Biofuelwatch comments relating to Rule 17 Questions of 6 June 2023 (R17QA)

The Rule 17 Questions of 6 June 2023 (R17QA) asked Biofuelwatch "if it is able to provide evidence to support its view that there are a range of meteorological conditions likely to exist under which less-than-maximum ground level impacts could combine to exceed the maximum ground level impact for one plant?"

Summary Response

Concentrations arising from two sources are typically regarded as cumulative. When meteorological conditions cause these areas of impact to overlap, concentrations will be increased above the levels from just one emissions source for those meteorological conditions. When this overlapping area includes the point with the maximum ground level impact from just one plant, the cumulative concentration will exceed the maximum ground level impact for that one plant. The overlapping areas of impact from two sources do not need to perfectly align for this effect to occur so there will be a range of meteorological conditions when the areas overlap sufficiently for the ground level impacts to combine to exceed the maximum ground level concentration from one plant.

A more detailed and thorough response follows which includes important factors that can be expected to further increase combined nitrosamine concentrations.

More Thorough Response

The dispersion of emissions from a stack depends on meteorological conditions, but, usually, once a plume disperses sufficiently to reach ground level, it will result in elevated pollution levels at ground level over a significant distance downwind with concentrations diminishing with further distance from the source. There are examples of ground level concentration contour maps in the ADMS user guide which can be found on the CERC website. The plume will also have a width at a certain distance from the source with the width depending on wind speed and other meteorological conditions. As a result, at any given time, there is typically a significant area subject to elevated pollution levels from a single emissions source. This is inline with experience: an outdoor source of odour is usually noticeable at more than just a single location and can extend downwind of the source for considerable distance. Large emission sources have higher stacks to disperse the emissions further. This reduces peak pollution levels, but also increases the area that will experience increased pollution levels at any given time. Drax's stack is higher than most, so its emissions are dispersed over a large area.

Consider what would happen to Drax's emissions if the wind direction is towards Keadby 3. Drax's plume often results in elevated ground level concentrations at the distance that Keadby 3 is from Drax (the figures in the Environmental Statement, such as Figure 6.8, predicts Drax's nitrosamine concentrations). Drax's plume would spread in width over the distance to Kaedby 3 and Drax's ground level nitrosamine pollution would be expected to typically extend for a considerable distance downwind (more on this further down). This spread in the plume, both in width and distance, means that there will be a range of meteorological conditions that would result in elevated pollution levels from Drax in the vicinity of Keadby 3. The width of the plume means the wind direction does not have to be precisely in the direction of Keadby 3 from Drax for there to be elevated levels near Keadby 3. Elevated levels from Drax will also occur for a range of wind speeds, temperatures etc.

Now consider the emissions of Keadby 3. Keadby 3's emissions will increase ground level concentrations and have their own maximum location somewhere downwind of Keadby 3. If the wind direction is carrying Drax's emissions towards Keadby 3, at the location of the maximum ground level concentration of Keadby 3's emissions, it is also likely that Drax's emissions would increase ground level concentrations. This may not be Drax's maximum ground level concentration, but any additional ground level nitrosamine pollution concentration from Drax will be additional to Keadby 3's maximum ground level concentration. As long as the meteorological conditions are such that the maximum concentration from Keadby 3 is within the width and length of Drax's plume, the resulting cumulative concentration would exceed the maximum concentration from the Keadby 3 plant alone.

Now consider a location near the point where Keadby 3's ground level concentration is a maximum. Let's say that the concentration at this point from Keadby 3 is not quite the maximum. Let's say the concentration from Keadby 3 at this point is x less than the maximum Keadby 3 concentration. This far from Drax, the concentrations from Drax will vary less over short distances than the concentrations from Keadby 3. As long as the contribution to pollution levels from Drax exceeds x, the concentration at this point will still exceed the maximum pollution level there would have been from just Keadby 3 alone. For any meteorological conditions that bring the Drax plume to Keadby 3 at ground level, the result will be an area where the ground level concentration exceeds the ground level concentration from Keadby 3 alone.

