AtkinsRéalis

## Air Quality Assessment

UKBIC

July 2025

100110436

# UK BATTERY INDUSTRIALISATION CENTRE – ENVIRONMENTAL PERMIT VARIATION

# Notice

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# Non-technical summary

This report presents the air quality assessment for the environmental permit variation application for the UK Battery Industrialisation Centre (UKBIC) facility in Coventry. The facility uses the solvent N-Methyl-2-Pyrrolidone (NMP) and water in its existing production process and is equipped with mitigation systems to minimise its release into the atmosphere. NMP is a harmful substance and can affect human health if inhaled therefore emission limits are set in the environmental permit.

The currently permitted emission source at the facility is associated with the existing Volume Industrialisation Line (VIL). A new line, the Flexible Industrialisation Line (FIL), is proposed, which will enable the use of alternative solvents. The process air would be abated using a regenerative thermal oxidiser (RTO) prior to being exhausted via a stack. As the FIL will emit NMP and other pollutants, a variation to the existing environmental permit is required. This report presents an assessment of the combined impact of emissions from the existing VIL and the proposed FIL on local air quality.

Emissions of NMP from the existing carbon bed condenser (VIL), along with emissions of NMP, nitrogen dioxide ($NO_2$), carbon monoxide (CO), and volatile organic compounds (VOCs) from the new RTO (FIL), have been modelled using a recognised methodology, in line with Environment Agency guidance for environmental permitting. Emissions were modelled for the years 2020 to 2024 using a conservative approach to inform the impact assessment.

The dispersion modelling has shown that, for all pollutants, both short-term and long-term concentrations were substantially below (by two to five orders of magnitude) the relevant air quality criteria and the European Chemicals Agency (ECHA) derived no-effect level for general population exposure to NMP. Therefore, the emissions associated with the new FIL, in combination with the existing VIL, are likely to have a negligible impact on human health in the local area.

# 1. Introduction

The battery production process at the UK Battery Industrialisation Centre (UKBIC) in Coventry involves the coating of metal surfaces, with subsequent solvent emissions, which is a regulated process under the Environmental Permitting (England and Wales) Regulations 2016[1] (as amended). It operates under an environmental permit issued by Warwick District Council (WDC) as a Part B process under the Local Authority Pollution Prevention and Control (LAPPC) regime.

The existing Volume Industrialisation Line (VIL) at Coventry uses the solvent n-methyl-2-pyrrolidone (NMP) and water. The primary emission point on the existing VIL, is the cathode line. Emissions are treated by means of an abatement system comprising a carbon bed condenser and a carbon filter (emission point A1) to reduce atmospheric releases of NMP. NMP is a controlled substance, limited due to harm to human health from inhalation.

This variation application seeks to amend the current environmental permit (dated July 2020) to include a new processing line at the facility: the Flexible Industrialisation Line (FIL), currently under consideration. The FIL would enable the use of alternative solvents with the process air abated using a regenerative thermal oxidiser (RTO) prior to exhaust of residual emissions via a stack (emission point A2). As part of the variation application, a detailed dispersion modelling exercise has been undertaken to assess the impact on local air quality of additional process emissions (NMP and volatile organic compounds (VOCs)) and combustion emissions from the RTO (nitrogen dioxide ($NO_2$), carbon monoxide (CO)), alongside NMP emissions from the carbon bed condenser on the existing line.

This air quality assessment has been carried out in line with the Air Emissions Risk Assessment for your Environmental Permit[2] guidance, Environmental Permitting: Air Dispersion Modelling Reports[3] guidance and in accordance with accepted good practice for atmospheric dispersion modelling.

This report provides:

- a review of background concentrations and the local area sensitivities and constraints;
- a summary of model input data including the flow rates and emission rates;
- a dispersion modelling study using meteorological data for five individual years of data;
- an assessment of pollutant concentrations for human health receptors;
- a tabulated summary of results showing the maximum results at receptors;
- a graphical presentation of the results as concentration isopleths overlaid on a base map;
- a comparison of estimated concentrations against air quality criteria; and
- conclusions regarding the significance and effect of emissions.

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[1] The Environmental Permitting (England and Wales) Regulations 2016, UK Statutory Instrument 2016 No. 1154. Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents

[2] Defra (2025) 'Air emissions risk assessment for your environmental permit'. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[3] Defra (2024) 'Environmental permitting: air dispersion modelling reports'. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

# 2. Baseline conditions

## 2.1 Site setting

The UKBIC Coventry facility is located within the WDC administrative area. It is accessed via Rowley Road from the junction with the A45 trunk road to the north. Industrial and commercial buildings are located to the east of the facility, Coventry Airport is situated to the south, and the village of Baginton is located to the west.

The closest Air Quality Management Area (AQMA)[4] to the UKBIC installation boundary  is located approximately 260 metres away, within the Coventry City Council (CCC) administrative area. This AQMA was declared for the entire administrative area due to exceedances of the annual mean $NO_2$ objective.

The site location and nearby AQMA is shown in Figure 3-2.

## 2.2 Monitoring data

Ambient concentrations of the pollutants relevant to this study have been included in the assessment, in accordance with modelling guidance[3]. Data has been sourced from the Department for Environment, Food and Rural Affairs (Defra) national monitoring networks[5] and local air quality monitoring networks.

Information from relevant sites for the pollutants of interest to the study is summarised below.

### 2.2.1 N-Methyl-2-pyrrolidone

There is no established atmospheric background concentration for NMP in the UK, as there are no regulatory standards in ambient air and it is not routinely monitored by national air quality networks. NMP is primarily considered an industrial solvent and is more commonly assessed in occupational settings rather than in general environmental air. Sources of NMP in the atmosphere, if present, would likely be localised to specific industrial facilities using it in manufacturing, coatings, or cleaning processes. A review of the Environment Agency’s Pollution Inventory[6], shows there are no permitted Part A(1) processes in the vicinity that emit NMP as part of their activities.

### 2.2.2 Nitrogen dioxide

The closest monitoring site to the UKBIC facility that represents a relevant background location and measures $NO_2$ is the Coventry Allesley (UKA00592) Continuous Monitoring Station (CMS) which is part of the UK Automatic Urban and Rural Network (AURN)[5]. As this urban background site is located

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[4] Defra AQMA interactive map Available at: https://uk-air.defra.gov.uk/aqma/

[5] Defra Interactive monitoring networks map. Available at: https://uk-air.defra.gov.uk/interactive-map

[6] Environment Agency (2025). Pollution Inventory. Available at: https://www.data.gov.uk/dataset/cfd94301-a2f2-48a2-9915-e477ca6d8b7e/pollution-inventory

approximately 6.5 kilometres to the north west of the UKBIC site, it is likely representative of the suburban locations and receptors in the study area.

The annual mean $NO_2$ concentrations measured between 2020 and 2024 at the Coventry Allesley monitoring site are set out in Table 2-1.

**Table 2-1 - Annual Mean $NO_2$ Concentrations (µg/$m^3$) at Coventry Allesley, 2020-2024**

| Site ID | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|
| Coventry Allesley | 15.0* | 16.0* | 15.0 | 13.0 | 12.0 |

* Concentrations may have been affected by Covid-19 lockdowns.

The annual mean $NO_2$ concentrations in Table 2-1 show little variance between 2020 and 2024, ranging between 12 and 16 µg/$m^3$. Overall, there appears to be a slight decreasing trend with the latest concentrations less than a third of the annual mean objective of 40 µg/$m^3$.

As shown by the latest monitoring data provided by CCC, there are several diffusion tube monitoring locations within two kilometres of the facility (STM1, GL1, STM2, STL1, and LON8). The annual mean $NO_2$ concentrations at these locations in 2023 ranged from 13.3 to 26.8 µg/$m^3$. As these are roadside monitoring sites in a neighbouring authority, they can be considered representative of receptors in proximity to the UKBIC facility that are near the roadside.

## 2.2.3 Carbon monoxide

There is no relevant monitoring station in the vicinity of the facility which routinely measures concentrations of CO.

## 2.2.4 VOCs

Information on the speciation of VOCs emitted from the RTO suggests that there may be residual amounts of NMP, ethanol, methanol, isopropyl alcohol, propyl acetate, acetone, and benzyl alcohol in the exhaust. In line with Environment Agency permitting guidance, it is conservatively assumed that all VOCs are emitted as benzene, which has a very stringent Air Quality Strategy (AQS) objective[7] of 5 µg/$m^3$.

The closest monitoring site to the UKBIC facility that measures benzene is the Leamington Spa CMS (urban background location), which is part of the UK AURN[5]. This site is approximately 9.5 kilometres to the south of the UKBIC site, so is likely to be representative of suburban locations and receptors near the UKBIC facility. No other CMS in the vicinity of the UKBIC facility currently monitors benzene.

