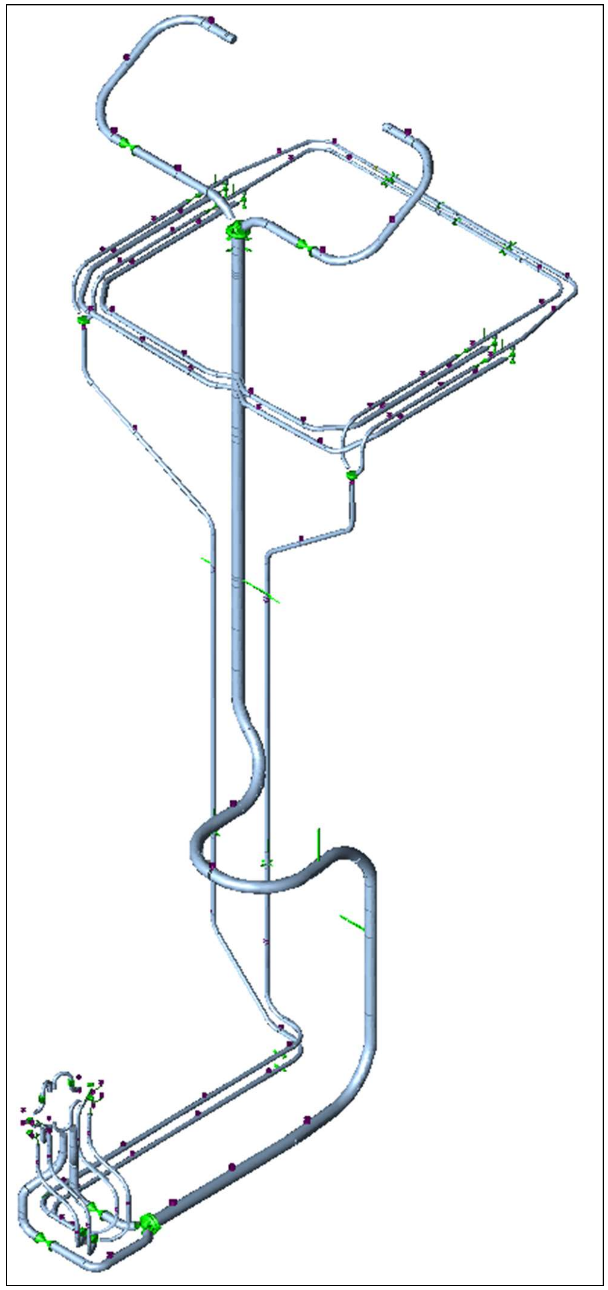

FIGURE 1: MODEL OF THE MAINSTEAM, HP BYPAS, AND HOT REHEAT PIPING LAYOUT.

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THE CHALLENGE

The challenge was to replace the pipework with the best possible configuration. Therefore the design had to be viewed in different perspectives and they were:

- Best material for the service.
- Loads on existing structures and pipe hangers.
- Existing piping and structures around the header that could obstruct the thermal movement of the header.
- Constructability

BEST MATERIAL FOR SERVICE

The replacement material was expected to have superior creep resistance and would need to be available for short and long term strategic purchases.

LOADS ON STRUCTURES AND PIPE HANNGERS

Loads on structures and pipe hangers computed from the CAESAR II stress analysis model for the new pipework with nominal thicknesses would be an appropriate guide. Any new supporting positions would require additional steelwork constructed to support the pipe hangers. A few combined load cases will have to be run to determine the acceptable loads.

A process review was completed in order to more accurately establish the reaction forces during upset conditions.

EXISTING PLANT IN THE VICINITY.

Operating companies modify existing plant for operational improvements, yet often overlook the room for the thermal movement of existing pipework. From experience, this step is considered a must and can add immense value to the plant design, at a minor additional redesign and/or demolition effort. It is recommended that every brownfield modification project undertakes this step as minimum.

DESIGN CONSIDERATIONS:

With the material selected for the replacement having a higher yield strength and better creep resistance, the replacement piping would be considerably lighter than the original pipework. This critical clue would then lead to the entire supporting system being replaced.

The additional task of adding cold pull into the piping system during construction, was considered in order to minimise the required wall thickness of the new piping. This would further reduce the weight, but more importantly reduce the risk of overstressing the material or the terminal points.

CONSTRUCTION PLANNING:

Due to the client's restrictive outage duration, Babcock was prompted to solve the problem through using technology in groundbreaking ways. Streamlining both the design process and construction methods through in-depth analysis and planning.

