DRIVE FOR EXCELLENCE AT **CONNAH'S QUAY POWER STATION**

COOLING FAN EXCHANGE PROVES VITAL TO IMPROVE OVERALL PERFORMANCE

THE ENHANCEMENTS AT **CONNAH'S QUAY POWER STATION** ARE DESIGNED TO IMPROVE RELIABILITY, AVAILABILITY AND EFFICIENCY WHILE ALSO BRINGING ENHANCED ENVIRONMENTAL PROTECTION. THE CHANGES ARE BEING UNDERTAKEN UNDER THE STATION'S 'DRIVE 4 EXCELLENCE' PROGRAMME.

Connah's Quay is a 4 x 345 MW combined-cycle power plant situated on the River Dee estuary in Wales, United Kingdom. The location has been designated a Site of Special Scientific Interest (SSSI), a wetland of International Importance under the Ramsar Convention and a Special Protection Area under the EC Conservation of Birds Directive. The plant's gas turbines are fuelled with natural gas from either Liverpool Bay or the UK national grid and the station has a gas treatment plant that can process any surplus gas for export to the national gas grid.

Connah's Quay Power Station
River Dee Estuary
Wales, United Kingdom

The plant has been operational since 1996. It has hybrid cooling towers to reduce visible plume, and special routines for cooling water makeup withdrawal. Each generating unit is supported by two adjacent cooling towers comprised of five cells above a common pond, making 10 cells per unit.

Point of departure

The cooling tower air flow was severely restricted by noise attenuation, due to the environmental constraints imposed during the construction of the plant because of the close proximity of local residents. The noise attenuation equipment reduces the thermal efficiency of the tower, leading to the generation of low level plume and contributing to major failures in the fan drive trains. The detrimental effects on plant and performance due to the restriction of the airflow can be summarised as follows:

- The water/air ratio required to achieve optimum performance is not being achieved.
- At times the tower operates very close to the point where low level plume will be generated.
- The restriction to air flow in the fan outlet stack induces mechanical stress in the fan drive train, contributing to a high level of failures especially during start-up of the fan. The repairs often require the removal of the attenuation, the fan and the gearbox. This leads to major production losses. The engineers are therefore reluctant to shut down the fans, and this leads to unnecessary power consumption.

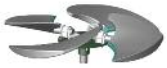
Improvement Plan

The goal is to reduce the common pond temperature by ≈ 2°C in order to increase the generator efficiency and to improve the reliability of the plant. To achieve this, the following actions will be taken:

- The water distribution will be improved.
- The fan outlet attenuation will be removed, increasing the air flow through the cooling tower pack and reducing the mechanical stresses during start-up.
- The existing Howden 30ELF9 standard low noise fans will be replaced by Howden ultra low noise SX-Series fans in order to operate within the constraints set by the Environment Agency without the attenuation equipment.
- The existing gearboxes will be refurbished to a new low noise specification to operate within the constraints set by the Environment Agency.
- 50% of the dry section attenuation will be removed, increasing the warm air flow to the mixing plenum and subsequently reducing plume generation.

The project covers half of the plant's total cooling capacity. Twenty of the forty cooling tower cells will be retrofitted. Following this, an evaluation will be carried out to determine future actions. The table right illustrates the improved airflow and noise reduction achieved through the use of Howden's ultra low noise SX fans, without any need for changing the transmission ratio or fan speed.

The total Sound Power Level has been improved without installed dampers.

FAN SELECTION DATA DURING WET MODE OPERATION		
Fan Selection Data during wet mode operation (the shutters of the dry section are closed)	 BEFORE: E-SERIES	 AFTER: SX-SERIES
FAN TYPES	FAN 30ELF9	FAN 30SX5
RPM	89.9	89.9
Volume Flow (m^3/s)	465	500
Static Pressure (Pa)	163	147
Sound Power Level Fan (dB(A))	101.3	93.7
Sound Reduction Dampers (dB(A))	-7	Dampers removed
Total Sound Power Level (dB(A))	**94.3**	**93.7**

Results

Although the new fans will produce less noise, the gearboxes, and the sound from the water splashing will be exposed to the environment after the attenuation equipment has been removed. The existing gearboxes will become the dominant noise source, and were therefore partially refurbished to bring the noise within the maximum acceptable day and night levels set by the Environment Agency. Further, the plant's noise models had to be revised due to the construction of a main road running alongside the plant.

