APPLICANT’S RESPONSES TO ISSUES RAISED AT DEADLINE 8

Drax Bioenergy with Carbon Capture and Storage

Infrastructure Planning (Examination Procedure) Rules 2010

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PUBLIC

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1. INTRODUCTION

1.1. PURPOSE OF THIS DOCUMENT

1.1.1. On 23 May 2022, Drax Power Limited ("the Applicant”) made an application (“the Application”) for a Development Consent Order (DCO) to the Secretary of State for Business, Energy and Industrial Strategy (“the SoS”). The Application relates to the Drax Bioenergy with Carbon Capture and Storage (BECCS) Project (“the Proposed Scheme”) which is described in detail in Chapter 2 (Site and Project Description) of the Environmental Statement (ES) (APP-038).

1.1.2. The Application was accepted for Examination on 20 June 2022.

1.1.3. Representations from Biofuelwatch were received by PINS at Deadline 8:

a. Biofuelwatch’s comments in response REP7-017 The Applicant’s response to issues raised at Deadline 6

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

1.1.4. This document, submitted at Deadline 9 of the Examination, contains the Applicant’s responses to the representations from Biofuelwatch at Deadline 8. The Applicant has focussed on responding to points that have not already been made and responded to by the Applicant.

2. BIOFUELWATCH

2.1.1. In general, Biofuelwatch has simply reiterated the position set out in their deadline 6 responses. The Applicant has responded in detail to these responses and does not propose to repeat these here.

2.1.2. In summary, the Applicant's position is that:

- Uncertainty, inherent to all modelling studies, has been addressed by using realistic worst-case assumptions wherever appropriate;
- Cumulative impacts have been addressed within the ES, including a worst-case assessment of cumulative short and long term impacts on amines and their degradation products;
- Variability in meteorological data has been taken into account using best practice, through consideration of 5 years of meteorological data. Calm conditions are very rare and do not affect the conclusions of the study;
- The ADMS dispersion model is well validated and the most appropriate software for the study;
- The mid-merit and worst-case emission scenarios appropriately represent the realistic envelope of future operating conditions;
- Additional control measures are being introduced with the carbon capture process to minimise emissions of sulphur dioxide; and
- The process will operate under permit from the Environment Agency and be subject to ongoing review to ensure environmental impacts are acceptable and minimised.

2.1.3. Notwithstanding these general points, further detailed responses are provided in the following sections, AQ1 and AQ2, in response to comments Biofuelwatch has made in relation to:

- The potential for short-term cumulative impacts (AQ1), and
- The potential for tall stacks to disperse pollutants over a wider area than shorter stacks (AQ2).

3. AQ1: CUMULATIVE SHORT-TERM IMPACTS

3.1.1. Biofuelwatch were asked by ExA 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” [R17QA.9]. The ExA’s question specifically referenced the Applicant’s response regarding cumulative short-term impacts in which it was stated that “to exceed the maximum impacts presented in the ES, the meteorological conditions would have to be such that the near maximum impacts from two plants will occur [...] at the location of maximum impact of the two or more plants in the same hour. This simply will not occur and does not warrant assessment” [REP7-017].

3.1.2. Biofuelwatch provided a theoretical response stating that where areas of impact arising from two sources overlap there will be a range of meteorological conditions where the areas overlap sufficiently for the ground level impacts to combine to exceed the maximum ground level concentration from one plant.

3.1.3. In addition, Biofuelwatch made reference in their response to short term nitrosamine levels for which there is no Environmental Assessment Level published by EA. The relevant assessment standard for nitrosamine exposure is long term (annual mean) and, whilst hourly mean concentrations are used to calculate the annual mean, the hourly variations are, of themselves, irrelevant. There are, however, short term standards for amines (hourly and daily means), as opposed to nitrosamines, and the Applicant will focus on these concentrations in their response below.

