

To: William Wallace

From: Paul Wright

Company: Natural Resources Wales

SLR Consulting Limited

cc: V Morris-Jones

Date: 13 October 2026

Project No. 410.065169.00001

RE: PAN-029803: Query on water emissions

Dear William,

Further to your recent emails requesting additional information on AOX levels in water emissions, we provide the consolidated response below.

1.0 Background

The tissue manufacturing process for 'kitchen towel' utilises a cationic wet-strength resin to achieve the required product performance characteristics. The active AOX compound of the resin are Polyamide Epichlorohydrin (PAE). The wet-strength resin is added to the paper machine stock at the wet end of the process. Cellulose fibres used in papermaking possess a naturally negative surface charge arising from carboxyl functional groups present within the fibre structure. The wet-strength resin is supplied as a cationic polymer and therefore carries a positive charge. Upon addition to the stock, the positively charged resin molecules are strongly attracted to the negatively charged cellulose fibre surfaces. This electrostatic attraction results in rapid adsorption of the resin onto fibres and fines within the furnish and represents the primary retention mechanism prior to sheet formation. During sheet formation, water is removed through the forming wire, resulting in the development of a fibre network. The adsorbed resin remains associated with the fibres as drainage occurs. Subsequent drying promotes further fixation of the resin through polymer cross-linking and covalent bonding reactions with cellulose. Consequently, the majority of the wet-strength resin becomes chemically incorporated within the finished tissue product and is not present in a freely dissolved form.

Any residual resin not retained in the paper sheet is captured within the paper machine white water system. White water generated during sheet formation is routed to a Dissolved Air Flotation (DAF) plant, where suspended fibres, fines and associated organic solids are separated from the process water. Wet-strength resin associated with these solids is removed from the aqueous phase and returned to the fibre stream for reuse within the manufacturing process. Following DAF treatment, clarified process water is collected in the Clarified Water Tank and is reused within the mill for stock preparation, pulping, equipment cleaning and other process requirements. This internal water recycling further reduces the potential for resin loss from the manufacturing system.

Any excess water not reused within the process is directed to the on-site Effluent Treatment Plant (ETP). The ETP incorporates multiple stages of treatment comprising solids separation, anaerobic biological treatment, activated sludge treatment and final clarification therefore, reducing significantly any residual levels of resin in the water discharge to levels which are lower than the BAT-AEL.

2.0 AOX assessment

It has been confirmed with the regulatory team at the resin manufacturer, that the PAE (AOX) content of the wet strength resin is confirmed to be up to **0.03kg/tonne**.

Taking the PAE content of 0.03kg/tonne for calculation, the residual content in the waste water is as follows:

Total annual tissue production = 70,000 tonnes

Annual production of 'kitchen towel' anticipated to be 20% of total production = 14,000 tonnes.

A retention rate of 90% has been assumed, resulting in approximately 10% of PAE being transferred to the wastewater associated with 'kitchen towel' production. Therefore:

- $0.03\text{kg/t} \times 10\% = 0.003\text{kg/t}$
- $14,000\text{ tonnes} \times 0.003\text{kg} = 42\text{kgs of PAE/year in wastewater sent to the ETP}$

The ETP has an 80% removal efficiency, therefore the estimated residual active PAE resin in the final effluent will be:

- $0.003\text{kg/t} \times 20\% = 0.0006\text{kg/t}$
- $14,000\text{ tonnes} \times 0.0006\text{kg} = 8.4\text{kgs of PAE discharged to lagoon system.}$

Flow through the ETP = 1,200m³/hr, so annual flow associated with 'kitchen towel' production = 2,102,400,000lts (20% of total flow).

Therefore, total annual PAE content discharged from the ETP:

- $8.4\text{kg} = 8,400,000\text{mg}$
- $8,400,000\text{mg} / 2,102,400,000\text{lt} = 0.004\text{mg/lt}$

The discharge to the lagoon system will undergo significant further dilution due to the volume of water in the lagoons prior to pumped discharge.

3.0 Dilution in Lagoon System

The Shotton Mill site benefits from an extensive lagoon system which is utilised to store final effluent prior to pumped discharge to the tidal Dee Estuary. Lagoon 3 is the final holding lagoon, which has a capacity of 55,000m³.

Discharge from the ETP to the lagoon system contains 0.004mg/lt of PAE.

The flows to Lagoon 3 will transport approximately 44,000mg of PAE over a 12-hour period between pumped discharges, which are further diluted by up to 55,000,000lt.

The anticipated PAE content of the pumped discharge will be:

- $44,000 / 55,000,000 = 0.0008\text{mg/lt}$

4.0 Conclusion

1. The calculated discharge of 0.0006kg/tonne of AOX to the lagoon system, before dilution in the lagoon system, is orders of magnitude below the BAT-AEL of 0.05kg/tonne.
2. The calculated discharge to the Dee Estuary of 0.0008mg/lt is below the Limits of Detection of standard ISO 9562 (LOD = 0.005 to 0.01mg/lt AOX as Cl)



Regards,

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