The Leamington Spa CMS had an annual mean benzene concentration (calculated using period mean values) of 0.45 µg/$m^3$ in 2024. This annual mean concentration is an order of magnitude below the benzene annual mean criterion.

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[7] Defra (2011). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Available at; https://assets.publishing.service.gov.uk/media/5a758459ed915d731495a940/pb12654-air-quality-strategy-vol1-070712.pdf

## 2.3 Mapped background data

Mapped background concentrations of the pollutants relevant to this study have been reviewed as part of this assessment, in accordance with Environment Agency modelling guidance[3]. Data have been sourced from the Defra local air quality management (LAQM) background maps, and modelled background pollution datasets. The background maps, which are a combination of measured and modelled data, provide estimates for each one-kilometre grid square across the UK. As discussed in section 2.2.1, there is no established atmospheric background concentration for NMP in the UK and these are not included in Defra's maps.

Estimates of background $NO_2$ concentrations in the UK are available from the Defra website. for a base year of 2021[8]. Estimates of background pollutant concentrations for CO are available for a base year of 2001[9] (no longer updated by Defra due to very low concentrations nationwide and thus are considered to be conservative). Modelled background pollutant concentrations of benzene are available up to 2023[10].

The mapped Defra background annual mean concentrations across the study area for $NO_2$ for 2025, CO for 2021 and benzene for 2023 are presented in Table 2-2.

**Table 2-2 - Defra Mapped Annual Mean Pollutant Concentrations**

| Grid Square x, y | $NO_2$ (µg/m$^3$) | CO (mg/m$^3$) | Benzene (µg/m$^3$) |
|---|---|---|---|
| 435500, 275500* | 10.6 | 0.39 | 0.34 |
| 435500, 276500 | 10.5 | 0.43 | 0.39 |
| 436500, 275500 | 10.9 | 0.38 | 0.36 |
| 434500, 273500 | 7.8 | 0.35 | 0.29 |
| 434500, 274500 | 9.0 | 0.37 | 0.32 |
| 434500, 275500 | 10.8 | 0.39 | 0.34 |
| 433500, 275500 | 10.9 | 0.39 | 0.36 |
| 434500, 276500 | 13.7 | 0.43 | 0.43 |
| 435500, 274500 | 8.6 | 0.37 | 0.31 |

*Grid square where the centre of the UKBIC facility is located.

The highest modelled background 2025 $NO_2$ annual mean grid square concentration across the UKBIC study area was 13.7 µg/m$^3$. This is well below the $NO_2$ annual mean AQS objective of 40 µg/m$^3$.

The highest modelled background CO annual mean grid square concentration across the study area was 0.43 mg/m$^3$ in 2001. Although the AQS does not specify an annual mean objective for CO, this

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[8] Defra background maps (2025). Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2021

[9] Defra (2001). 2001-based background maps for $SO_2$, CO, benzene and 1,3-butadiene. Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2001

[10] Defra (2023). Benzene Annual Mean Modelled Background 2023. UK Air Quality Compliance Data Hub. Available at: https://compliance-data.defra.gov.uk/datasets/605c8e3d4f944649ad8441fd098831ea_0/about

concentration is several orders of magnitude below the 8-hour mean objective of 10 mg/m$^3$ (10,000 µg/m$^3$).

The highest modelled background benzene annual mean grid square concentration across the study area was 0.43 µg/m$^3$ in 2023. This is well below the benzene annual mean AQS objective of 5 µg/m$^3$.

## 2.4 Sensitive receptors

### 2.4.1 Human health receptors

The nearest residential properties to the UKBIC facility are in Baginton Village, approximately 335 metres to the west of the main building, along Rowley Road and Coventry Road.  Baginton Fields School and additional residential properties are located approximately 1.1 kilometres to the north-east, along Sedgemoor Road and the B4110. Additionally, two schools and residential properties are situated in Whitley, approximately 1.3 kilometres to the north, and further residential properties are located approximately 1.3 kilometres to the north-west in Finham, along Leaf Lane.

The nearby receptors that represent locations that are potentially sensitive to emissions in terms of human health effects were included as discrete receptors in the dispersion model and are discussed further in section 3.1.3.

Members of the public do not have access to the grounds of UKBIC or of the surrounding commercial and industrial facilities therefore such locations are not included in the assessment. UKBIC workers are not considered to be members of the public for the purposes of the air quality assessment and are covered by separate, health and safety at work provisions. In any event, UKBIC employees would not spend the relevant amount of time outdoors at the industrial facility, such as in the car park. For this reason, locations within these facility boundaries were not included in the air quality assessment.

# 3. Methodology

## 3.1 Atmospheric dispersion modelling

### 3.1.1 Modelling software

The atmospheric dispersion modelling was undertaken using the latest version of the US EPA model AERMOD (24142), as incorporated by Trinity Consultants Inc. in the software BREEZE AERMOD. This model is the result of many years development by the US EPA and the American Meteorological Society. It has been developed as a regulatory model that incorporates the current understanding of atmospheric physical processes. This model is used by regulatory agencies, consultants and industry worldwide to assess the impact of air emissions from point, area, line, flare and volume sources.

AERMOD simulates essential atmospheric physical processes and provides refined concentration estimates over a wide range of meteorological conditions and modelling scenarios. The dispersion modelling system includes:

- an advanced meteorological pre-processor to compute site-specific planetary boundary layer parameters;
- highly developed dispersion formulations that incorporate current planetary boundary layer understanding and variables for both convective and stable boundary inversions;
- enhanced treatment of plume rise and plume penetration for elevated inversions, allowing for effects of strong updrafts and downdrafts that occur in unstable conditions;
- improved computation of vertical profiles of wind, turbulence and temperature; and
- a “dividing streamline” approach for computations in complex terrain.

AERMOD includes two data pre-processors for streamlining data input: AERMET, a meteorological pre-processor, and AERMAP, a terrain pre-processor. The model can address both local topography and building downwash effects concurrently, where relevant to the study. The model provides reasonable estimates over a wide range of meteorological conditions and modelling scenarios. The building downwash algorithms in AERMOD PRIME, using parameters calculated by the Building Parameter Input Program (BPIP), distinguish this model from earlier versions of AERMOD, which used a simpler procedure to address downwash.

### 3.1.2 Meteorological data

The most appropriate meteorological station with adequate records in the format required for the dispersion modelling study is the Church Lawford meteorological station. This station is located approximately 10.8 kilometres to the east of the UKBIC facility. Hourly sequential meteorological data for the five year period 2020 to 2024 (covering the most recent five years of available data) were used in the dispersion model. The general topography of the area is such that records from Church Lawford are suitably representative of conditions in Coventry and at the UKBIC site. Furthermore, the meteorological station and the facility are at comparable elevations above sea level.

Each meteorological data file contains over 43,000 hourly records and, in accordance with best practice, is considered adequate to characterise local meteorology in terms of both extreme events and long-term average conditions.

In accordance with the US EPA guidance, the near-field land use within a one kilometre radius of the site was evaluated to determine the surface roughness length[11]. Land uses were specified by directional sector. A determination of the percentages of each type of land use was made based on inspection of Ordnance Survey mapping and aerial photography. The Bowen ratio[12] and albedo[13] were determined by the land use categories within the far-field, represented by a 10 x 10 km square centred on the site. A determination of the percentages of each type of land use was made based on inspection of Ordnance Survey mapping and aerial photography. The land use proportions are simply averaged over the area and are independent of distance or direction from the site: cultivated land 46%, urban 49% and deciduous forest 5%.

Land use categories and sectors were entered in the AERMET software programme to generate site surface characteristics for use in the model. The model parameters (AERMOD recommended values and alternative values where appropriate) used to represent the area around the site are shown in Table 3-1.

**Table 3-1 - Site surface characteristics**

| Sector | Degrees | Albedo | Bowen Ratio | Surface Roughness, m |
|---|---|---|---|---|
| Urban | 0 - 200 | 0.241225 | 1.185 | *0.5 |
| Cultivated land | 200 - 240 | 0.241225 | 1.185 | ^0.3 |
| Urban | 240 - 360 | 0.241225 | 1.185 | 1.0 |

*The default urban surface roughness value was adjusted and lowered to 0.5 metres to account for the mixture of localised land uses, which include industrial facilities, Coventry Airport, and suburban housing.

^The default surface roughness value for cultivated land was adjusted up to 0.3 metres to represent the mix of predominately agricultural land but interspersed with wooded areas and buildings.