3.1.4. Furthermore, prior to providing additional detail, the Applicant notes the following:

a. The technology suppliers for Keadby and the Proposed Scheme are different and, therefore, the amine compounds will be different. Their toxicology and mechanism for action will likely be different and, therefore, even where cumulative impacts occur, it is by no means certain that cumulative health effects will occur;

b. The technology supplier for the Proposed Scheme provided compound-specific EALs for the project. For example, as set out in Air Quality Technical Note 1 (AQ TN1) [AS-019], the hourly mean EALs for the Amine 1 and Amine 2 compounds were changed from 400µg/m^3 (for the amine MEA) to 1120µg/m^3 and 53µg/m^3 respectively, with 53µg/m^3 being used in AQ TN1 to ensure a conservative assessment for the total amine impact. For Keadby, impacts were assessed against the EAL for MEA; and

c. Notwithstanding the Applicant’s position that modelling short term cumulative impacts is unnecessary, their explicit modelling for amines would require further assumptions since the degradation process reaction rates are different for the Proposed Scheme specific amines (Amine 1 and Amine 2) and the amines from the Keadby plant, and ADMS cannot model multiple reaction rates at the same time. (The Applicant has now undertaken modelling using highly conservative assumptions as set out below).

3.1.5. The Applicant re-emphasises their previous response that whilst they do not disagree with Biofuelwatch's assertion in relation to cumulative impacts from overlapping plumes as a theoretical premise, given the distance (approximately 22km) between Keadby Power Station and Drax Power Station, in this particular case, the potential for plumes combining to generate impacts that exceed the maximum impacts presented in the ES is vanishingly small.

3.1.6. To recap, para 6.12.9 of Chapter 6 Air Quality of the ES [APP-043] assessed the short and long term cumulative amine impacts of Keadby and the proposed Project. The paragraph was updated in AQ TN1 (page 5) following revisions to the proposed amine emission limits, as follows:

Amine cumulative maximum 1-hour mean PC (µg/m^3)

= 0.287 (Proposed Scheme) + 25.2 (Keadby 3) = 25.487 µg/m^3

Amine cumulative maximum 24-hour mean PC (µg/m^3)

= 0.070 (Proposed Scheme) + 0.22 (Keadby 3) = 0.290 µg/m^3

3.1.7. Where the summation was undertaken highly conservatively, with for the maximum hourly concentrations from each process being added without consideration of either spatial or temporal separation between the impacts.

3.1.8. For amines, this is clearly and unambiguously the maximum possible cumulative short-term impact since the maximum modelled concentrations for all amines individually (Keadby and Proposed Scheme) are summed. It is also noted that the maximum contribution of the Keadby Project to amine (and nitrosamine) concentrations far outweighs the maximum contribution of the Proposed Scheme.

3.1.9. Biofuelwatch maintain that it is possible that due to the neglect of cumulative NOx concentrations in the overlapping plumes that nitrosamine impacts may be underestimated. Their argument would logically work in reverse for amine concentrations since increased degradation would reduce the amine concentration and further emphasises that the impacts above are conservative. However, the Applicant has previously concluded that the effect of cumulative NOx concentrations will be insignificant [REP7-017].

3.1.10. To further illustrate the conservatism of the Applicant's approach, the dispersion model for cumulative impacts has been run, using 2016 meteorological data, to assess the maximum short term (hourly mean) cumulative impacts on amines whilst neglecting the degradation of amines. The spatial distribution of these impacts is shown in Figure 3-4 below, where 'cumulative' impact implies the hourly concentrations modelled in the cumulative impacts model scenario including both the Proposed Scheme and Keadby 3. However, as will be demonstrated, the maximum hourly impact at any location does not necessarily result from cumulative impacts from these processes in the same hour. The spatial distribution is explained in the following sections.

3.1.11. As noted above, the ADMS model cannot be run with multiple reaction rates and the assumption of no degradation adds further conservatism to the assessment.

