Natural Resources Wales
OMA Report – Discharges to Water
Connah's Quay Power Station
Responses to Report Dated 18th Feb 2019

Uniper's Connahs Quay Power Station (CQPS) is located on the south bank of the Dee Estuary in Connahs Quay, North Wales at Grid Reference SJ 2770 7120. The installation consists of a gas treatment plant and four Combined Cycle Gas Turbines (CCGT's) providing 1426 MW of electricity exported to the National Grid.

The power station gas supply is sourced from a site-specific gas terminal in Liverpool Bay (operated by ENI) and delivered straight to the site through a 27km pipeline via the Point of Ayr gas terminal.

Each gas turbine exhausts directly to a Heat Recovery Steam Generator (HRSG), which supplies a steam turbine comprising separate high, intermediate and low-pressure cylinders. The exhaust emissions from each HRSG are dispersed to the atmosphere via 85m high chimney stacks. Exhaust steam is condensed back into water and fed back to the HRSG for re-use. Water abstracted from the River Dee is used to cool the condenser. The cooling water is circulated through a cooling water system. Each of the four units is equipped with low level hybrid cooling tower. Each of the four cooling towers is divided into ten individual cells units and each cell is equipped with a cooling fan and external concrete fan housing. The towers are used to cool the water as heat is rejected to atmosphere via conduction, convection and evaporation.

The Environmental Permit (EPR) for the installation also covers the accompanying (on-site) Gas Treatment Plant (GTP) at Connahs Quay, which is used to remove any nitrogen or water impurities which may remain in the gas prior to combustion. The contracts governing fuel supply require Uniper to be able to continually accept a set volume of gas from the Point of Ayr terminal. Therefore, at times of reduced generation, the GTP is also used to process any excess gas so that it can be exported into the National Transmission System for supply to the national distribution network. The nitrogen rich 'off gas' from the treatment process is sent via the Thermal Oxidiser (emission point A11) to remove any hydrocarbon content and reduce pollution potential via combustion.

On the 26th November 2018, Stuart Ross and Rhys Ellis of Natural Resources Wales (NRW) audited Connahs Quay Power Station against the requirements of the Operator Monitoring Assessment criteria with regards to emissions to water arising from the installation. Following the audit, NRW issued a report requesting Uniper to provide additional information in response to three further action requests. This document therefore provides Uniper's formal response to these points:

Q1, Action - *Provide NRW with justification as to why the new oil in water analyser was not installed to monitor the final discharge. If Uniper proposes to continue using the oil in water analyser at its current position, then a risk assessment must be completed to assess the risk of oil entering the purge ponds and discharging from the site undetected. Uniper currently complete a visual inspection of presence of oil and grease on the purge ponds pre-discharge – the results of which shall be included in the all future quarterly monitoring returns..*

A1, Response :

The power station was constructed with a fully integrated drainage system (including specific colour coded systems) to segregate all process waters, chemically contaminated waters, oil contaminated waters, sewage and surface waters arising across the installation.

These drainage systems are colour coded:

- Oily Water Drains (Red)
- Chemical Drains (Green)
- Sewage (Orange)
- Surface Water (Blue)

This colour coding ensures easy and clear understanding to prevent the contamination of drains with incorrect substances and process the effective collection and separation of differing types of waste waters. Additionally, the systems ensure that (if required) these waters can be successfully contained and treated to prevent any potential environmental impact from their eventual discharge. Consequently, this power station is equipped with continuous monitoring equipment on all emission to water points (W1, W2 and W3). These relevant emissions point discharge from the following sources:

W1 – All process waters arising across the installation
(Waste Water Treatment Plant Effluent, Waste Boiler Waters, Waste Sewage, Waste Cooling Waters or Former Oil Contaminated Waters).

W2 – Surface water drainage from most site roads.

W3 – Surface water drainage from the Contractor's compound, heavy goods store roof and gas treatment plant entrance road.