The processed meteorological data were used to generate five individual annual meteorological data files for use in this assessment. Frequency distribution of wind speed and direction for each year is presented in Figure 3-1. It is evident from the figures that there is a primary prevailing wind from the south west and adjoining sectors; there is a secondary prevailing wind from the north east.

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[11] Surface roughness length is a measure of the height of obstacles to wind flow. It is not equal to the physical dimensions of obstacles but is generally proportional to them.

[12] The Bowen ratio is a measure of the amount of moisture at the earth's surface. This influences other parameters which in turn affect atmospheric turbulence.

[13] Noon-time albedo is the fraction of incoming solar radiation reflected from the ground when the sun is directly overhead. Adjustments are made in AERMET to incorporate the variation in the albedo with solar elevation angle.

**Figure 3-1 - Church Lawford Wind Roses, 2020-2024**

### 3.1.3 Modelled receptors

Pollutant concentrations were modelled using nested Cartesian receptor grids covering the local area. A 100 metre resolution grid over an area 4 by 4 kilometres centred on the facility was used in combination with a smaller, localised 800 metre wide grid set at 20 metre resolution. The higher resolution grid improves the spatial resolution of the model results in those areas subject to the highest concentration gradients close to the site boundary.

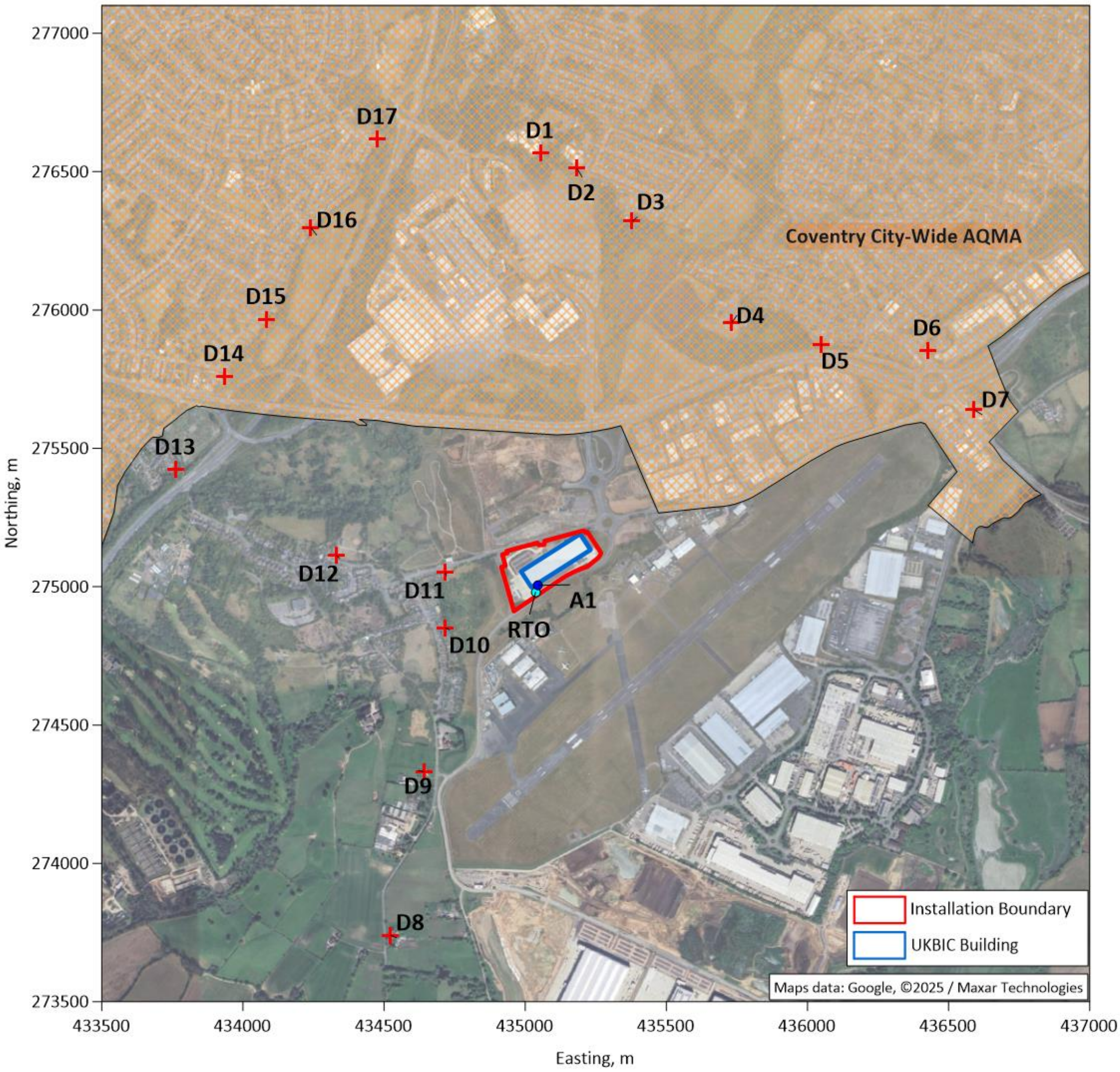
Receptors representing locations that are potentially sensitive to emissions in terms of human health were included as discrete receptors in the model. These are listed in Table 3-2 and illustrated in Figure 3-2.

All grid and discrete receptors were specified at a height of 1.5 metres above local ground elevation to represent the breathing zone.

**Table 3-2 - Selected local human health receptors**

| ID | Address | Eastings, m | Northings, m |
|---|---|---|---|
| D1 | Meadow Park School, Abbey Road | 435054 | 276566 |
| D2 | Tiverton School, Ashington Grove | 435184 | 276512 |
| D3 | Hill Fray Drive | 435379 | 276321 |
| D4 | Baginton Fields School, Shetland Road | 435732 | 275955 |
| D5 | Selsey Close | 436048 | 275877 |
| D6 | Montgomery Close | 436426 | 275852 |
| D7 | London Road, Stonehouse Estate | 436591 | 275639 |
| D8 | Baginton, Warwick | 434523 | 273740 |
| D9 | Stoneleigh Road | 434642 | 274331 |
| D10 | Andrews Close | 434717 | 274851 |
| D11 | Rowley Road | 434718 | 275052 |
| D12 | Coventry Road | 434330 | 275113 |
| D13 | Mylgrove | 433761 | 275422 |
| D14 | Fenside Avenue | 433934 | 275760 |
| D15 | Gregory Hood Road | 434084 | 275966 |
| D16 | Leaf Lane | 434240 | 276298 |
| D17 | Leaf Lane | 434477 | 276616 |

**Figure 3-2 – Site location, local human health receptors and nearby AQMA**



## 3.1.4 Building downwash

Buildings close to point source plume discharges that are more than 40% of the stack height may potentially cause downwash effects. The BPIP programme within AERMOD was used to calculate for each wind sector the direction specific building downwash parameters for each stack. The BPIP programme determines which structures are significant for each of the 360-degree wind directions and modifies the AERMOD input files with the appropriate parameters.

The main structure included in the dispersion model is shown as a schematic in Figure 3-3, viewed from the south. The detailed dimensions for the modelled building are provided in Table 3-3.