3.2. MAXIMUM MODELLED CUMULATIVE IMPACT IN THE STUDY AREA

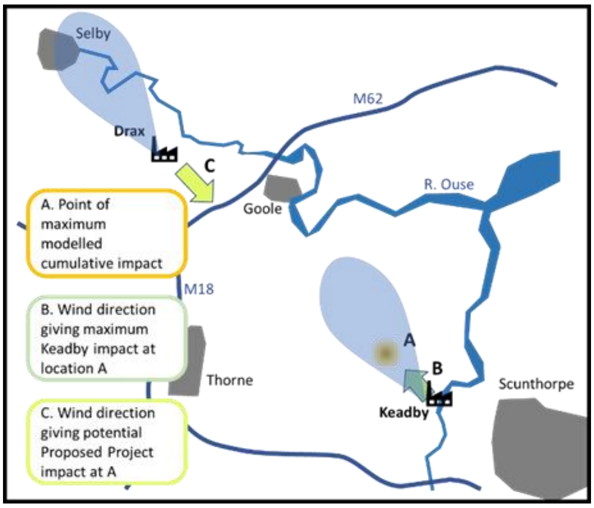
3.2.1. Within the study area for the project, the maximum cumulative concentration of amines is, neglecting amine degradation, 3.7µg/m^3 as an hourly mean.

3.2.2. The maximum concentration is markedly lower than the maximum cumulative concentration of amines reported in Chapter 6 of the ES [APP-043] and updated in cumulative impacts assessed in AQ TN1 (25.487µg/m^3, as repeated above). Taking into account the maximum hourly concentration reported in the ES for Keadby 3 (25.2µg/m^3), it is readily apparent that the point of maximum impact of the Keadby 3 amine emissions lies outside of the study area for the Proposed Scheme (15km x 15km, centred at Drax Power Station).

3.2.3. The maximum cumulative hourly mean impact occurs at the south-eastern extreme of the study area (location A in Schematic 1, close to Keadby) when the wind is blowing from the south-east i.e. from Keadby towards the study area (Direction B in Schematic 1). Under such conditions, the entire impact at A arises from Keadby alone since the contribution of the Proposed Scheme is precisely zero due to the location of maximum impacts being over 15km upwind of Drax.

3.2.4. At the point of maximum impact of the Keadby plume within the Proposed Scheme study area (i.e. the same location as for the maximum cumulative impacts, A in Schematic 1), the maximum potential impact from the Proposed Scheme would occur under north-westerly winds i.e. when the wind was blowing from the Drax Power Station (Direction C in Schematic 1). Under this wind direction, the contribution from Keadby at location A would be zero since it would be upwind of the Keadby power station.

Plate 3-1 - Schematic 1: Location of maximum cumulative hourly mean amines impact (Proposed Scheme plus Keadby 3). Indicative plumes shown in blue for wind direction B.



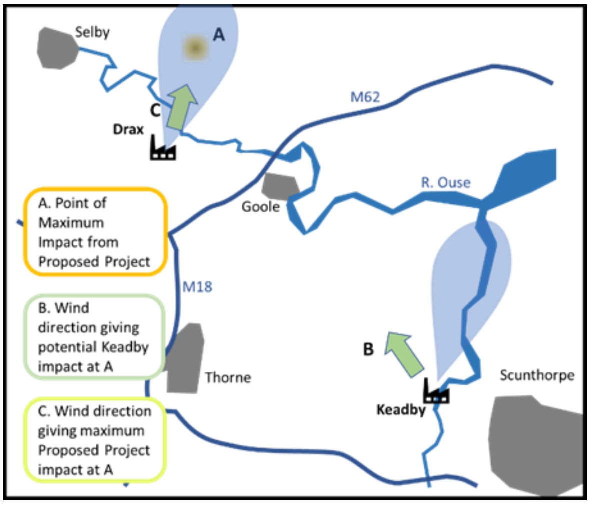
3.2.5. There is, therefore, no potential whatsoever for cumulative impacts on hourly mean concentrations at locations between the Drax and Keadby Power Stations.

3.3. POINT OF MAXIMUM MODELLED IMPACT OF PROPOSED SCHEME

3.3.1. The maximum impact from the Proposed Scheme alone, neglecting amine degradation, is 0.30µg/m^3 as an hourly mean. This maximum impact occurs approximately 5km to north-north-east of Drax Power Station (location A in Schematic 2), when the wind is blowing from the south-south-west (Direction C in Schematic 2).

