Fosse Green Energy

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EN010154

6.3 Environmental Statement Appendices

Appendix 14-G: Unplanned Emissions Assessment

Planning Act 2008 (as amended)

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

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Planning Act 2008

The Infrastructure Planning

(Applications: Prescribed Forms and

Procedure) Regulation 2009 (as amended)

Fosse Green Energy

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6.3 Environmental Statement Appendices

Appendix 14-G: Unplanned Emissions Assessment

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1. Introduction

1.1 Purpose of this Report

1.1.1 This technical appendix considers the potential consequences of unplanned emissions to air from the use of battery technology within the proposed Fosse Green Energy Development (hereafter referred to as 'the Proposed Development').

1.1.2 By its very nature a thermal event (the overheating of batteries or a fire) in part of the Battery Energy Storage System (BESS) is not an intended outcome from the use of a BESS. Considerable effort goes into designing and operating BESS units in a way that avoids any thermal event and thereby maintains the units in an operational condition. Such events are therefore 'unlikely' and global experience is that most modern BESS sites should operate without experiencing a single fire during their operational lifetime.

1.1.3 A fire is a 'possible' event for any development and there are regulatory requirements in place to ensure that the safety and environmental consequences of a fire have been considered and planned for. That work is normally finalised at the detailed design stage for a proposed development with BESS, after planning consent has been granted. This appendix aims to bridge the information gap at this stage and provide information on the likely magnitude of impacts of accidental (unplanned) emissions to air as the result of a thermal event at a BESS.

1.1.4 The scope of this study includes:

a. A review of potential emissions to air from out-gassing and from fire;

b. Consideration of the potential magnitude of emissions;

c. Consideration of likely rates of dilution between potential emission locations and sensitive receptors located outside the DCO Site; and

d. Consideration of the likely consequences of emissions to air from the proposed Battery Energy Storage System (BESS).

1.2 Background

1.2.1 Battery technologies are used at renewable energy generation facilities to store electrical power so it can be supplied to the National Grid when it is most needed. In the case of a solar farm, this may be during the hours of darkness, for example.

1.2.2 The precise number of individual battery storage containers for the BESS component of the Proposed Development will depend upon the duration of required energy storage; however, it is expected that there would be approximately 480 megawatt hours (MWh) of BESS capacity, which equates to approximately 328 batteries either distributed throughout the Principal Site (referred to as 'distributed BESS' arrangement) and located alongside the

Solar Stations, or located at a single BESS Compound (referred to as 'centralised BESS' arrangement). The 480MWh BESS capacity would be fully charged by 2 hours of peak production of the Proposed Development.

1.2.3 Details of the design for the BESS elements, including their power and energy ratings, and their final enclosure dimensions and appearance, are currently under development and, therefore, the assessment has been based on maximum parameters which would not be exceeded (as set out in **Chapter 3: The Proposed Development** of this Environmental Statement (ES) **[EN010154/APP/6.1]** and the Design Commitments at **Appendix A** of the **Design Approach Document [EN010154/APP/7.3]** that are secured by Requirement 3 of the **Draft DCO [EN010154/APP/3.1])**. At this stage it is known that:

a. Each battery enclosure will be a single storey,

i. There will be no enclosure located within 150m of residential facades.

b. Included within the design, each enclosure will have:

   i. Detectors and control systems for temperature and gas concentrations;

   ii. Passive ventilation to prevent build up of off-gases;

   iii. Enclosure cabinets will have non-combustible walls, floor and ceiling, and will have a minimum internal fire resistance rating of 2 hours;

   iv. Cells or modules will have proven fire performance, demonstrated by a standard test, such as UL9540A.

2. Emissions from Incident Fires

2.1 Potential Sources of Emissions to Air

2.1.1 The battery technology for the Proposed Development has not been confirmed at this stage but is likely to be based on either lithium-ion (Li-ion) chemistry, as Li-ion are the most widely installed BESS at this time or on a lithium iron phosphate (LFP) chemistry which are a widely used alternative to the Li-ion technology.

2.1.2 The general arrangement for both Li-ion and LFP BESSs is to have ‘cells’ grouped into ‘modules’ (sometimes called ‘packs’) and a number of modules housed on shelves within a ‘rack’. The racks are housed in a container, that takes the form of a metal, fireproof cabinet, with front opening doors. Older BESS designs had more racks in a single large container (10-12 was common) and newer designs employ a smaller number of racks (typically 4 or 6) in each of multiple cabinets to provide additional fire protection. The amount of electrical energy stored can be the same with either design, but small numbers of racks per cabinet is inherently more likely to limit emissions to air from a fire.