The above NRW assigned action specifically deals with emission point W1 which collates all process waters across site into two large purge discharge ponds and two smaller SDX tanks 30 and 40 for discharge. These ponds are jointly emptied via a common discharge tank into a 1.5-mile-long pipeline at each high tide. During this discharge all W1 waters are continuously monitored at the final outfall for relevant determinants apart from Oil in Water which is measured further up the pipeline at source (and discussed in section 1.5.2). The waters emitted from W1 are finally discharged into the River Dee.

1.0 W1 Waste Water Constituents

As initially explained, several different site operations produce waste waters for eventual transfer into the purge discharge ponds and / or SDX Tanks 30 & 40. Between them, these various sources make up the full discharge from emission point W1.

1.1 Waste Water Treatment Plant Effluent

The power station uses a reverse osmosis water treatment plant to process Town Main water and treat it to 99.9% purity. This process involves the use of positive and negatively charge ion exchange resin beds, which require refreshment via treatment with Sodium Hypochlorite and Hydrochloric Acid respectively. Following a resin bed refreshment, these waste chemicals are reacted together, and the resulting neutralised effluent pumped to the Chemical Drains system (Green) for transfer across to the purge ponds via SDX tanks 30 & 40. Both SDX tanks are equipped with pH analysers to monitor the entering wastes. There is no oil containing machinery whatsoever within the water treatment plan and so the reacted effluent does not encounter any oil containing systems prior to transfer to the SDX Tanks 30 / 40 to await disposal via W1 to the waters of the River Dee.

There is no possibility for this waste to become contaminated with oil during its generation, and so this waste poses no likelihood for the contamination of purge pond waters with oil.

1.2 Purge Boiler Waters

Following processing to 99.9% purity, the treated waters (from the water treatment plant) are stored prior to use in the Heat Recovery Steam Generators (HRSG) / Auxiliary boilers to raise steam. Ammonia and Cetamine additives are used as boiler water treatments to inhibit corrosion during this process. Boiler waters are eventually purged over time and replaced with fresh supplies to prevent erosion or damage to the boilers and prolong the operational life of the equipment. These purged waters are then passed into the chemical drains system to eventually transfer to the SDX tanks 30 / 40. Once in these tanks, they undergo further pH analysis before eventual discharge with all other purge waters for disposal via the 1.5-mile pipeline to W1 and subsequently into the waters of the River Dee.

There is no possibility for this waste to become contaminated with oil during its generation, and so this waste poses no likelihood for the contamination of purge pond waters with oil.

1.3 Sewage

There is no mains sewer connection from the power station into the public sewer network. Therefore, all waste toilet and wash waters are transported (via the orange coloured sewage only drains) to one of three on-site sewage treatment plants. In each a plant, a klargester process is used to break the waste down into a grey water which is then pumped into the purge discharge ponds to await disposal via W1 to the waters of the River Dee.

There is no possibility for this waste to become contaminated with oil during its generation, and so this waste poses no likelihood for the contamination of purge pond waters with oil.

1.4 Cooling Tower Purge Waters

Cooling water is abstracted from the River Dee for use in the cooling system at CQPS. During generation, this water is used in a closed-circuit cooling system, and passed from turbine enclosure to cooling tower for temperature reduction before returning to the turbine water jacket to cool it once more.

Over time, fresh cooling waters are pumped from the settling pond into the closed-circuit cooling system (to minimise a build-up of conductivity) and subsequently waste cooling waters purged from the boilers from the cooling towers into the purge discharge ponds. This is the largest volume of water discharged into the purge discharge ponds and consists solely of estuary waters which have been mildly treated with sodium hypochlorite for biocidal control.

During the cooling process, the water does not come into close contact with any oil containing plant however there is equipment located high in the cooling towers above the cooling waters which (under extreme plant failure) could lead to possible contamination of cooling waters with oil (see section 1.4.1)

1.4.1 Potential for Cooling Water Contamination

Each of the four cooling water towers is equipped with ten separate cooling fans and each fan is located within an individual external concrete fan housing. Thus, every fan housing holds a direct drive gearbox which supplies operational movement to each fan (via a vertical prop shaft).