3.3.2. In the hour of maximum impact from the Proposed Scheme at location A, the impact from Keadby is imperceptibly small i.e. <10 10µg/m^3, since there is no significant overlap of plumes from Keadby and Drax under the required south-south-westerly winds.

Plate 3-2 - Schematic 2: Location of maximum hourly mean amines impact from Proposed Scheme alone. Indicative plumes shown in blue for wind direction C.



3.3.3. The maximum cumulative hourly concentration at this location is 0.44µg/m^3. This is significantly lower than the maximum hourly impact assessed in AQ TN1 (25.487µg/m^3) and equates to the maximum impact from Keadby alone at this location i.e. the maximum impact at this location results from the impact of Keadby alone without the influence of overlapping plumes.

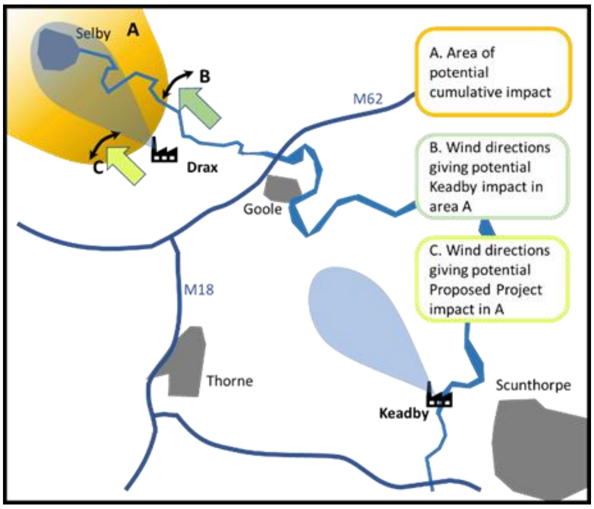
3.3.4. It can, therefore, be concluded that the potential for cumulative impacts to the north-east, or indeed south-west, of Drax Power Station is negligible i.e. the plumes simply will not overlap to any significant degree in this area.

3.4. ZONE OF POTENTIAL PLUME OVERLAP

3.4.1. Given the distance separating Drax and Keadby Power Stations, the only realistic zone in which the plumes from Keadby and the Proposed Scheme could combine to produce a cumulative hourly mean impact in the same hour lies to the north-west of Drax (area A in Schematic 3) under south-easterly winds, or winds at least approximately aligned to south-easterly. This area of marginally enhanced cumulative impacts is apparent to a minor degree in a slight deviation to the generally pattern of decreasing hourly mean amine concentrations away from the south-east of the study (and the Keadby Power Station) seen in the north-west area of Figure 3-4.

3.4.2. It has already been noted that the modelled impacts from Keadby far exceed those from the Proposed Project. With the area of potential cumulative impacts lying further from Keadby Power Station than the point of maximum impact (location A in Schematic 1), the maximum contribution from Keadby is much lower within area A than it was at its point of maximum impact. Whilst the impacts from Drax in area A are comparable to, but lower than, the maximum modelled impacts from Drax alone (at location A in Schematic 2), the potential cumulative impacts in this region are significantly lower than at the point of maximum cumulative impact nearer to Keadby.

Plate 3-3 - Schematic 3: Location of potential cumulative impact. Indicative plumes shown in blue for wind direction B/C.



3.4.3. For example, the maximum hourly mean impacts to the north-west of the Drax Power Station over Selby are, neglecting amine degradation:

Impact from Proposed Power Plant	0.00004µg/m^3
Impact from Keadby Power Plant	0.371µg/m^3
Cumulative Impact	0.371µg/m^3

3.4.4. i.e. over 99.99% of the maximum cumulative impact arises from Keadby alone, even when the plumes overlap.