2.1.3 The National Fire Chiefs Council (NFCC) has developed guidance to help inform the Fire and Rescue Services (FRS) of design information to help assess risk and form effective emergency response plans (Ref 1). In July 2024 a draft update to the NFCC Guidance was issued for consultation, but at the current time remains a draft document (Ref 2). The NFCC guidance documents outline the need to have effective battery management systems in place, including alerts for battery fault and combustible gas detectors. The guidance further outlines the need for means of containment, suitable thermal barriers and emergency plans.

2.1.4 If the battery cells become damaged by heat or are burnt within a fire affecting a single module, a rack of modules or multiple racks, then the combustible materials consumed in the fire could give rise to a range of organic and inorganic air pollutants. This situation is true of any incident fire and sets of emission factors have been collated by the Environment Agency (Ref 3) for incident fires involving automobiles, buildings, and waste materials, for example. A standardised set of emission factors for BESS is not currently available from the Environment Agency and, therefore, equivalent data must be sourced from manufacturers and the research literature.

2.1.5 In 2016, a U.S. based organisation, The Fire Protection Research Foundation (FPRF), published a report (Ref 4) on ‘Hazard Assessment of Lithium-Ion Battery Energy Storage Systems’ that included gas sample measurements from batteries subjected to external and internal ignition tests for BESS up to 100kWh size. While the total BESS size for the Proposed Development may be greater than 100kWh, the modular nature of BESS means useful lessons can be learnt from studies undertaken using a BESS that is not the same size as is proposed for the Proposed Development. The gases were measured near the tested unit, and included methane (CH_4), chlorine (Cl_2), hydrogen fluoride (HF) and carbon monoxide (CO).

2.1.6 The observations from the FPRF tests included:

a. The 100kWh BESS unit was located outdoors for the test and with no fire suppressant system in operation, it was on fire for 3.7 hours until it had burnt out.

b. Elevated concentrations of carbon monoxide (CO) were detected in the first 30 minutes of the test and this decreased to near zero during the main period of self-sustaining combustion, which is not unexpected for a fire occurring outdoors.

c. Chlorine and methane were not detected (<1ppm) during the test.

d. Hydrogen fluoride (HF) was detected at concentrations > 100ppm (i.e., over range for the detector used) after 30 minutes and then for the duration of the fire.

2.1.7 From the FPRF study, the emissions of potential concern are considered to be HF and CO. Of these only HF is likely to be present at concentrations of concern at distances of more than a few tens of metres from the fire.

2.1.8 The conclusion that HF emissions occur is supported by more recent fire tests and also by the small-scale laboratory trials undertaken by Anderson et al. at the SP Technical Research Institute of Sweden (Ref 5). Although Anderson et al.'s study used small 26,650 type cells, laptop battery packs (including housings) or extracts of electrolytes, rather than it being a BESS scale study, it also had access to monitoring equipment that was capable of more precise measurements over a larger concentration range. The observations from Anderson et al. included:

a. HF was always detected in combustion tests.

b. Cells burnt when at 100% SOC (state of charge) produced less HF than cells at 50% SOC.

2.1.9 More recently, a standard test for battery systems has been established in the U.S.A. that documents the consequences of deliberately overheating a cell within a battery module. The test is UL 9540A (Ref 6) forms part of UL 9540 Energy Storage Systems and Equipment standard and can be applied to a battery module or a whole BESS unit. The test reports include consideration of how heat is transferred within the tested equipment, whether any fire spreads to other cabinets and measures the concentration of emissions to air. Most BESS suppliers in the UK only offer systems with a UL 9540A test accreditation, so at the point when a supplier has been selected for a scheme the system specific fire test information can be shared with the relevant authorities.

2.1.10 In theory it would be possible to base a dispersion model on the concentration of a pollutant, such as HF, measured in the plume near to the BESS during a whole unit test firing. For example, one test firing (Ref 8) reported a very large amount of variation in measured concentrations for HF from sample to sample, ranging from 575mg/m^3 down to the low tens of mg/m^3. The peak concentrations are short lived and infrequent events, typically lasting seconds. Such peak values are not representative of conditions that occur over the timescales of relevance to this study, which uses criteria that are 10 min mean and 1 hour mean concentration values. The use of mean values in air quality standards takes into account the present values being higher than the mean value for the time period. The use of the peak measured value as a basis for assessment would be overly conservative. Data with sufficient granularity to enable the mean concentration over a relevant time period to be calculated from short term measurements are not captured during the standard fire tests.