**Figure 3-3 - Schematic of modelled structure and stacks**

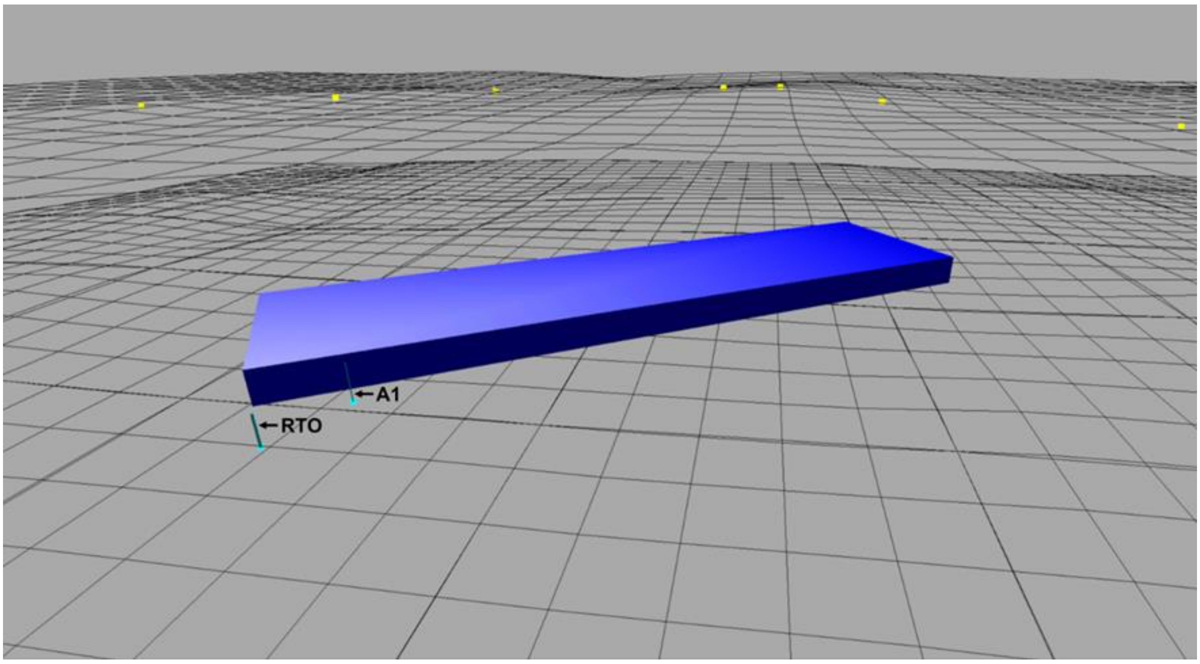


**Table 3-3 -Building input data^**

| Name | Height, m | X Length, m | Y Length, m |
|---|---|---|---|
| UKBIC main building | 10.8 | 247.7 | 66.3 |

^ Sourced from: PHP-DR-0105-PDF, see Figure A-1 and Figure A-2 in Appendix A.

## 3.1.5 Terrain

Terrain elevations (above Ordnance Datum (aOD)) for all off-site receptor points (grids and discrete receptors) and structures were included in the dispersion model, as derived from Ordnance Survey[14] digital terrain data files (in “DEM” format).

## 3.1.6 Model scenario

Dispersion modelling of NMP emissions from the existing operation (VIL, emission point A1 abated by carbon bed condenser), combined with emissions of NMP, $NO_2$, CO, and VOCs from the new line operation (FIL, A2, abated by RTO), has been carried out using parameters that represent typical operating conditions and emissions.

The current maximum operational regime for the VIL is 20 hours per day over a four-day working week, 48 weeks each year. The maximum proposed operational regime for the FIL is 14 hours per week over a four-day working week, at a maximum of nine hours a day. To provide a conservative assessment, the modelled scenario assumes continuous operation of both emission sources in combination, 24 hours a day, seven days a week throughout the year.

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[14] Ordnance Survey (OS). OS Terrain 50 – Free Digital Terrain Model (DTM). Available at: https://osdatahub.os.uk/Downloads/Open/Terrain50

## 3.2 Assessment criteria

The model results have been compared to relevant air quality criteria, including EU Directive limit values, national AQS objectives and/or environmental assessment levels (EALs) used in permitting as set out in the Environment Agency's online guidance for air emissions risk assessment[2].

The short-term and long-term air quality criteria for the pollutants of concern in this assessment are presented in Table 3-4.

**Table 3-4 - Air quality assessment criteria (µg/m$^3$)**

| Pollutant | Short-term | Long-term |
|---|---|---|
| Nitrogen dioxide | 200* (1h) | 40 (1y) |
| Carbon monoxide | 30,000 (1h)<br>10,000 (8h) | n/a |
| VOCs (assessed as benzene) | 30 (24h) | 5 (1y) |

*Not to be exceeded more than 18 times a year.

There is no defined national air quality standard for NMP in the UK and no EAL in permitting guidance[2]. In line with the guidance on air dispersion modelling[3], as the substance has no air emission environmental standard, the CAS registry number for NMP is provided in Table 3-5.

An appropriate assessment threshold for NMP has been adopted from the European Chemicals Agency (ECHA) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)[15] guidance. Two Derived No-Effect Levels (DNELs) for inhalation exposure to NMP are provided in the REACH guidance, provided in Table 3-5. The lower of the two values has been used as an EAL in this assessment to assess off-site human health impacts.

**Table 3-5 - Air quality assessment criterion for NMP**

| Pollutant | CAS | DNEL | EAL |
|---|---|---|---|
| N-Methyl-2-pyrrolidone | 872-50-4 | Workers: 14.4 mg/m$^3$<br>General population: 3.6 mg/m$^3$ | 3.6 mg/m$^3$<br>(3,600 µg/m$^3$)<br>(3,600,000 ng/m$^3$) |

The modelled annual mean pollutant concentrations of NMP have been compared to the EAL to assess long-term exposure, while the maximum 1-hour concentrations have also been compared against the same EAL to assess short-term impacts in a conservative approach.

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[15] ECHA. N-Methyl-2-pyrrolidone (NMP) Substance Dossier. Available at: https://chem.echa.europa.eu/substance-information/-/substanceinfo/100.011.662

## 3.3 Post processing

The maximum modelled "Process Contributions" (PCs) for the five individual years modelled (2020 to 2024) were derived for each pollutant and compared against the relevant assessment criteria set out in Table 3-4 and Table 3-5.

Although the existing and proposed processes are batch processes and do not operate continuously throughout the year, time-weighted adjustments have not been applied to the modelled PCs to maintain the conservative nature of this assessment (see section 3.1.6).

## 3.4 Uncertainty

Any atmospheric dispersion modelling exercise has inherent areas of uncertainty, including:

- input data (e.g. daily and seasonable variability in process emissions, source dimensions);
- simplifications in model algorithms and empirical relationships that are used to simulate complex physical and chemical processes in the atmosphere; and
- meteorological data.

Uncertainty associated with the atmospheric dispersion modelling of NMP, $NO_2$, CO and VOC emissions from the UKBIC facility has been minimised by:

- making conservative assumptions such as continuous operational hours with emissions at the emission limit value (VIL) and design characteristics (FIL);
- assuming all VOC emissions are benzene;
- using algorithms and relationships within a dispersion model (AERMOD) that has been independently validated and judged as fit for purpose;
    - a recent version of AERMOD (v12, Executable 24142) and AERMET (v10, Executable 24142) has been used to incorporate the latest bug fixes and algorithms; and
- using hourly sequential meteorological data provided by an approved supplier and which has been subject to robust quality checks.

The approach taken for this assessment is considered sufficiently robust and is in line with best practice.  Given the low magnitude of the results presented, additional sensitivity test scenarios were not required.

# 4. Impact assessment

## 4.1 Source characteristics

### 4.1.1 Emissions inventory

Source characteristics for the detailed dispersion modelling study were derived from the comprehensive technical specifications provided by the manufacturers for the carbon bed condenser (A1, see Appendix B) and RTO (A2, see Appendix C).

The NMP emission rate for the carbon bed consender was derived using the calculated normalised flow rate based on emissions sampling (see Appendix D) and the emission concentration limit in the current permit (July 2020).

The emission rates for the RTO for the pollutants NMP, $NO_2$, CO, and VOCs, were derived using calculated normalised flow rates combined with the worst-case emission limit value set out in the environmental permit (July 2020).

The adopted approach ensures a conservative assessment as the dispersion model is based upon the maximum theoretical operational conditions (see section 3.1.6). No further emission sources have been considered, as any additional emissions are anticipated to occur only at trace levels.

### 4.1.2 Carbon bed condenser

Data relating to the stack discharge characteristics for the A1 emission point are summarised in Table 4-1.

**Table 4-1 - Carbon Bed Condenser stack discharge characteristics**

| Parameter | A1 | Source |
|---|---|---|
| Stack location national grid reference, x, y | 435046.3,<br>275004.9 | Site drawings |
| Stack height, m (above ground level) | 11.9 | Technical specifications^ |
| Actual discharge flow rate, $Am^3/s$ | 0.6 | Calculated from stack emissions report* |
| Stack diameter, m | 0.3 | Technical specifications** |
| Discharge velocity, m/s | 8.7 | Stack emissions report* |
| Flue gas discharge temperature, °C | 18.0 | Stack emissions report* |
| NMP emission conc., $mg/Nm^3$ | 2.0 | Permitted limit July 2020 |
| NMP emission rate, g/s | 0.0011 | Calculated |

^ 101 Platforms & Stack Layout GA Rev A, see Figure B-1 in Appendix B.

* LSW 240412 UKBIC Coventry Run 2 Report V2, see Figure D-1 in Appendix D.

** Emission summary: 100 Flue Layout GA Rev A, see Figure B-2 in Appendix B.

### 4.1.3 Regenerative thermal oxidiser

Data relating to the stack discharge characteristics for the RTO (emission point A2) are summarised in Table 4-1.