3.4.5. In the hour when the impact from the Proposed Scheme is a maximum over Selby, the cumulative concentration is lower than the maximum arising from Keadby alone:

Impact from Proposed Scheme	0.145µg/m^3
Impact from Keadby Power Plant	0.119µg/m^3
Cumulative Impact	0.264µg/m^3

3.4.6. Most notably, the impacts arising when the impact from a) Keadby is a maximum and b) the Proposed Plant Scheme is a maximum are both considerably lower than the maximum modelled cumulative impact in the study area (3.7µg/m^3) and also the maximum cumulative impact reported in AQ TN1 (25.487µg/m^3).

3.4.7. Taking into account the degradation of the amine compounds with distance downwind, these concentrations will overestimate the actual cumulative amine concentrations.

3.5. CONCLUSIONS

3.5.1. The cumulative short-term impacts presented for amines in Chapter 6 Air Quality of the ES [APP-043], as updated by AQ TN1, area highly conservative and robust.

3.5.2. Biofuelwatch's arguments hold in theory, for example, where the emission sources lie in proximity to each other but are wholly unrealistic for the particulars of the Proposed Scheme. There is, as stated by the Applicant on numerous occasions, no realistic prospect for cumulative short-term impacts arising as a result of the combination of amine emissions from Keadby and the Proposed Scheme that exceed the maximum impacts presented in the Environmental Statement.

3.5.3. This conclusion applies to:

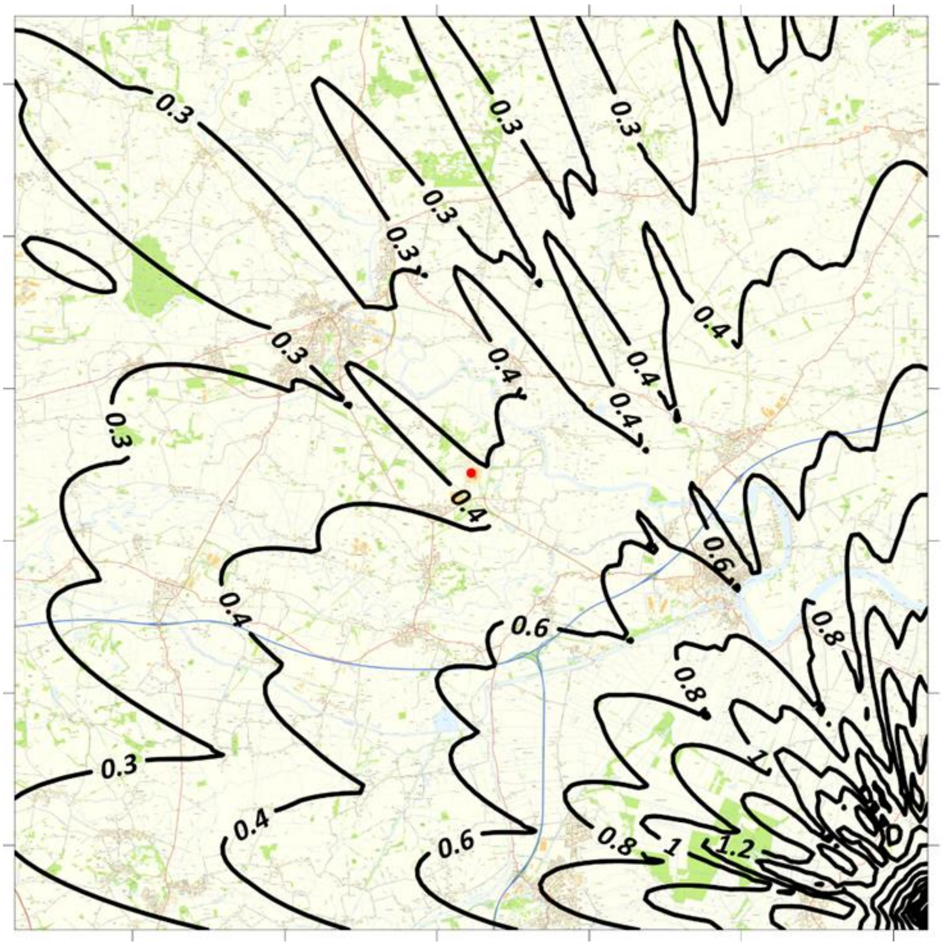
a) Amine concentrations,

b) All meteorological years,

c) Non-amine pollutants such as NOx, and

d) Biofuelwatch's assertion that the rate of degradation of amines to nitrosamines may have been underestimated at times due to neglecting the effect of NOx concentrations within the Keadby plume when modelling the degradation of the Proposed Scheme amines. There is simply no significant potential for cumulative short-term impacts.