2.1.11 The Electrical Power Research Institute (EPRI) (Ref 9) is a research Institute in the U.S.A. that provides technical research for its corporate membership, which are mostly electricity generation companies. In 2024 they published a review of *Lessons Learned from Air Plume Modelling of Battery Energy Storage System Failure Incidents)*. Of particular relevance to this report are the following findings:

a. Staking multiple conservative assumptions in dispersion model studies, even if not “worst case” (i.e. conservative and improbable) can result in unrealistically conservative results.

b. Based on 67GW and 150GWh of Li-ion BESS deployed to end of 2023 and 85 cell failure incidents from those units, a cell failure rate of less than 0.1% was observed. This is 1 incident per 1.76GWh deployed. Only a small fraction of those cell failures would then develop into fires. The implication is that the likely number of fire incidents at a BESS of less than 1GWh, operating for 20 year is less than 1 incident during its operational lifetime.

c. Consideration of the proportion of the time when meteorological conditions would give rise to potential impacts at actual receptors is a useful approach to establish how often an exposure pathway is present under real world conditions.

2.1.12 EPRI have collated best practice in the dispersion modelling of emissions from BESS fires (Ref 10) and have noted that, where UL 9540A emission data is not available, an appropriate emission factor for HF emissions would be in the range of 0.4g to 1.5g of HF per kilogram of battery weight. For example, taking a nominal cell weight of 5.4kg, a cabinet of 840 cells (Ref 11) would have a weight of battery of approximately 4,536kg. At 100% SOC this equates to 1.8kg of HF from a fire that consumes the whole cabinet.

2.1.13 An increasing number of modules and whole cabinets have demonstrated during testing that no fire propagation occurs beyond the tested unit. For example a module containing 104 cells (Ref 12) with the same nominal cell weight of 5.4kg, would have a battery weight of 562kg. At a low SOC this equates to 0.84kg of HF from a fire that consumes a single module.

2.1.14 These HF content values are similar to values used in some previous Development Consent Order (DCO) Environmental Impact Assessments (EIA) (Ref 13) where values of 2kg of HF content have been cited based on the more limited data available at that time. There is a trend of greater density of cells being used per module, but also of having fewer modules per fireproof cabinet and of modules becoming increasing less likely to propagate a fire to another module. Consequently, the likely magnitude of emissions of HF from a fire event is remaining largely unchanged, as new battery chemistries and BESS designs are brought forward.

2.1.15 In summary, the use of emission factors based on the HF content of battery systems remains the most defensible approach for dispersion modelling. As the volume of available test reports grows the design of BESS is changing to meet the requirements of fire safety tests, resulting in increased use of smaller fireproof cabinets to restrict fires to smaller number of battery modules than was the case ten years ago. The approach taken in this assessment will be to assume that a 2kg of HF content per cabinet fire remains a reasonable central estimate, with a 50% higher and lower sensitivity test scenario. However, in recognition that these estimates are becoming increasing conservative as technology develops, a low HF content scenario of 0.5Kg of HF has also been included.

2.1.16 At the detailed design stage, further modelling can be done to consider the thermal risk from the fire, based on an understanding of combustible materials released in a fire for the selected make and model of equipment and such modelling can also include a plume assessment to confirm that the density of smoke or pollutant concentrations remain in keeping with fire and rescue service expectations.

2.2 Assessment Criteria

2.2.1 The UK Health Security Agency (UKHSA) (formerly Public Health England (PHE)) publish Incident Management guidance for specific air pollutants including HF (Ref 14). These documents summarise the physical and chemical properties of the substance and the hazard they pose to human health. Internationally recognised best practice emergency response guidelines are reported by UKHSA.

2.2.2 Emergency response planning guideline (ERPG) values, that start at ERPG-1 and increase in concentration to ERPG-3. The ERPG-1 criteria define "*the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects*".