**Table 4-2 - Regenerative thermal oxidiser stack discharge characteristics**

| Parameter | A2 | Source |
|---|---|---|
| Stack location, national grid reference, x, y | 435037.0,<br>274980.7 | Site drawings |
| Stack height, m (above ground level) | 9.0 | Technical specifications^ |
| Actual discharge flow rate, $Am^3/s$ | 3.0 | Calculated |
| Stack diameter, m | 0.6 | Technical specifications^ |
| Discharge velocity, m/s | 10.4 | Calculated |
| Flue gas discharge temperature, °C | 285 | Technical specifications* |
| NMP emission conc, $mg/Nm^3$ | 1 | Emission limit value (Technical specifications^^) |
| NOx-LT emission conc, $mg/Nm^3$ | 100 | |
| NOx-ST emission conc, $mg/Nm^3$ | 100 | |
| CO emission conc, $mg/Nm^3$ | 100 | |
| VOCs emission conc, $mg/Nm^3$ | 50 | |
| NMP emission rate, g/s | 0.0002 | Calculated |
| NOx-LT emission rate, g/s | 0.2350 | |
| NOx-ST emission rate, g/s | 0.2350 | |
| CO emission rate, g/s | 0.0235 | |
| VOCs emission rate, g/s | 0.0118 | |

^ 13601C01 rev6 Layout, see Figure C-1 in Appendix C.

* EFIL-D-1446_13601RTO-CTY02_PFD_Rev0_01, see Figure C-2 in Appendix C.

^^ EFIL-D-730_tech_Doc_RTO_5300_01,see Figure C-3 in Appendix C.

## 4.2 Modelled results

### 4.2.1 N-Methyl-2-pyrrolidone

The maximum hourly and annual average modelled PCs for NMP at sensitive off-site receptors are presented in Table 4-3.

The maximum field-wide NMP concentration beyond the site boundary is 2.15 µg/$m^3$ for the hourly mean and 0.06 µg/$m^3$ for the annual mean. Both of these values were several orders of magnitude below the EAL of 3,600 µg/$m^3$ (3.6 mg/$m^3$) and are not representative locations of relevant public exposure.

The highest hourly PC at a location of relevant public exposure was modelled at Receptor D11, Rowley Road, where the concentration is 0.27 µg/m$^3$, four orders of magnitude below the EAL of 3,600 µg/m$^3$ (3.6 mg/m$^3$). The modelled concentrations at all other receptors were even lower.

The modelled annual mean concentrations at all receptors were below 0.01 µg/m$^3$. The highest modelled annual mean PC was 0.004 µg/m$^3$, also at Receptor D11 (Rowley Road), and again several orders of magnitude below the EAL for NMP of 3,600 µg/m$^3$ (3.6 mg/m$^3$).

**Table 4-3 – Maximum 1-hour and annual average NMP process contributions at human health receptors**

| ID | Description | 1-hour | | Annual | |
|---|---|---|---|---|---|
| | | PC (µg/m$^3$) | PC/EAL, % | PC (µg/m$^3$) | PC/EAL, % |
| D1 | Meadow Park School, Abbey Road | 0.05 | <0.01 | <0.01 | <0.01 |
| D2 | Tiverton School, Ashington Grove | 0.08 | <0.01 | <0.01 | <0.01 |
| D3 | Hill Fray Drive | 0.07 | <0.01 | <0.01 | <0.01 |
| D4 | Baginton Fields School, Shetland Road | 0.09 | <0.01 | <0.01 | <0.01 |
| D5 | Selsey Close | 0.08 | <0.01 | <0.01 | <0.01 |
| D6 | Montgomery Close | 0.05 | <0.01 | <0.01 | <0.01 |
| D7 | London Road, Stonehouse Estate | 0.04 | <0.01 | <0.01 | <0.01 |
| D8 | Baginton, Warwick | 0.06 | <0.01 | <0.01 | <0.01 |
| D9 | Stoneleigh Road | 0.16 | <0.01 | <0.01 | <0.01 |
| D10 | Andrews Close | 0.23 | <0.01 | <0.01 | <0.01 |
| D11 | Rowley Road | 0.27 | <0.01 | <0.01 | <0.01 |
| D12 | Coventry Road | 0.14 | <0.01 | <0.01 | <0.01 |
| D13 | Mylgrove | 0.05 | <0.01 | <0.01 | <0.01 |
| D14 | Fenside Avenue | 0.06 | <0.01 | <0.01 | <0.01 |
| D15 | Gregory Hood Road | 0.07 | <0.01 | <0.01 | <0.01 |
| D16 | Leaf Lane | 0.05 | <0.01 | <0.01 | <0.01 |
| D17 | Leaf Lane | 0.04 | <0.01 | <0.01 | <0.01 |

A breakdown of the maximum 1-hour and annual average NMP process contributions at human health receptors by emission source is set out in Appendix E (see Table E-1 and Table E-2).

The distribution of the maximum 1-hour and maximum annual average process contributions of NMP are presented as concentration isopleths overlaid on a base map in Figure F-1 and Figure F-2 of Appendix F, respectively. These are the maximum modelled results at each receptor from the five modelled years of data.

### 4.2.2 Nitrogen dioxide

The maximum hourly and annual average modelled PCs for $NO_2$ at sensitive off-site receptors are presented in Table 4-3.

The maximum field-wide $NO_2$ concentration beyond the site boundary is 2.96 µg/m$^3$ for the hourly mean and 0.31 µg/m$^3$ for the annual mean. Both results were several orders of magnitude below the relevant assessment criteria for $NO_2$ (see Table 3-4) and are not at locations of relevant public exposure.

The highest hourly PC at an area of relevant public exposure was modelled at Receptor D11, Rowley Road, where the modelled concentration was 0.25 µg/m$^3$, three orders of magnitude below the assessment criterion of 200 µg/m$^3$. The modelled concentrations at all other modelled receptors were lower.

The highest modelled annual mean concentrations of 0.02 µg/m$^3$, were found at Receptors D10 and D11, again several orders of magnitude below the assessment criterion of 40 µg/m$^3$. Concentrations at all other modelled receptors were lower.

The modelled PCs from the facility, which were all below 0.1% of the annual mean criterion, would make an insignificant contribution to existing concentrations in the study area (including within the nearest AQMA, see section 2), which ranged from 8.6 µg/m$^3$ to 26.8 µg/m$^3$.

**Table 4-4 - Maximum 1-hour and annual average $NO_2$ concentrations at human health receptors**

| ID | Description | 1-hour | | Annual | |
|---|---|---|---|---|---|
| | | PC (µg/m$^3$) | PC/EAL, % | PC (µg/m$^3$) | PC/EAL, % |
| D1 | Meadow Park School, Abbey Road | 0.09 | 0.05 | <0.01 | 0.02 |
| D2 | Tiverton School, Ashington Grove | 0.10 | 0.05 | <0.01 | 0.02 |
| D3 | Hill Fray Drive | 0.12 | 0.06 | <0.01 | 0.02 |
| D4 | Baginton Fields School, Shetland Road | 0.21 | 0.10 | 0.01 | 0.03 |
| D5 | Selsey Close | 0.16 | 0.08 | 0.01 | 0.03 |
| D6 | Montgomery Close | 0.08 | 0.04 | <0.01 | 0.02 |
| D7 | London Road, Stonehouse Estate | 0.08 | 0.04 | <0.01 | 0.01 |
| D8 | Baginton, Warwick | 0.09 | 0.05 | <0.01 | <0.01 |
| D9 | Stoneleigh Road | 0.18 | 0.09 | <0.01 | 0.02 |
| D10 | Andrews Close | 0.24 | 0.12 | 0.02 | 0.05 |
| D11 | Rowley Road | 0.25 | 0.12 | 0.02 | 0.04 |
| D12 | Coventry Road | 0.12 | 0.06 | <0.01 | 0.01 |
| D13 | Mylgrove | 0.07 | 0.03 | <0.01 | <0.01 |
| D14 | Fenside Avenue | 0.08 | 0.04 | <0.01 | <0.01 |
| D15 | Gregory Hood Road | 0.08 | 0.04 | <0.01 | <0.01 |

| ID | Description | 1-hour | | Annual | |
|---|---|---|---|---|---|
| | | PC (µg/m³) | PC/EAL, % | PC (µg/m³) | PC/EAL, % |
| D16 | Leaf Lane | 0.08 | 0.04 | <0.01 | <0.01 |
| D17 | Leaf Lane | 0.07 | 0.04 | <0.01 | <0.01 |

The distribution of the maximum 1-hour and maximum annual average process contributions of $NO_2$ are presented as concentration isopleths overlaid on a base map in Figure F-3 and Figure F-4 of Appendix F, respectively. These are the maximum modelled results at each receptor from the five modelled years of data.

