

Abbey Mills Pumping Station

motor & switchgear replacement

by Umang Patel BEng CEng MIET & Siu-Sing Ip MEng MIET

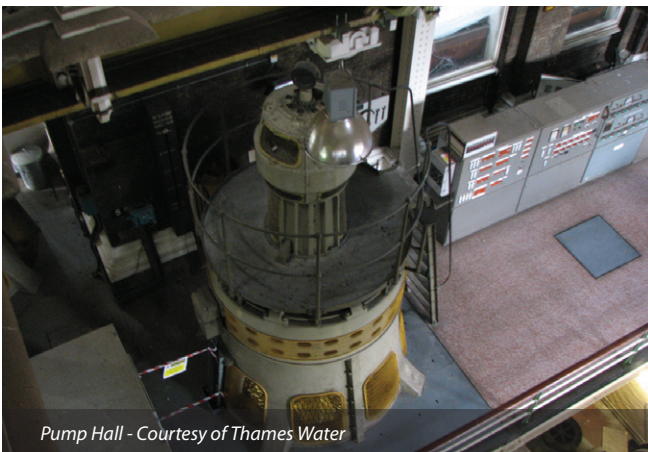
Abbey Mills A Pumping Station is a grade II listed building located in Stratford that was designed by Joseph Bazalgette in 1865-1868 as part of a scheme to divert the majority of London's sewage flows into the River Thames downstream of the city. Bazalgette's design eliminated the cholera pandemic and is one of London's iconic pumping stations that still preserves its Victorian heritage. Abbey Mills A Pumping Station was formerly the major pumping station within the Abbey Mills complex until the commissioning of Abbey Mills F Pumping Station in 1998. From this date, Abbey Mills A Pumping Station ceased continuous dry weather and storm flow operation, and was re-designated as a standby storm pumping station.



Abbey Mills Pumping Station - Courtesy of Thames Water



Pump Hall Gallery - Courtesy of Thames Water



Pump Hall - Courtesy of Thames Water



Pump Hall - Courtesy of Thames Water

Background

Abbey Mills A Pumping Station receives excess storm flow from the Low Level Sewer No.1 and No. 2 (main lines) when Abbey Mills F Pumping Station is unable to handle storm flow conditions. Abbey Mills A Pumping Station can lift flows to the Northern Outfall Sewer flowing to Beckton STW but it is normally configured to pump storm flows into the Channelsea River.

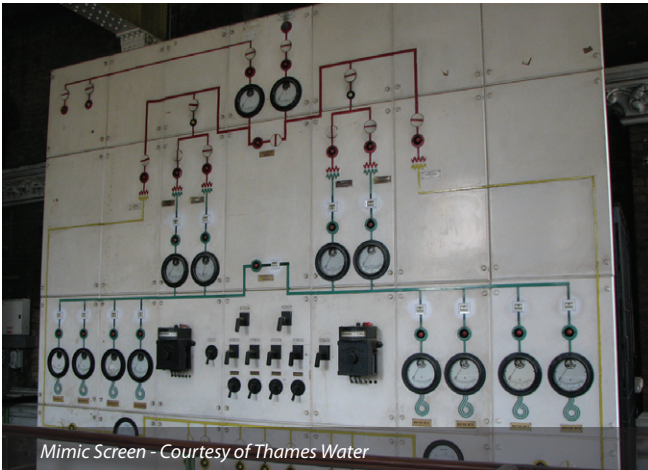
This refurbishment project forms part of a scheme to divert the CSO, which is known to have the largest discharge in London, to the Beckton STW via Shaft F and the new Lee Tunnel. It has been identified that the Station requires a significant upgrade to allow the pumps to operate against the range of heads that will be encountered under future Lee and Thames Tideway Tunnel operations. In addition, the existing pump motors and switchgear are life expired, generally becoming unreliable and are in need of replacement.