Plate 3-4 - Maximum hourly mean cumulative amine impacts (Proposed Scheme plus Keadby) for 2016. Drax Power Station is shown by the red circle. Concentrations shown in µg/m3. The degradation of amines is neglected in the modelling.



4. AQ 2: DISPERSION OF EMISSIONS FROM TALL STACKS

4.1.1. Biofuelwatch have, over the course of their questions and responses at Examination, made repeated reference to the fact that, due to the height of the stack at Drax, emissions will be dispersed over a particularly large area.

4.1.2. For example, in “Biofuelwatch’s comments in response to “REP7-017” The Applicants responses to issues raised at deadline 6”, Biofuelwatch state:

> At Response Ref 5.1 – “Drax’s emissions can be expected to disperse further because of its higher stack” (in comparison to a Norwegian study with lower stack)

4.1.3. To be clear, with the same exhaust parameters, the ground level impacts from a tall stack will be lower than or equal to the impacts from a lower stack *at all distances downwind of the stack*. It is incorrect to assert that emissions will be ‘dispersed further’ with the tall stack.

4.1.4. Figures 4-1 and 4-2 overleaf show examples of dispersion of pollutants from stacks of height 50m, 150m and 250m with a neutrally stable boundary layer (typical of cloudy and windy conditions) and an unstable boundary (typical of sunny conditions, with relatively light winds) respectively. The exhaust parameters are representative of Drax Power Station exhaust conditions but, for the purpose of this exercise, are arbitrary.

4.1.5. In these figures, Figures 4-1/4-2 a, b and c show the ground level footprint of the plume, where the x and y axes are the distances in metres down and cross wind respectively, for the stack heights of 50m, 150m and 250m. Figure 4-1/4-2 d shows the same spatial distributions overlaid on a single plot, to demonstrate that the envelope of the plume from each stack converges with distance downwind. Figure 4-1/4-2 e shows the evolution of ground level concentration along the plume centreline and Figures 4-1/4-2 f and g show cross sections of the ground level footprint at distances of 6000m and 15000m downwind of the stacks.

4.1.6. The following observations are made:

- The highest ground level concentrations are seen with the lowest stack height, at all distances downwind;
- The point of maximum impact moves downwind as the stack height increases, but the maximum concentration decreases with stack height, irrespective of the location of maximum impact;
- Ground level concentrations from all stack heights converge with distance downwind;
- The horizontal extent of the plume from the various stacks converges for all stack heights with distance downwind; and
- The distance downwind into which the plume disperses is no greater for the tall stack than the short stack.

4.1.7. The explanation for these observations is that:

a) Ground level impacts are determined by both the horizontal and vertical dispersion of the plume. As the plume height increases, the plume takes longer to disperse vertically down to ground level and, as such, the plume has longer to disperse horizontally, reducing peak concentrations, and the point of maximum impact moves downwind; and

b) With distance downwind, the plume is well mixed throughout the boundary layer and the concentration of pollutants from the stack emissions will be similar at all heights, from ground level to the top of the atmospheric boundary layer. Beyond this distance (a few kms downwind), ground level concentrations are independent of stack height since you cannot mix a well-mixed plume any further once the plume is mixed throughout the boundary layer.

4.2. CONCLUSIONS

4.2.1. It is illogical to assert that the high stack at Drax Power Station is anything other than a benefit for the dispersion of pollutants from the Proposed Scheme. This applies at all distances downwind.

Plate 4-1 - Spatial distribution of dispersion from stacks of 50m, 150m and 250m height in a neutrally stable atmosphere.