2.2.3 Acute exposure guideline level (AEGL) values start at AEGL-1 and increase in severity of health outcome to AEGL-3. The AEGL-1 criteria define the *"level of the chemical in air or above which the general population could experience notable discomfort".*

2.2.4 The values adopted as being most protective of receptors (or the most conservative in terms of likely impacts on receptors) surrounding the Proposed Development are listed in **Table 1**. Concentrations of 1ppm and 2ppm of HF gas are equivalent to 0.82 milligrams per cubic meter (mg/m^3) and 1.64mg/m^3 respectively. The time periods used for ERPG and AEGL are based on different considerations, but for the purposes of this assessment they represent a maximum concentration value in a 10-minute period. These concentration values are also valid at an averaging time of 1 hour, which is the resolution of the meteorological data used in this assessment.

Table 1. Summary of Emergency Response Criteria

Substance	EPRG-1 Value (ppm)	Time period for EPRG	AEGL-1 (ppm)	Time Period AEGL
HF	2	10 minutes & up to 1 hour	1	10 minutes & up to 8 hours

3. Dispersion and Dilution

3.1 Introduction

3.1.1 Any gaseous pollutants emitted from a fire at a BESS would be transported from the BESS towards receptor locations by the air movements occurring at the time of the emission to air. These movements are determined by the direction of the wind and the amount of turbulent mixing of the air as it blows towards the receptor location. Differences in the temperature of the plume of air containing the emission and the surrounding air can also affect the vertical movement of the pollutants. To help understand the minimum rates of dilution likely to occur to pollutant concentrations as they disperse from the source of the emission to receptor locations, the dispersion has been modelled.

3.1.2 The calculations have made use of the dispersion model ADMS (version 6.0.0.1). As a definitive emission rate will not be known until later in the detailed design stage (once battery technology and the number of modules, racks and enclosures is fixed), the dispersion model has not been used to predict absolute impacts at specific receptor locations. Instead, a nominal unit emission rate has been used to calculate concentrations close to the source and at fixed nodes that are at 50m increments downwind, for all wind directions in 10-degree segments. The relative concentration at the nodes is expressed as the amount of dilution compared to the near source concentration. This is then displayed as a colour scale on a polar plot overlaid onto base mapping.

3.1.3 The dispersion modelling has been undertaken using 5 years of hourly sequential meteorological data to represent approx. 43,800 sets of meteorological conditions that have been observed at a representative meteorological station. The values reported represent the minimum amount of dilution (maximum concentration at the receptor) predicted in any 1-hour period (100th percentile). In addition, the 99th percentile (upper 1% of cases) and 90th percentile (upper 10% of cases) values have also been calculated to provide context to the likelihood of each outcome. If the magnitude of the maximum (100th percentile) concentration was very similar to the 99th or 90th percentile value, then the likelihood of those meteorological conditions being present at the time of the fire is high. If the 100th percentile concentration value is much larger in magnitude than the 99th or 90th percentile values, then the predicted concentration would only occur under meteorological conditions that are very unusual and that may only occur for a small number of hours per year.

3.2 Emission Parameters

3.2.1 As the exact emissions from the BESS cannot be meaningfully estimated at present, the modelling is based on emissions that have been modelled as a volume source, at a nominal emission rate of 1µg/m^3/s. This approach establishes the pattern of dispersion and dilution, that can be scaled up to consider any other emission rate value.

3.2.2 A number of simplifications have been made to the model to ensure the assessment approach is precautionary and provides an upper estimate of likely outcomes. Near source temperatures in excess of 300°C can be reasonably expected to be present, which would result in the plume rising rapidly, reducing near-ground concentrations. However, this model has assumed a volume source with no initial vertical momentum and the temperature has been modelled as if it was emitted at ambient air temperature. These two assumptions represent a very conservative approach in terms of dispersion modelling as they remove the vertical momentum of the emission and consequently the predicted near ground level concentrations from the model are considerably higher than would be experienced under real world conditions, as the plume has been modelled without that initial vertical momentum caused by the fire.

3.2.3 The emission parameters modelled are summarised in **Table 2**, and they are discussed in the following sections.

Table 2. Emission Parameters and General Model Conditions Included with the Model

Variable	Input
Surface Roughness at source	0.3m
Receptors	Polar grid centred at location of source. Nodes at 50m intervals, segments at 10 degrees intervals.
Emissions	Indicative scenario at unit emission rate
Sources	A single volume source 2m (length) by 2m (width)
Volume Source Vertical height	2m, located between 1m and 3m above ground
Emission Temperature	Ambient (15°C)
Exit Velocity	None
Emission Rate	1μg/m^3/s
Source Location	Indicative location
Meteorological data	5 years of hourly sequential data from Waddington meteorological station (2020 – 2024)

3.3 Modelling Domain

3.3.1 The model outputs are at nodes on a polar coordinate grid extending 1.5km from the source (i.e., 1.5km radius circle) with grid nodes at 50m intervals along each of the 36 segments (one every 10 degrees).