If a total gearbox failure should occur, then it may be possible for loss of oil containment to occur, potentially resulting in minor contamination of the cooling waters within the tower. Uniper believe this to be the only way by which Cooling Tower Purge Waters may suffer oil contamination. Therefore, this is the only means by which oil might potentially be discharged in water which is not analysed by the oil in water analyser (see section 1.5.1).

Appendix 1 details calculations regarding the dimensions of the cooling towers & purge ponds, the cooling water capacities and the possibility for oil in water contamination. These calculations can be used to assess the probability of oil contamination as follows:

Each cooling tower fan gearbox contains 40 litres of Mobil Glycoyle oil.

Should one gearbox totally fail and empty 100% of its contents into the cooling tower waters then a maximum level of 7.72 mg/l oil in water could be registered at the discharge pipe to emission point W1. Therefore, should two gearboxes suffer total failure, then a maximum of 15.44 mg/l could be detected at W1, and subsequently three gearbox failures could result in 23.16 mg/l which would exceed the 20 mg/l emission limit placed upon emission point W1.

However, the following factors are in place which Uniper believe ensure that such a situation cannot happen, and gearbox failure will not result in an exceedance of oil in water concentrations at emission point W1.

- In 23 years of site operation (1996 to the present day), a full cooling tower gearbox failure with loss of oil containment has never happened at Connahs Quay.
- The site maintains a fully comprehensive program of preventative maintenance out on the cooling tower gearboxes, including the following points
    - Oil level and integrity checks are made on the gearboxes every 2 weeks
    - All cooling tower fans and gearboxes undergo a daily inspection from the production shift team member operation on outside duties.
    - All 40 gearboxes operate with a conditional monitoring system, which (via the variable speed drive), will automatically instantly alert shift team operatives to any potential failure.
- In the event of a full gearbox failure (with loss of oil containment), then the oil must drain past 300mm length of drift eliminators followed by a further 2.1 metres of mud clogged cooling tower pack before possibly contaminating the water sump in the bottom of the cooling tower. The time taken for this to occur would be significant and much greater than the time required for a site shift operative to close emission point W1 (if it was discharging at the time of failure).
- In the event of three or more gearboxes failing (with full loss of oil containment) on any one generation unit., then the unit would automatically trip and shut down due to loss of vacuum, fully alerting all site staff of a potential issue.
- In the event of any gearbox failure (with full loss of oil containment), then the rate of water discharge from cooling tower into purge pond (maximum 250 tonnes per hour) places a restriction on the speed at which lost oil can reach / pollute the main purge discharge ponds. Therefore, any lost oil would be detected, long before the discharged oil would fully reach the purge discharge ponds and / or the closure of emission point W1 (if discharging at the time).
- Prior to allowing any emissions from W1, Operational staff take individual samples from each purge discharge pond, which undergo compulsory laboratory analysis including assessment for oil in water. Emission point W1 is only opened within the relevant time window after these samples have been proven to be oil free. Sampling includes a visual assessment of waters in both purge ponds where oil contamination would be sighted. Therefore, even in the extraordinary situation of gearbox failure which oil contaminating the purge discharge ponds,

any contamination would always be detected prior to releasing any waters to emission point W1.

Several significant pollution prevention measures exist at Connah's Quay Power Station to ensure that even in the worst-case scenario of multiple cooling tower gearbox failure, it is not possible for this oil to enter the final discharge for emission to W1. Considerable efforts have been taken to ensure every area of the cooling tower water system has been designed to ensure plant failure cannot result in the direct and immediate contamination of emissions to water from the site. Therefore, Uniper believe it would be impossible for loss of oil containment from a cooling tower gearbox to lead to an exceedance of the oil in water emission limit on emission point W1.

1.5 Oily Water Drains

All areas of permanent heavy / oil intensive plant and equipment across the power station are serviced with a purpose installed oil in water capture / drainage system, utilised to ensure comprehensive drainage of any potentially contaminated waters in a contained manner to prevent any potential pollution.