MVB (Morgan Sindall, Vinci Construction Grand Projects and Bachy Soletanche) were appointed by Thames Water to carry out detailed design and construction of the upgrade and refurbishment of the existing Abbey Mills Pumping Station A.

Scope

The main scope of the detailed design services included:

- Design of 8 (No.) 11kV Variable Frequency Drives (VFD) to give flexibility in operation of the pumping station, manage variable flow and ensure that the pumps do not operate in potentially unstable conditions.
- Replacement of the existing 2.2kV, 600HP, 28-pole motors with new 3.3kV, 450kW, 4-pole motors and epicyclic reduction gearboxes.
- Design of a new 11kV Switchboard to supply the 11kV VFDs.



Mimic Screen - Courtesy of Thames Water

- Replacement of the existing auxiliary transformers with new 2 (No.) 11kV/0.433kV transformers to supply low voltage services.
- Refurbishment of the existing 8 (No.) storm pump discharge valves.

Key aspects

Configuration and Layout: Careful consideration had to be given to the new layout so as to minimise disruption to the grade II listed elements of the building.

The Lee Tunnel delivery team developed the detailed design to provide the best long-term value to the client. For example, by removing the single point of failure presented by having the 2 (No.) HV switchboards in the same room, as envisaged by the reference design, provided greater resilience against fire. The alternative proposal, having the HV switchboards in separate rooms with their respective VFDs, will ensure that, in the event of a contained fire in one room, 4 (No.) of the VFDs will remain available. The reduction in the number of rooms required for the equipment also provided an immediate cost saving.

New Floor: A new mezzanine floor was created to provide additional floor space and to support the estimated 58 tonne weight of all the newly designed electrical equipment to be located within the West Boiler House.

Minimising disruption within the existing building was a key driver to ensure compliance with the building consent of the listed building. The team developed a value engineered design which considered use of the existing structure with temporary supports. This was to cater for the one off load condition that the mezzanine would experience during equipment installation.

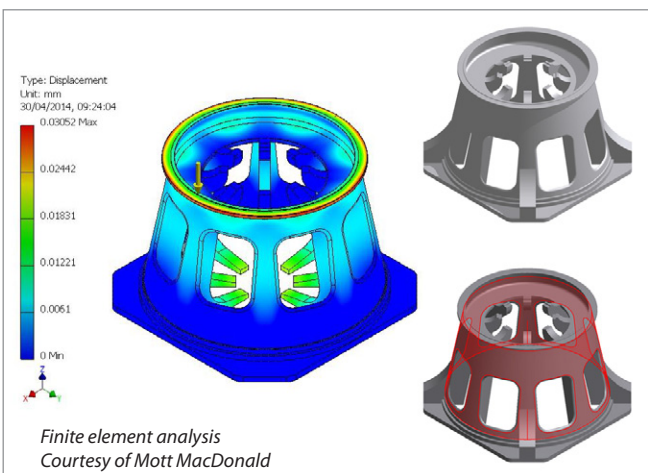
Reuse of the Existing Motor Casings: By using finite element analysis, it was demonstrated that it would be possible to reuse the existing motor casings with a load of up to 13 tonnes. This is sufficient to support the new 3.3 kV 450 kW 4-pole motors and means that the casings can be retained, thereby saving an important part of the building's grade II listed heritage.

Epicyclic gearbox: Early engagement of specialist suppliers allowed for the design of epicyclic gearboxes that reduce the motor speed from 1480rpm to the 214rpm required by the pumps. The gearbox solution was carefully designed to not only achieve gear ratio but also to maintain the listing of the casing.

Storm Pump Discharge Valves: In another case of early supplier engagement, the team arranged and witnessed the testing of the valves to verify that their internal condition would be suitable for a minimum of twenty years further use. This investigation saved unnecessary work on the replacement of the valves.