### 4.2.3 Carbon monoxide

The maximum 1-hour and 8-hour average modelled PCs for CO at sensitive off-site receptors are presented in Table 4-3.

The maximum field wide CO concentration beyond the site boundary is 8.45 µg/m$^3$ for the 1-hour mean and 5.67 µg/m$^3$ for the 8-hour mean. Both were several orders of magnitude below the relevant assessment criteria for CO (see Table 3-4).

The highest hourly PC was modelled at Receptor D11, Rowley Road, where the concentration is 0.71 µg/m$^3$, several orders of magnitude below the relevant assessment criterion of 30,000 µg/m$^3$. The modelled concentrations at all other modelled receptors were lower.

The highest 8-hour mean modelled concentration of 0.57 µg/m$^3$, was at Receptor D10 Andrews Close, again several orders of magnitude below the relevant assessment criterion of 10,000 µg/m$^3$. Concentrations at all other modelled receptors were lower.

**Table 4-5 - Maximum 1-hour and 8-hour average CO concentrations at human health receptors**

| ID | Description | 1-hour | | 8-hour | |
|---|---|---|---|---|---|
| | | PC (µg/m³) | PC/EAL, % | PC (µg/m³) | PC/EAL, % |
| D1 | Meadow Park School, Abbey Road | 0.27 | <0.01 | 0.14 | <0.01 |
| D2 | Tiverton School, Ashington Grove | 0.28 | <0.01 | 0.15 | <0.01 |
| D3 | Hill Fray Drive | 0.33 | <0.01 | 0.16 | <0.01 |
| D4 | Baginton Fields School, Shetland Road | 0.59 | <0.01 | 0.28 | <0.01 |
| D5 | Selsey Close | 0.46 | <0.01 | 0.19 | <0.01 |
| D6 | Montgomery Close | 0.24 | <0.01 | 0.13 | <0.01 |
| D7 | London Road, Stonehouse Estate | 0.23 | <0.01 | 0.11 | <0.01 |
| D8 | Baginton, Warwick | 0.26 | <0.01 | 0.13 | <0.01 |
| D9 | Stoneleigh Road | 0.50 | <0.01 | 0.23 | <0.01 |
| D10 | Andrews Close | 0.67 | <0.01 | 0.52 | <0.01 |
| D11 | Rowley Road | 0.71 | <0.01 | 0.57 | <0.01 |

| ID | Description | 1-hour | | 8-hour | |
|---|---|---|---|---|---|
| | | PC ($\mu g/m^3$) | PC/EAL, % | PC ($\mu g/m^3$) | PC/EAL, % |
| D12 | Coventry Road | 0.33 | <0.01 | 0.21 | <0.01 |
| D13 | Mylgrove | 0.20 | <0.01 | 0.09 | <0.01 |
| D14 | Fenside Avenue | 0.22 | <0.01 | 0.13 | <0.01 |
| D15 | Gregory Hood Road | 0.24 | <0.01 | 0.13 | <0.01 |
| D16 | Leaf Lane | 0.22 | <0.01 | 0.13 | <0.01 |
| D17 | Leaf Lane | 0.21 | <0.01 | 0.12 | <0.01 |

### 4.2.4 Volatile organic compounds

The maximum 24-hour and annual average modelled PCs for VOCs at sensitive off-site receptors are presented in Table 4-3.

The maximum modelled field-wide VOC concentration beyond the site boundary is 1.88 $\mu g/m^3$ for the 24-hour mean and 0.22 $\mu g/m^3$ for the annual mean. Based on the very conservative assumption that all VOC emissions are benzene, both these values were an order of magnitude below the adopted assessment criteria (see Table 3-4).

The highest 24-hour mean PC is found at Receptor D10, Andrews Close, with a concentration of 0.17 $\mu g/m^3$, two orders of magnitude below the adopted assessment criterion of 30 $\mu g/m^3$ (benzene short-term). The modelled concentrations at all other receptors were even lower.

The highest annual mean modelled concentration of 0.01 $\mu g/m^3$, was found at Receptors D10 and D11. This value is two orders of magnitude below the adopted assessment criterion of 5 $\mu g/m^3$ (benzene long-term). Concentrations at all other modelled receptors were even lower.

As the ECHA DNEL for NMP is less stringent than the benzene AQS (3,600 vs 5 $\mu g/m^3$) it is clear that, even were the maximum NMP PC to be combined with the maximum VOC PC the total still make a negligible contribution to the NMP criterion.

**Table 4-6 - Maximum 24-hour and annual average VOC concentrations at human health receptors**

| ID | Description | 24-hour | | Annual | |
|---|---|---|---|---|---|
| | | PC ($\mu g/m^3$) | PC/EAL, % | PC ($\mu g/m^3$) | PC/EAL, % |
| D1 | Meadow Park School, Abbey Road | 0.04 | 0.13 | <0.01 | 0.10 |
| D2 | Tiverton School, Ashington Grove | 0.04 | 0.14 | <0.01 | 0.10 |
| D3 | Hill Fray Drive | 0.05 | 0.16 | <0.01 | 0.13 |
| D4 | Baginton Fields School, Shetland Road | 0.06 | 0.20 | <0.01 | 0.20 |
| D5 | Selsey Close | 0.06 | 0.19 | <0.01 | 0.18 |
| D6 | Montgomery Close | 0.04 | 0.14 | <0.01 | 0.12 |

| ID | Description | 24-hour | | Annual | |
|---|---|---|---|---|---|
| | | PC (µg/m$^3$) | PC/EAL, % | PC (µg/m$^3$) | PC/EAL, % |
| D7 | London Road, Stonehouse Estate | 0.03 | 0.12 | <0.01 | 0.08 |
| D8 | Baginton, Warwick | 0.04 | 0.12 | <0.01 | 0.05 |
| D9 | Stoneleigh Road | 0.07 | 0.23 | <0.01 | 0.13 |
| D10 | Andrews Close | 0.17 | 0.56 | 0.01 | 0.29 |
| D11 | Rowley Road | 0.16 | 0.55 | 0.01 | 0.26 |
| D12 | Coventry Road | 0.06 | 0.21 | <0.01 | 0.08 |
| D13 | Mylgrove | 0.03 | 0.10 | <0.01 | 0.04 |
| D14 | Fenside Avenue | 0.03 | 0.10 | <0.01 | 0.04 |
| D15 | Gregory Hood Road | 0.04 | 0.14 | <0.01 | 0.05 |
| D16 | Leaf Lane | 0.03 | 0.11 | <0.01 | 0.04 |
| D17 | Leaf Lane | 0.03 | 0.10 | <0.01 | 0.05 |

# 5. Conclusions

A detailed dispersion modelling study has been undertaken in support of the environmental permit variation application for a new process line (FIL) at the UKBIC facility in Coventry. This new line would enable the use of alternative solvents with the process air abated using an RTO prior to exhaust of residual emissions via a new stack.

The study, conducted in line with the Environment Agency's air emissions risk assessment for your environmental permit[2] guidance and air dispersion modelling reports guidance[3], used conservative operational assumptions to estimate off-site concentrations of NMP, $NO_2$, CO and VOCs at human health receptors.

The maximum modelled combined increments to ground-level concentrations of NMP from the two key emission points (A1 and A2), at all sensitive off-site locations, were well below the relevant EALs by several orders of magnitude.

The maximum modelled increments to ground-level concentrations of $NO_2$, CO, and VOCs (assuming all benzene) from the RTO at all sensitive off-site locations were also well below the relevant short-term and long-term assessment criteria, and in many cases by several orders of magnitude.

Therefore, in accordance with Environment Agency guidance and *de minimis* principles[16], the emissions can be considered insignificant as they would not affect the achievement of the relevant air quality criteria.

It can therefore be concluded that the operation of the new FIL, in conjunction with the existing VIL at the UKBIC facility, is likely to have a negligible impact on both short-term and long-term human health in the local area.