The same effect will occur when the wind is in the opposite direction and carries Keadby 3's plume towards Drax: there will be meteorological conditions when Keadby 3's emissions add to the maximum concentration of Drax's emissions and result in ground level concentrations exceeding those that would just from Drax.

All the above assumes that the plumes can be considered independent of each other, but, when considering nitrosamine concentrations, this is not a safe assumption. Amines and NOx combine to form nitrosamines in the atmosphere. The ADMS Chemistry Module requires NOx concentrations for this reason (see also Biofuelwatch's deadline 2 submission). Both Drax and Keadby 3 are NOx emitters, so, when the wind direction brings Drax's plume towards Keadby 3 (or vice versa), NOx emissions from one plant could increase NOx levels and so increase the formation of nitrosamines arising from the amine emissions from the other plant. As a result, simply summing the ground level concentrations from the two plumes on the assumption that the emissions are independent of each other can be expected to underestimate nitrosamine concentrations. The applicant has not demonstrated they have modelled the impact of the complex interaction of the two plumes on nitrosamine concentrations to show ground level concentrations would not be increased in this way. If the modelling tools do not exist to do this, then, at minimum, Biofuelwatch considers worst-case assumptions should be made about the cumulative NOx concentration levels that may arise from the combined emissions to ensure modelling predictions used to inform the ExA's assessment cannot underestimate nitrosamine concentrations.

It is also important to recognise other considerable uncertainties. It is very possible that other pollutants may increase nitrosamines formation rates, perhaps acting as catalysts. Current scientific understanding of atmospheric nitrosamine formation is not complete. Biofuelwatch's deadline 2 submission considers many other modelling uncertainties.

Biofuelwatch understands the applicant's modelling uses a background average level of NOx. Using an average like this will not take into consideration the complex geographical and temporal variation in NOx levels as varying meteorological conditions carry NOx pollution from roads and other sources. These variations in atmospheric NOx will also vary nitrosamine formation and can be expected to cause greater variability in nitrosamine levels. This variability in NOx levels will increase maximum short-term concentrations of nitrosamines compared to a model that assumes NOx emissions are reflected in an average background level. If the complex geographical and temporal variation in NOx is not modelled or accounted for, maximum short-term concentrations of nitrosamines are likely to be underestimated.

Nitrosamines, once formed in the atmosphere, are relatively stable so able to travel considerable distances. Elevated nitrosamine concentrations can be expected further from the amine source than less stable pollutants that are not formed in the atmosphere. This effect can be seen in the applicant's diagrams, cf. Figure 6.8 of the Environmental Statement [APP-075] with Figure 6.20 showing nitrogen deposition. Peak nitrosamine concentrations may not even be within the modelled area of Figure 6.8 and are clearly at a greater distance from the source than peak nitrogen deposition. This is supported by section 7.2 of “Amines Worst Case Studies: Worst Case Studies on Amine Emissions from CO2 Capture Plants (Task 6)”, 2009, Matthias Karl, Steve Brooks, Richard Wright and Svein Knudsen, Norwegian Institute for Air research (NILU) and Norwegian Institute for Water) who found maximum nitrosamine concentrations diminish slowly with increased distance from the source. The 2022 report by Imperial College and the Norwegian Institute for Public Health (section 5.2.1 of “Human Health hazard assessment strategy for amine emissions around PCC facilities”, Maria Lathouri, Anna Korre, Maria Dusinska, Sevket Durucan, 2022) said "building another PCC plant within a distance of 100 – 200 Km downwind of an existing PCC plant will cause interferences, and amine emissions released from the neighbouring PCC plant will add to the already chemically produced N-nitrosamines and N-nitramines and so will be continuously accumulated in the surrounding environment and endanger human health". The distance from Drax to Keadby 3 is small compared to 100 - 200 Km so, from Lathouri et al, interference effects should be considered likely. The increase in short-term nitrosamine levels when one plant is downwind of the other is such an interference effect.