The oily water drains system has been installed in the follow areas

- Turbine Hall (Gas Turbine & Steam Turbine)
- Boiler Hall (Heat Recovery Steam Generator & Ancillary Equipment)
- Diesel Generators & Fuel Tanks
- Fire Pumps & Tanks
- General Oil & Lubrication Stores

All these areas contain heavy plant, machinery or fuel / lubricant storage which (in the event of an accident or structural failure) could lead to a loss of containment of oily or oil related substances. Therefore, this drainage system (painted red) exists to minimise and prevent any potential environmental impact.

In total, the oily water drains system surrounds plant items containing approximately 707,000 litres of oil products and acts as the direct point of collection and drainage in the event of loss of containment.

In the event of any oil leakage then all lost material would fall via gravity and enter this drainage system. All areas of the oily water drains system lead to the SEO pit, a substantial concrete storage pit with interceptor equipment located to the south of the site. Within the SEO pit all oil is separated from collected waters and the pollutant removed and recovered for re-use and / or recycling. The remaining clean water is subsequently pumped across the site to the newly installed recently installed oil in water analyser where it is analysed prior to entry into SDX tanks 30 and 40.

Tanks 30 and 40 are separated tanks which can be emptied into the common purge discharge chamber and the waters contained would be opened for ejection of waste waters into final purge waters discharge to emission point W1.

1.5.1 Oil in Water Analyser.

Since site construction, an Oil in Water Analyser has been utilised to continuously monitor for the presence of oil within the waste waters discharged from Oily Water Drainage system. A Turner Designs TD4100 was positioned at the end of the Oily Water Drainage System to monitor final discharges before they entered the SDX tanks 30 and 40 which in turn feed their waste waters into the final discharge for emission via W1.

In the unlikely event of oil detection in either outfall to these SDX tanks, then power station's operational logic systems would instantly halt the water transfer and prevent the displacement of any further oil pollutant into SDX tanks 30 and / or 40. Should a transfer shut down fail to prevent the presence of oil in water within these two tanks, then both containers would be held in isolation from the main purge discharge system so that the pollutant can be successfully removed (via external tankers for third party treatment) without entering the final discharge system.

In 2018, Uniper decided to upgrade this monitoring equipment and replace the Turner Designs Analyser with a new Advanced Sensors SA-100P2 Dual Line oil in water monitor (at a cost of over £50,000). This analyser utilises the latest Laser Induced Fluorescence (LIF) technology to maintain simultaneous continuous measurement of two streams (the oily water drains feed into SDX Tanks 30 and 40).

This analyser upgrade enabled increased accuracy in pollutant monitoring from the oily water drainage discharge whilst ensuring maximum instrument reliability and benefitting from a reduction in the requirements for calibration and maintenance from more modern technology.

1.5.2 Oil in Water Analyser Location

As previously mentioned, all W1 waste waters are passed through continuous monitoring analysers in the Purge Monitoring Cabinet (located close to the final outfall). Within this cabinet an extractive sample of discharge is processed for analysis for Temperature, pH, Chlorine Dioxide, Chlorite, Total Residual Oxidant, Salinity. However, the Oil in Water analyser is located further upstream and monitors discharge from the oil in water drains before they enter SDX tank 30 / 40. The analyser is located at this point for the following reasons:

i, Effective Monitoring of Drainage from Oil Containment Areas.

The oily drains system surrounds most of the oil containing equipment at Connahs Quay Power Station. Each generational unit has the following sources of notable oil containing equipment:

- Generator Transformer – 93,800 litres
- SFC Transformer – 27,600 litres
- Unit Transformer – 10,300 litres

Additionally, other areas across the installation hold additional volumes of oil related pollutants:

- Diesel Generator Tanks – 30,000 litres
- Waste Lubricating Oil – 2,750 litres
- Lubricating Oil Tanks – 147,040 litres

In total approximately 710,000 litres of oil related products are contained by the oily water drains system, and therefore monitored by the newly installed Advanced Sensors oil in water analyser.