In Figure 2, the numerous 3-D scans captured of the site, was assembled and a virtual model of the as-built condition was created. Within this virtual model, the final routing of the piping could be completed during the desktop design phase.

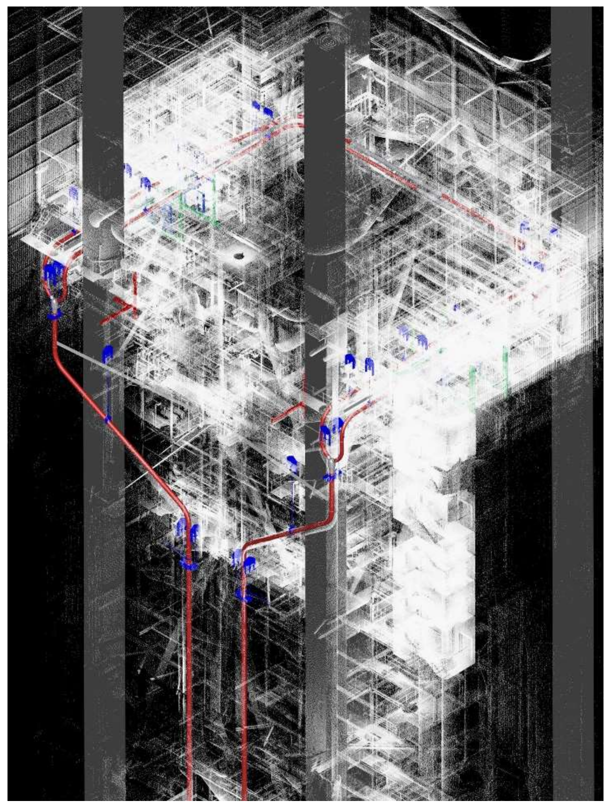

FIGURE 2: REGISTERED MODEL USED FOR ROUTING AND SUPPORTING

From the shear magnitude of piping that was to be the replaced and overall plant size in which the work would be conducted, the scope could be broken into five separate areas that could run in parallel. In addition in Figure 3, alternative access openings were identified through which material could be supplied to these individual areas, and minimise the influence on production activities in others.

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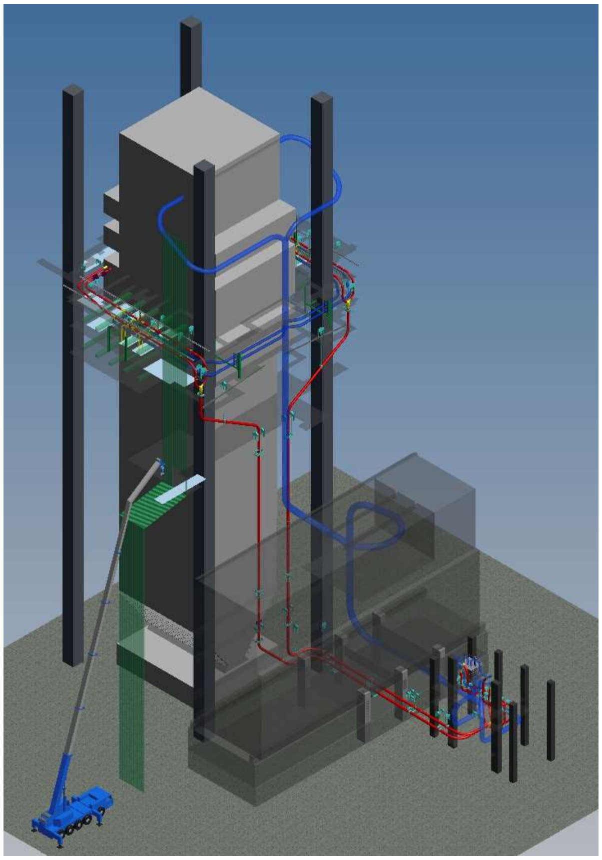

FIGURE 3: ACCESS OPENING FOR RIGGING MATERIAL INTO BOILERHOUSE

MATERIAL SUPPLY:

In order to reduce the risk to our client, Babcock secured longlead items along with the piping and forging material. Throughout the procurement process, the ultimate quality of the itmes were managed.

CONCLUSIONS

By sourcing out all the aspects of the project, the client empowered Babcock to deliver an outstanding service. From developing a detailed design to supply of all the appropriate material for piping and finally implementation of the design on site, all these factors contributed to a successful outcome.