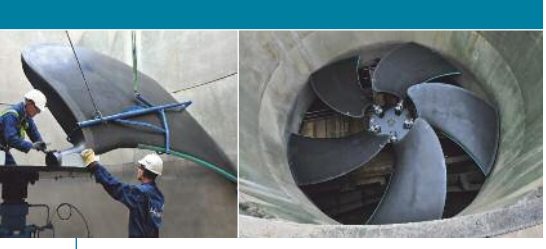
Evaluation of the improved cooling tower performance

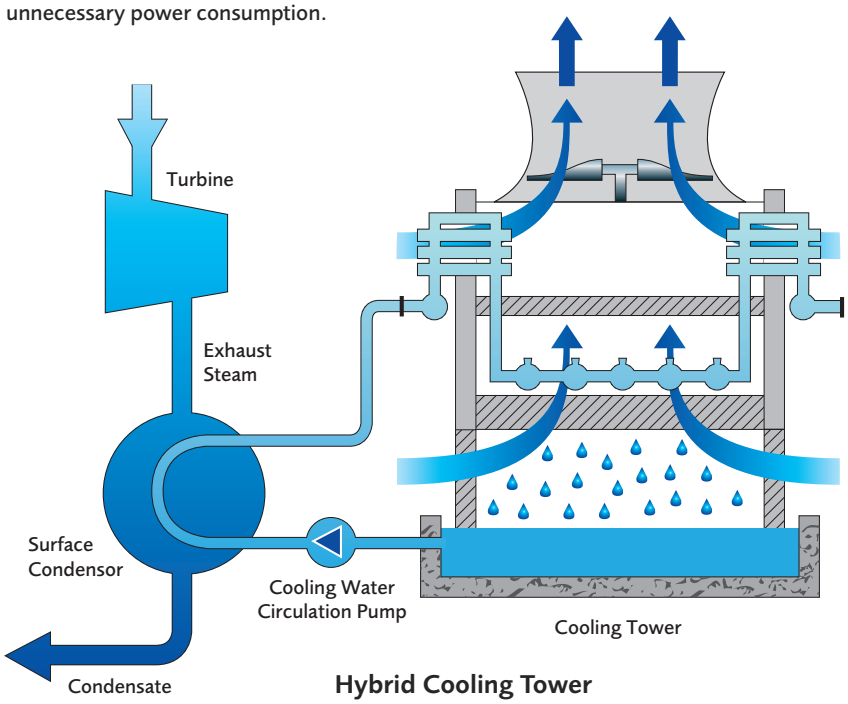
With the introduction of the new cooling fans, the temperature of the cooling water system has been improved by 1.4°C. This improved efficiency by 0.13%, which equates to a combined cycle output improvement of 0.8 MW. The efficiency figures may appear low, but in reality they are a significant improvement.

The projected results, when the improvement measures are complete, are as follows:

- **The steam-turbine will be more efficient, and consequently the gas-turbine consumes less gas.**
- **The reduction in gas consumption will reduce CO_2 production by 7,500 tonnes per year.**
- **The incidence of low level plumes will drop from ± 142 days to ± 23 days due to the improved water distribution alone. The fan exchange will further reduce this to ± 6 days.**
- **Maintenance costs will drop dramatically, and savings will be made by preventing unnecessary power consumption.**
- **Production losses because of repairs will be reduced to a minimum, and as a consequence the reliability of the plant will rise significantly.**

The entire cost of the modification will be recovered in seven years through efficiency gains alone, and there will be additional savings arising from other factors. The fans can now be shut down whenever required without the risk of stress failure when they are restarted, avoiding unnecessary power consumption, and by removing the cause of stress failure, the modification also eliminates the cost of major repairs and production losses.





Hybrid Cooling Tower

Connah's Quay will continue their 'DRIVE 4 EXCELLENCE' program, with the aim of setting a new benchmark in high efficiency, reliable and environmentally friendly power plants. The measures outlined here will make a huge contribution towards achieving that aim, and will contribute to the longevity of Connah's Quay as a base load electricity supplier.

"As demonstrated on other recent cooling water projects, the cooling towers are an area of plant with scope for significant efficiency gains for relatively low capital investment."

Graham Stevens,
Project Engineer, Connah's Quay.

Acknowledgements
This case study is a publication of Howden Netherlands. Special thanks are due to the Plant Manager, Mr. Pacey, and to the Project Engineers Mr. Stevens and Mr. Barrow of Connah's Quay Power Station for making this publication possible.

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