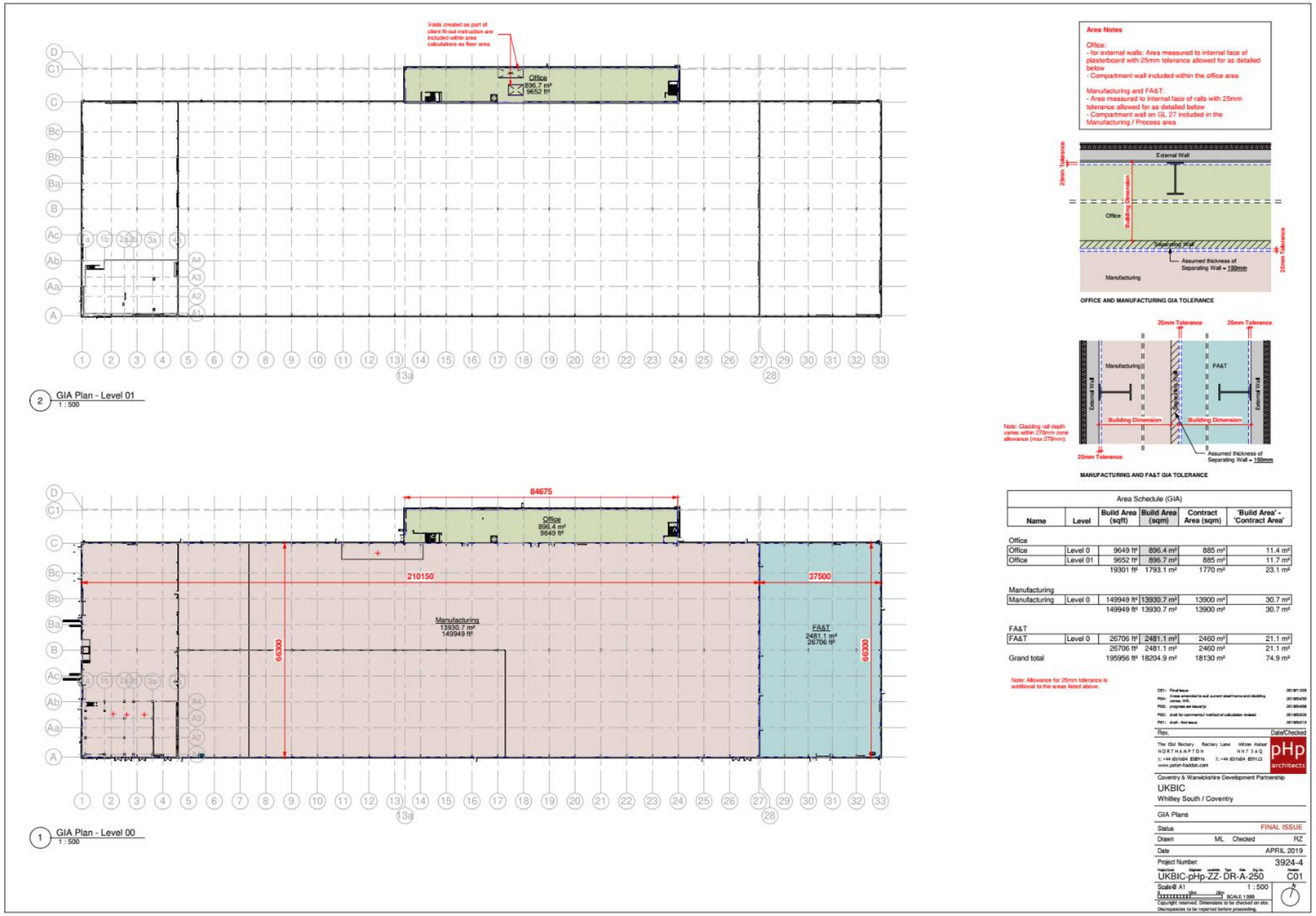
---

[16] JNCC Report No 696 Technical Report - De minimis and Air Pollution Thresholds (December 2021). Available at: https://data.jncc.gov.uk/data/6cce4f2e-e481-4ec2-b369-2b4026c88447/JNCC-Report-696-Technical-FINAL-WEB.pdf

# APPENDICES

# Appendix A. Building Parameters

**Figure A-1 – Drawing (page 250) – GIA Plans (PHP-DR-0105-PDF)**



**Area Notes**

Office:
- for external walls: Area measured to internal face of plasterboard with 25mm tolerance allowed for as detailed below
- Compartment wall included within the office area

Manufacturing and FA&T:
- Area measured to internal face of rails with 25mm tolerance allowed for as detailed below
- Compartment wall on GL 27 included in the Manufacturing / Process area

Note: Cladding rail depth varies within 270mm zone allowance (max 270mm).

Area Schedule (GIA)

| Name | Level | Build Area (sqft) | Build Area (sqm) | Contract Area (sqm) | 'Build Area' - 'Contract Area' |
|---|---|---|---|---|---|
| Office | | | | | |
| Office | Level 0 | 9649 ft² | 896.4 m² | 885 m² | 11.4 m² |
| Office | Level 01 | 9652 ft² | 896.7 m² | 885 m² | 11.7 m² |
| | | 19301 ft² | 1793.1 m² | 1770 m² | 23.1 m² |
| Manufacturing | | | | | |
| Manufacturing | Level 0 | 149949 ft² | 13930.7 m² | 13900 m² | 30.7 m² |
| | | 149949 ft² | 13930.7 m² | 13900 m² | 30.7 m² |
| FA&T | | | | | |
| FA&T | Level 0 | 26706 ft² | 2481.1 m² | 2460 m² | 21.1 m² |
| | | 26706 ft² | 2481.1 m² | 2460 m² | 21.1 m² |
| Grand total | | 195956 ft² | 18204.9 m² | 18130 m² | 74.9 m² |

Note: Allowance for 25mm tolerance is additional to the areas listed above.

Rev. Date/Checked

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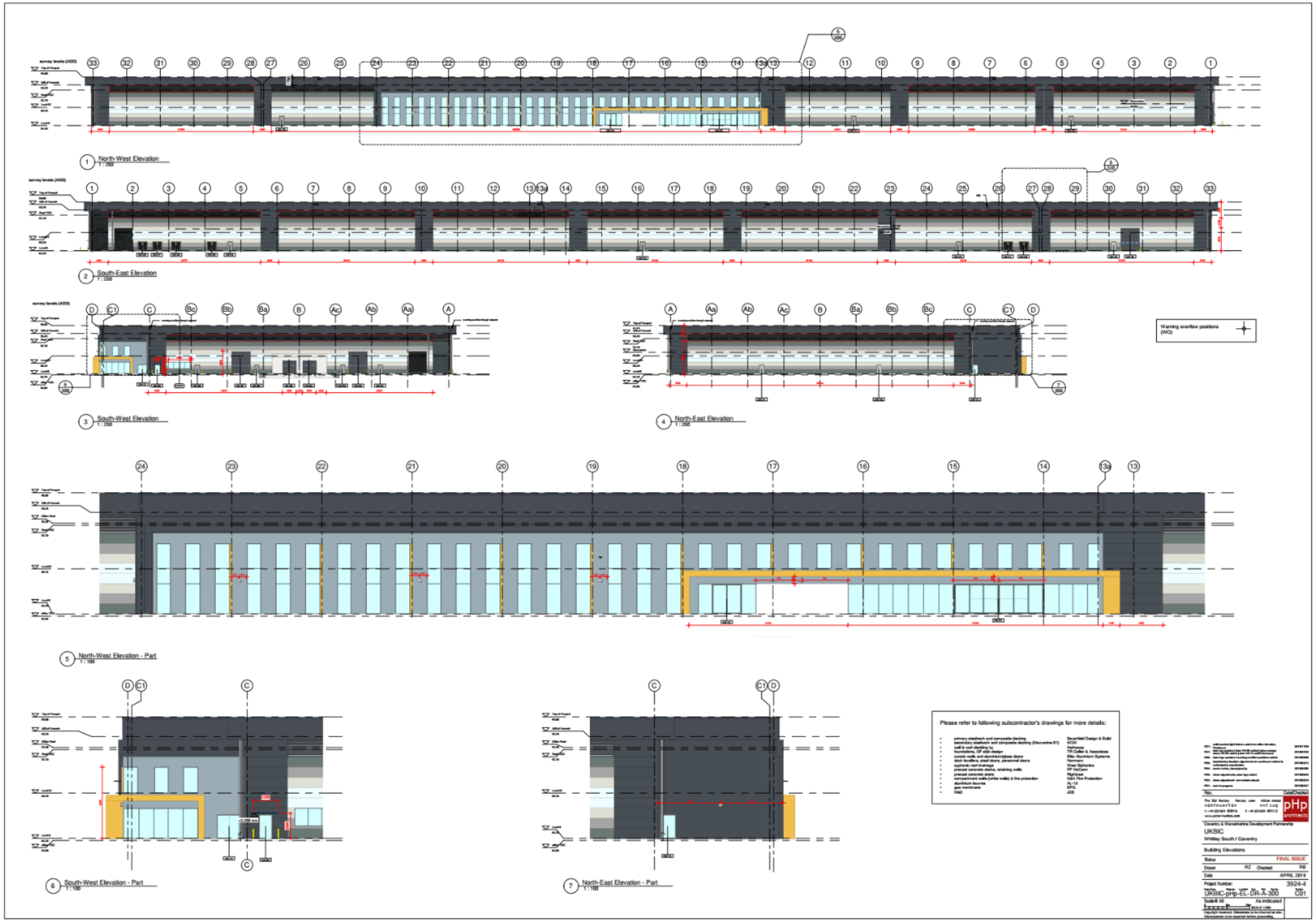
UKBIC
Whitley South / Coventry