3.4 Meteorology

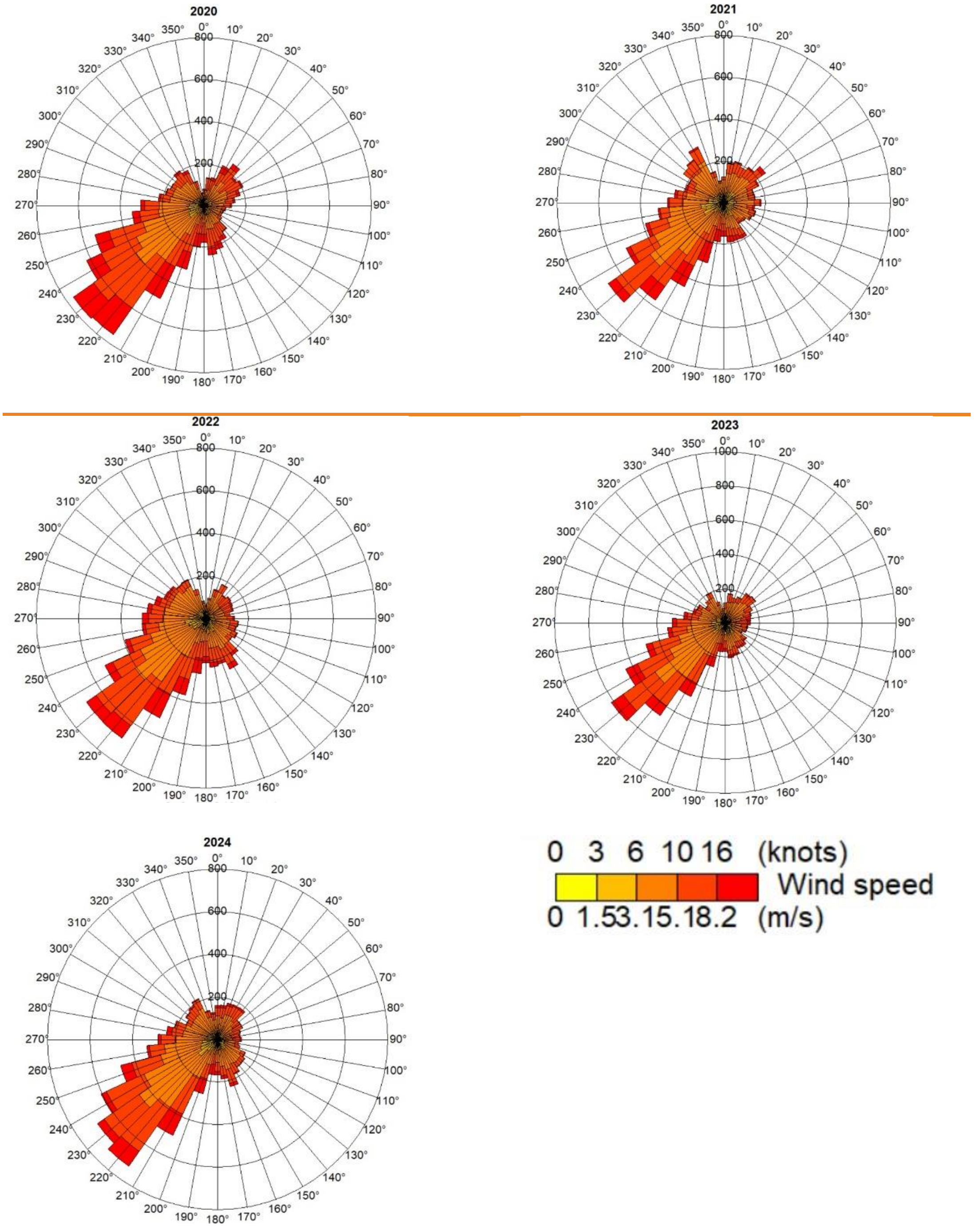
3.4.1 The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by buildings and local terrain.

