Release of Epoxy

The Issue

- Concern has been raised amongst Viking's stakeholders over quantities of epoxy, and by extension Bisphenol A ("BPA"), from wind turbine blades during operation.
- The wind industry in Norway (through NORWEA) states a maximum of 50 grams of material is emitted per blade, per year, of which this is mainly paint. However, a recent report by a Norwegian group of authors who refer to themselves as "The Turbine Group" states that "*Our estimates show that emissions can be 41,000 % greater than the figures provided by NORWEA.*"
- The analysis presented in The Turbine Group report attempts to extrapolate from the results of a peer-reviewed published research paper from the University of Strathclyde (Pugh & Stack, 2021).

Who's right?

- Actual emission of material would depend on a variety of factors such as site conditions, blade coatings, maintenance procedures, etc.
- SSE has conducted our own sense-check of both the NORWEA figure and The Turbine Group figure based on operational experience.
- The NORWEA figure quotes a maximum of 50 g of material emitted per blade per year, of which this is mainly paint. Based on the SSE sense-check, this figure seems credible. The corresponding figure from The Turbine Group (41,000% higher) does not.
- Note that the paint is epoxy-free and non-toxic.

Image: Vestas V117 Wind Turbine
Source: https://www.vestas.com/en/media/images

Why the gap?

SSE wanted to understand how The Turbine Group's (TTG) analysis had reached the results they quoted in their report.

SSE approached the authors of the referenced University of Strathclyde research paper to ask their opinion on how their results had been interpreted in the TTG analysis.

In response the University of Strathclyde stated the following:

- The Norwegian Report has not been peer reviewed or published in any academic journals and has therefore not been scrutinised by others who are experts in the field.
- The calculation made by The Turbine Group in Norway estimated a percentage mass loss based on the erosion rate at the leading edge and extrapolated that percentage to the total blade. This is a very significant overestimate and unrealistic assumption. The mass loss percentage values in the University of Strathclyde paper refer to a specific uncoated specimen size and geometry. The calculated values cannot be used to predict the erosion of the entire blade. Only a small part of the leading edge experiences measurable rain erosion while much of the surface of the blade rotates at lower velocities and is not subjected to rain drop impacts. Thus the report extrapolates our data for the entire turbine and not a very small area i.e. the leading edge as specifically stated in our paper and in the two previous papers published by the same authors. So mathematically the claims do not stand up.
- The material used in this experiment was G10 epoxy glass which is a similar glass fibre epoxy composite used within the wind turbine manufacturing industry. However, the material used was uncoated (i.e. no surface coatings or Leading Edge Protection (LEP) were applied). Coated wind turbine blades have a far superior rain erosion resistance, and therefore the mass loss would be expected to be much less.
- The Strathclyde group has previously issued a statement stating that The Turbine Group calculations of erosion rates were a very significant overestimate based on their analysis. Strathclyde do not agree with the assertions made in the Norwegian report.

Prevention at Viking

- Epoxy (and, by extension, BPAs) are present in the laminate that makes up the blade shell, however the surface coatings and LEP that protect the blade shell are epoxy-free and non-toxic.
- Any damage to turbine blades is categorised on a scale of 1 to 5. Cat 1 is good condition, Cat 5 is substantial structural damage. In terms of erosion, where the blade shell has been exposed and begun to get eroded this would typically be classified as Cat 4.
- In order to minimise any environmental and operational risk we take a number of steps to try and prevent erosion progressing to the point where the blade shell begins to get eroded, including:
  - Paint the blade with an erosion resistant paint, with an increased thickness on the leading edge compared to the rest of the blade.
  - Installation of a Leading Edge Protection (LEP) system below the topcoat on the blade leading edge. This provides a gel coat barrier that absorbs the energy of the impact from rain drops and greatly increases the erosion durability of the leading edge.
  - Undertake an ongoing inspection regime of operational blades to monitor for any signs of degradation and programme any required maintenance work accordingly.
- The above measures are successful at mitigating against blade damage. For context, in the fleet of over 3,500 onshore blades that SSE currently operates and maintains, there are currently around 21 instances (<0.6%) of Cat 4 damage which are scheduled for repair this year. It should be noted that this figure is itself conservative because:
  - These 3,500+ blades are a mix of sizes, technologies and age, with a large proportion of these not having the modern leading edge protection that will be installed on the blades at Viking.
  - Not all of these approximately 21 instances of Cat 4 damage will be due to erosion, as this figure will also include damage from other causes (lightning strikes, cracks, etc.).

Image: Vestas V117 Wind Turbine
Source: https://www.vestas.com/en/media/images