Technical Note

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LOW NOISE FANS FOR UK COOLING TOWERS

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Connah's Quay is a 4x345MW combined-cycle power plant situated on the River Dee estuary in 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. Figure 1 shows a schematic diagram of the hybrid cooling tower and the cooling cycle of the Connah's Quay power plant.

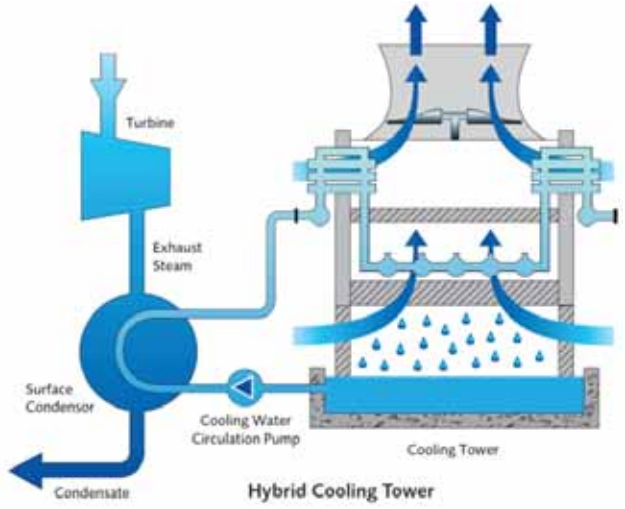

Figure 1.Schematic diagram of the hybrid cooling tower and cooling cycle.

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 adds static pressure loss to the system and 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 summarized 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 as a way of controlling the cooling tower during hours of reduced ambient temperatures. Instead, they maintain 100% fan speed at all time leading to unnecessary low water temperatures, power consumption and noise emission.

The major goal was to improve the power plant's efficiency and reduce the visible plume of the cooling tower, without increasing the existing noise emission. To achieve this goal, the following actions were recently taken:

- The fan outlet attenuation baffles were removed, increasing the air flow through the cooling tower pack and reducing the mechanical stresses during start-up.
- The existing fans were 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.
- With the Howden SX fans in place, the existing gearboxes became the dominant noise source at the fan outlet. To operate within the constraints set by the Environment Agency, they were refurbished to a new low noise specification.
- The lower sound power level of both the fan and the gearbox allow adaptation of the dry section attenuation, increasing the warm air flow to the mixing plenum. This increases the outlet air temperature while reducing the outlet air humidity and subsequently reducing the visible plume generation.

Since the fan noise is primarily related to operating speed, it was decided that the original fan drive and gear box ratio would be maintained. Although the air supply increased with the installation of the SX fans, the aerodynamic performance remained almost unchanged as the static pressure loss was reduced due to the removal of the noise attenuation baffles. Figures 2 and 3 respectively show the previously existing noise attenuation baffles at the fan outlet, and with the installation of the low noise SX fan instead of the attenuation baffles. Table 1 illustrates the improved airflow and noise reduction achieved through the use of Howden's ultra low noise SX fans. The total sound power was improved even with the removal of the noise attenuation baffles.

Figure 2. Noise attenuation baffles at fan outlet.

Figure 3. SX fan instead of the attenuation baffles.

Table 1. Fan data before and after installation of the SX fans.

		
Fan Type	**Original Fan**	**SX Fan**
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
Attenuation baffles (dB(A))	-7	Baffles removed
Total sound power level (dB(A))	94.3	93.7

With the introduction of the new cooling fans, the temperature of the cooling water system was improved by 1.4˚C. This improved efficiency by 0.13%, which equates to a combined cycle output improvement of 0.8MW. The efficiency figures may appear low, but in reality they represent a significant improvement. The projected results 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 CO2 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 are expected to drop dramatically. Savings will also be made by preventing unnecessary power consumption.
- Production losses because of repairs will be reduced to a minimum. As a consequence, the reliability of the plant will rise significantly.

In summary, the benefit of the installation of the super low noise fans is twofold. The SX impeller performs a similar duty with a significantly lower sound power output. Improved airflow and noise reduction was achieved without any need for changing the fan speed or gear box ratio. It is expected that the entire cost of the modification will be recovered in seven years through efficiency gains alone. In addition, 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. The modification also eliminates the cost of major repairs and production losses.

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