3.4.2 Actual observed hourly sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the DCO site that is modelled. This is usually achieved by selecting a meteorological station as close to the DCO site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data. For point sources, such as stacks, the Environment Agency recommends the use of five years of the recent available meteorological data be used in modelling assessments to ensure that all typical weather conditions are considered within the modelling.

3.4.3 The meteorological site used in the modelling was RAF Waddington for the years 2020 - 2024. The meteorological conditions at the airport are considered representative of those experienced at the Proposed Development.

3.4.4 The wind-roses for Waddington meteorological data are shown in **Figure 1**.

Figure 1. Wind-roses for Waddington



3.5 Building and Terrain Effects

3.5.1 Another variable that can have a significant effect on the dispersion of emissions from sources is the presence of buildings or structures near to the emissions points. The wind field can become entrained into the wake of buildings, which causes the wind to be directed to ground level more rapidly than in the absence of a building. If an emission is entrained into this deviated wind field, this can give rise to elevated near-field ground-level concentrations. Building effects are typically considered where a structure of height greater than 40% of the release height, is situated within a distance that is less than 10 times the release height of the emissions source. Neighbouring enclosures could potentially fit these criteria. To assess dispersion of emissions in a conservative manner, the potential influence of buildings has not been considered in the assessment, along with the use of a ground level volume source with air at ambient temperature and no initial vertical momentum.

3.5.2 The ADMS model is capable of including topographical data, if required. There are two parameters (surface roughness and terrain) which can be employed in the model to describe local topography.

3.5.3 Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

3.5.4 The Proposed Development is situated on a plain adjacent mostly to agricultural land and surrounded by a few towns and villages. A surface roughness of 0.3m, corresponding to agricultural areas has been selected to represent the local terrain.

3.5.5 Site-specific terrain data has not been used in the model, as typically terrain data will only have a marked effect on predicted concentrations where hills with a gradient of more than 1 in 10 are present in the vicinity of the source, which is not the case at this site.

3.6 Results of dilution modelling

3.6.1 The conventional output from a consequence model would be a plot illustrating a series of rings denoting a maximum possible concentration at a stated distance from the source. The output from the dilution modelling is similar, with the plots showing rings of nodes at 50m increments from the source, with the dilution factor illustrated using a colour scale. The reported dilution factors are relative to the concentration at a location 10m out from the centre of the source **Table 3** illustrates the smallest rate of dilution likely to be experienced under any meteorological conditions (the 100th percentile), **Table 3** also illustrates a dilution rate that would be achieved under 99% (8,672 out of 8,760hrs per year) of meteorological conditions and a dilution rate that would be achieved under 90% (7,884 out of 8,760 hours per year) of meteorological conditions. In real world terms, these represent the lowest level of dilution and the longest distances to achieve that level for the stated percentage of the year.

3.6.2 Results indicate that source concentrations would be diluted to 1/1,000th of the source concentration (a dilution factor of 0.001) within 1,050m under any meteorological conditions (the 100th percentile) likely to occur at the application site. The same level of dilution is likely to occur under 99% of meteorological conditions within 450m to the east of the source.

3.6.3 Source concentrations would be diluted to 1/1,000th of the source concentration (a dilution factor of 0.001) under 90% of the meteorological conditions likely to occur at the application site (see **Table 3**), within 150m or less for all wind directions excluding north east of the BESS which would see the same level of dilution within 200m.

3.6.4 For any emission rate at the source, the use of the minimum (100th percentile) dilution rate gives an estimate of dilution rates that is approximately seven times more precautionary that the use of the 90% value. As such, it represents an extreme combination of meteorological conditions that are unlikely to occur should there be a fire incident.

Table 3. Dilution with distance from source

Distance from Source	Dilution factor of 0.001 for 100% of meteorological conditions	Dilution factor of 0.001 for 99% of meteorological conditions	Dilution factor of 0.001 for 90% of meteorological conditions
0° N	1,050m	350m	150m
50° NE	1,000m	400m	200m
90° E	1,050m	450m	150m
130° SE	1,050m	350m	150m
180° S	1,050m	300m	150m
230° SW	1,050m	400m	150m
270° W	1,050m	400m	150m
310° NW	1,050m	400m	100m

*based on 2021 meteorological data as highest impact in the period 2020 – 2024.

4. Likely Consequences of Battery Emissions

4.1.1 At present the specific details of the modules and numbers of racks of BESS have still to be confirmed for the Proposed Development, but the Proposed Development is rated as 480MWh (0.48GWh). Based on information from **Section 2** of this Appendix, indicative scenarios to represent the potential emissions of HF are summarised in **Table 4**.