In comparison the 40 cooling tower gearboxes (detailed in section 1.4.1) contain a total of 1600 litres of oil, which represents less than 2% of the total volume of oil products in the entire installation.

If the analysers were located to only monitor the discharges arising from waters purged from the four cooling towers, then leakage from only 2% of the total volume of oil products on site would be potentially detectable which is not a fully representative sampling strategy.

Therefore, the analyser has been maintained in its chosen location to ensure the most efficient monitoring of oil drainage servicing those areas of the power station with the greatest pollution potential.

ii, Prevention of Pollution Transfer to Purge Ponds

By utilising the current chosen location of the oil in water analyser, the drainage system encompassing 98% of all site oil substances is monitored prior to discharge of waste waters into the two main cooling water purge discharge ponds at Connahs Quay. The real time monitoring of drainage flows at this location ensures identification of any oil leakage / pollution at the earliest possible opportunity prior to entering the ponds. Each pond holds a maximum of 11,160m3 of cooling water and so should unmonitored oil enter the ponds then the contamination of up to 22,320 tonnes of cooling water would occur, requiring major specialist removal and treatment at high environmental and financial cost.

Therefore, the analyser has been maintained in it's chosen location to ensure the most efficient monitoring of oil drainage whilst preventing the potential pollution of the purge discharge ponds and subsequent high environmental removal and / or treatment costs.

iii, Prevention of Discharge Pipeline Contamination / Potential Pollution Emission .

If the oil in water analyser was relocated to the purge discharge cabinet, then any oil contamination may not be fully identified until just prior to the polluted waters leaving site. The cabinet analyser assesses an extractive sample from the waters discharged via W1, with a sample point located at the very end of the duct. Should oil be detected at the purge cabinet, the power station would instantly initiate closure of the final penstock (valve FCV101). This activated closure of the pipe and penstock would not be instantaneous (due to the significant size of the pipeline, penstock and volumes of water contained within) and therefore the possibility for leaked oil to discharge into the River Dee while the valve is slowly closing cannot be ruled out.

Furthermore, should FCV101 be closed due to the existence of oil contaminated water within the discharge pipe, then further challenges could arise. Closure of the valve would leave the 1.5 mile length of subterranean pipework full of potential polluting substance. The pipeline would then require considerable work to empty, clean and inspect before the power station could recommence operations. Such delays would lead to a loss of generation potential and significant further financial impact.

Therefore, the analyser has been maintained in its current location to ensure the most efficient monitoring of oil drainage whilst preventing the potential pollution of river waters.

2.0 Conclusion

The oil in water analyser has been in its current position since the construction of the power station in 1996. In the 23-year period since then it has successfully monitored the drainage for 98% of contained oil at the installation. The remaining 2% of oil is stored in the 40 gearboxes located within the cooling towers. Real time monitoring ensures that operational staff would be alerted instantly to an episode of gearbox failure, and that it would require full failure of three gearboxes to contaminate the purge discharge ponds with enough oil to exceed the limit on W1. Furthermore, cooling water pump restraints ensure that even if three gearboxes were to simultaneously fail, it would take several hours for their oil contents to reach the purge discharge ponds.

The purge discharge ponds are only emptied within a short time window which surrounds high tide. This periodic constraint upon an emission window provides additional time for site staff to take suitable action to prevent emissions should a gearbox failure occur.

Additionally, the purge discharge window process is only authorised after a final manual sample including analysis for the presence of oil, which must be below emission point W1 emission limits. Therefore, the likelihood for the 2% of oil stored on site to both leak and be discharged to the River Dee is extremely low, with several successful preventative measures in place to ensure such an exceedance cannot occur. Because of this, Uniper intend to maintain operation of the new Oil in Water Analyser at its current location and remain confident that measures remain in place to prevent any potential exceedance of the environmental permit limits for emission point W1 at Connah's Quay Power Station.