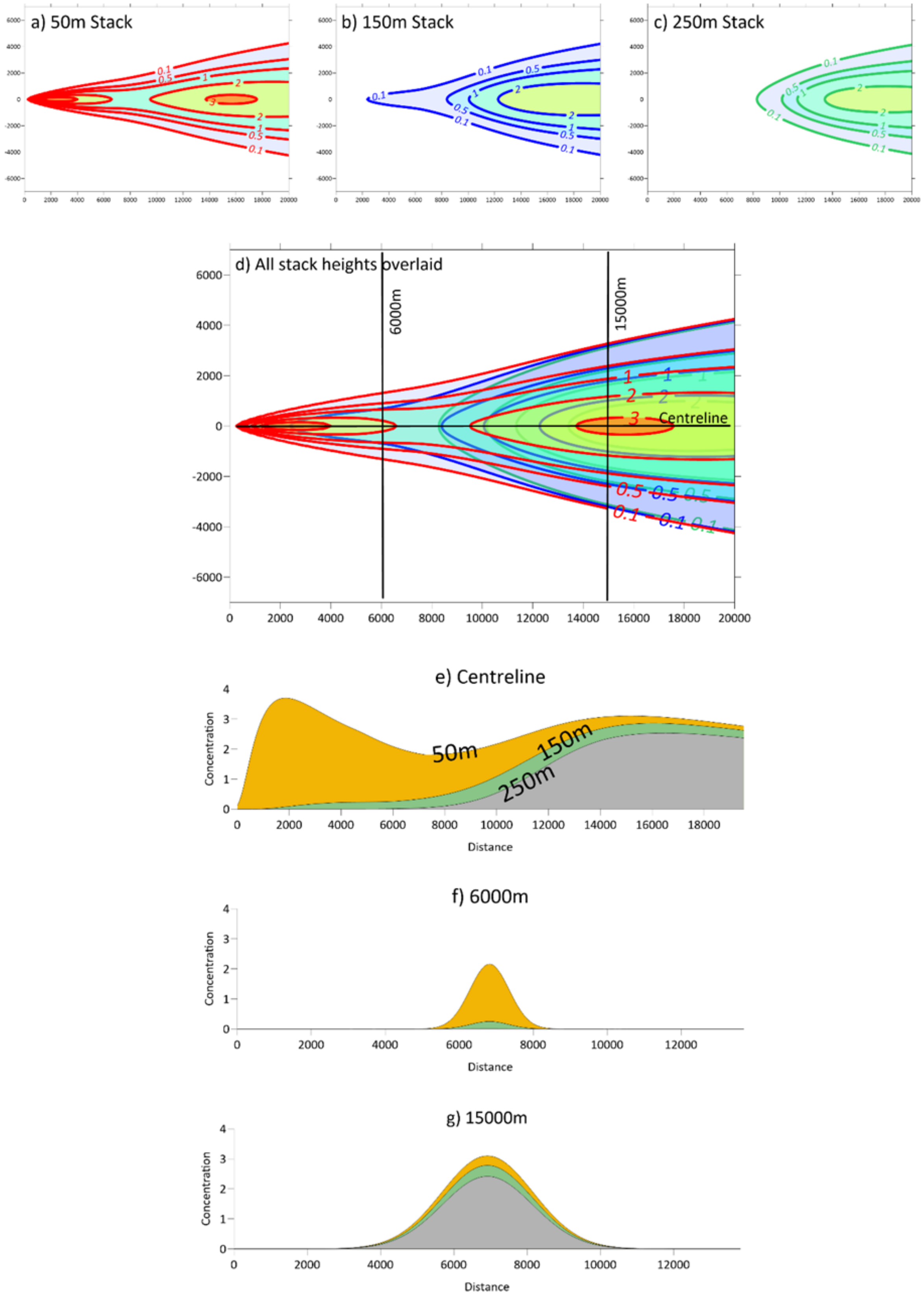


Plate 4-2 - Spatial distribution of dispersion from stacks of 50m, 150m and 250m height in an unstable atmosphere.