4.1.2 The central estimate of HF content that could be emitted has been taken as 2kg. A lower estimate based on 50% of the central estimate and an upper estimate of 150% of the central estimate are included in **Table 4** to reflect uncertainty about the SOC of the cells at the time of any future fire incident. An additional low HF content scenario based on a HF content of 0.5Kg is included in recognition of the increasing conservative nature of the main scenario.

4.1.3 The HF has been assumed to be released at a steady rate during a fire and a time period based on the FPRF BESS fire test of 3 hours has been adopted as the shorter time period. A longer 6-hour fire period has been adopted as a lower emission rate condition.

Table 4. Indicative Emission Rates

Scenario	HF content	Duration of Fire	Concentration in 2m x 2m x 2m volume at source	Dilution factor to achieve AEGL-1 value of 0.82mg/m^3	Indicative distance to achieve AEGL-1 value for 100% of met conditions (m)
Low HF shorter fire	0.5kg	3hrs	6mg/m^3	0.136	50 - 100m
Low HF longer fire	0.5kg	6hrs	3mg/m^3	0.273	50m
Lower HF shorter fire	1kg	3hrs	12mg/m^3	0.068	50 - 100m
Lower HF longer fire	1kg	6hrs	6mg/m^3	0.136	50 - 100m

Central HF shorter fire	2kg	3hrs	24mg/m^3	0.034	100 - 150m
Central HF longer fire	2kg	6hrs	12mg/m^3	0.068	50 - 100m
Upper HF shorter fire	3kg	3hrs	36mg/m^3	0.023	150 - 200m
Upper HF longer fire	3kg	6hrs	18mg/m^3	0.046	100 - 150m

4.1.4 Assuming a scenario that takes the form of a single cabinet fire, emissions of HF could cause impacts that are below the AEGL-1 value in magnitude, over time periods of 10 minutes, 1 hour or up to 6 hours, at all locations further than 200m from the fire. Under most scenarios considered which have a smaller HF content in the cells within a single cabinet, the distance required to achieve the AEGL-1 value decreases to 100m or to 50m. Given that containers will be sited a minimum of 150m from residential receptors, concentrations will be below AEGL-1 at any existing residential receptor location. Any workers on agricultural land within 250 m of the fire would be able to move back to a safer distance.

4.1.5 Given the specification reached in detailed design will be required (by a requirement to the DCO) to be consistent with the parameters assumed in this study (i.e., 1kg to 3kg of HF from a single cabinet fire) then the potential consequence exposure to HF at actual receptor locations surrounding the BESS would be below the AEGL-1 value.

4.1.6 The design of the BESS includes a number of design elements to prevent, detect and control the spread of a fire should one occur, these are described in the FBSMP. The introduction of design standards and the availability of standard fire performance testing for individual battery modules, cabinets and entire installations (containers) means that BESS system can now be purchased that are designed to contain a fire within a single module or within a single cabinet, without the fire spreading. The real world performance of equipment during a fire can now be demonstrated through testing against a BESS fire test standards, such as the widely adopted UL 9540A method. . Controlling the likely magnitude of a fire event is the most effective means of minimising the area that could potentially be effected should a fire occur,. .

4.1.7 In the unlikely event that a fire was to break out in a single module, it is very unlikely, given the control measures, that the fire would spread to the rest of the modules in a cabinet, or from a single cabinet to a larger BESS container. Even if all the systems should fail, and a large-scale fire break out within a cabinet, then the resultant hydrogen fluoride concentration at the closest receptors would be below the level that UKHSA has identified as resulting in notable discomfort to members of the general population.

4.1.8 The expected HF emissions will be checked against the assumptions in this report at detailed design stage once the make, model and layout of the BESS is known and confirmed. The FBSMP includes a commitment at **Section 5.1.5** to undertake a unplanned emissions assessment using consequence modelling methods to demonstrate that the impacts associated with an unplanned fire would not exceed the effects outlined in this report or cause any significance adverse health effects to the local community. The primary purpose of the plume assessment is to inform emergency services of the risks that may be present at the site, so that the fire service can more quickly plan their approach to managing a fire event under the weather conditions present at the time. The Plume assessment completed at detailed design stage should be approved by the fire authority. This will be secured by the **Framework Construction Environmental Management Plan [EN010154/APP/7.7]**.

5. References

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