10" 6" pipeline - Courtesy of Thames Water

Finite element analysis
Courtesy of Mott MacDonald

Construction - West Boiler House - Courtesy of MVB

Challenges

Space: Since the East Boiler House was destroyed during World War II (it is now a car park), the West Boiler House is the only suitable location for the high voltage switchgear and variable speed drives to be installed. However, standard sized electrical panels would not fit on the existing mezzanine. The Lee Tunnel delivery team optimised the layout of a new mezzanine to accommodate the new equipment, carefully considering the client's specification and the needs for emergency exit routes and panel accessibility.

Cable Routes: By designing for the reuse of the existing cable troughs around the pump hall, disruption to the historic building fabric and the cost of construction was minimised.

High Voltage Transformer: It was originally proposed to locate the HV transformers outside the pumping station. However, the site was too close to a protected tree and the 1800mmØ outfall pipework. The Lee Tunnel delivery team explored an alternative option than the one proposed which led to housing the high voltage transformer inside, on the new mezzanine floor. This improved constructability and resulted in significant savings, both in financial terms and in the carbon footprint of the site.

Cables: Massive savings on cabling were introduced through the Lee Tunnel delivery team's relocation of the transformers into the West Boiler House. An estimated 3.3kV cable length of 200m has been saved and it has also been possible to reduce the cross sectional area due to the lower Volt drop.

Motor: The choice of a 4-pole motor was both cheaper and lighter than a direct replacement for the previous 28-pole version. By choosing the standard 3.3kV voltage, the Lee Tunnel delivery team also saved the client money by allowing manufacturers' standard products to be used.

Current status

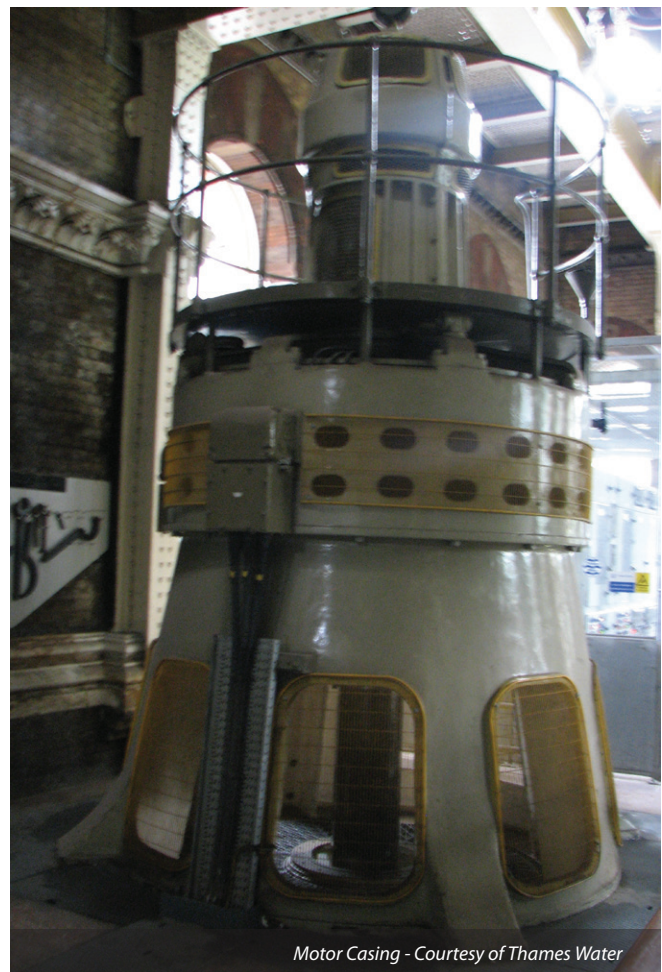
At the time of writing (May 2014) the mechanical and electrical detailed designs for Abbey Mills Station A are complete and MVB have commenced construction of the new mezzanine floor. The Lee Tunnel delivery team is currently reviewing tender documents for various procurement packages and it is estimated that the electrical & mechanical installation will be completed by 2015.

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Construction - West Boiler House - Courtesy of MVB



Motor Casing - Courtesy of Thames Water



Construction - West Boiler House - Courtesy of MVB