GIA Plans

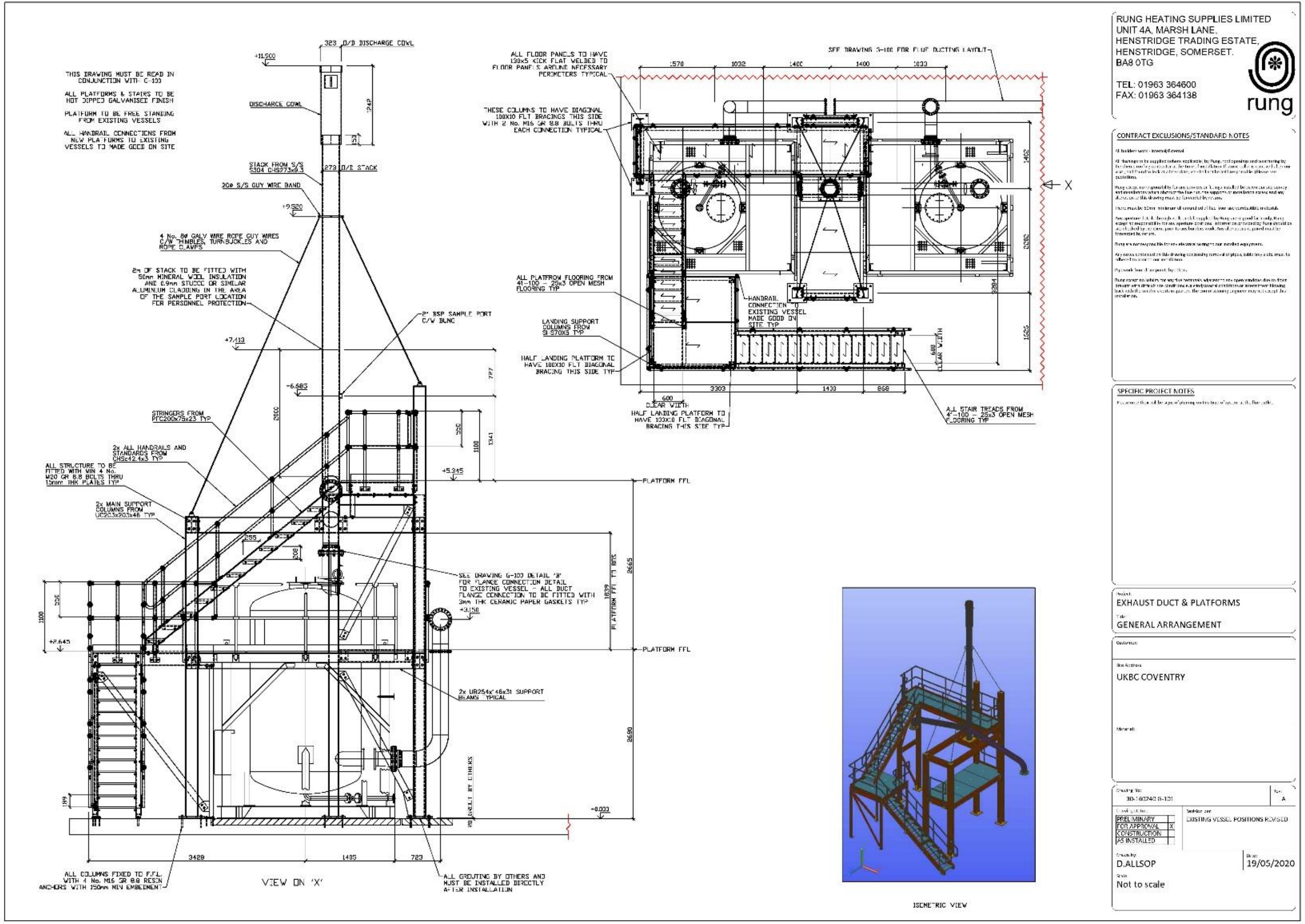
Status FINAL ISSUE
Drawn ML Checked RZ
Date APRIL 2019
Project Number: 3924-4
UKBIC-pHp-ZZ-DR-A-250 C01
Scale@ A1 1 : 500
SCALE 1:500
Copyright reserved. Dimensions to be checked on site. Discrepancies to be reported before proceeding.

## Figure A-2 – Drawing (page 300) - Building Elevations (PHP-DR-0105-PDF)

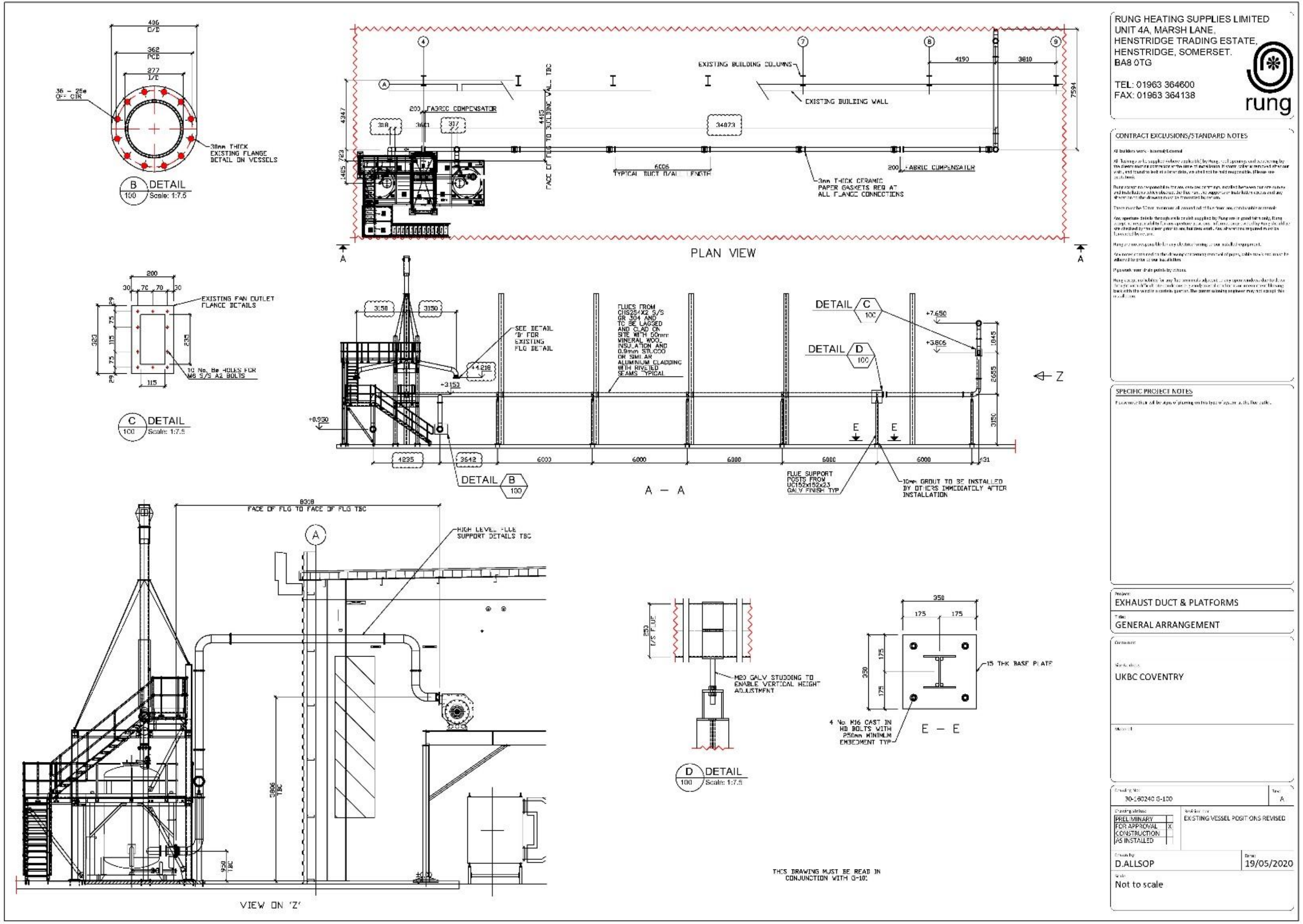


# Appendix B. Technical Specifications (A1)

Figure B-1 - Platforms and Stack Arrangement

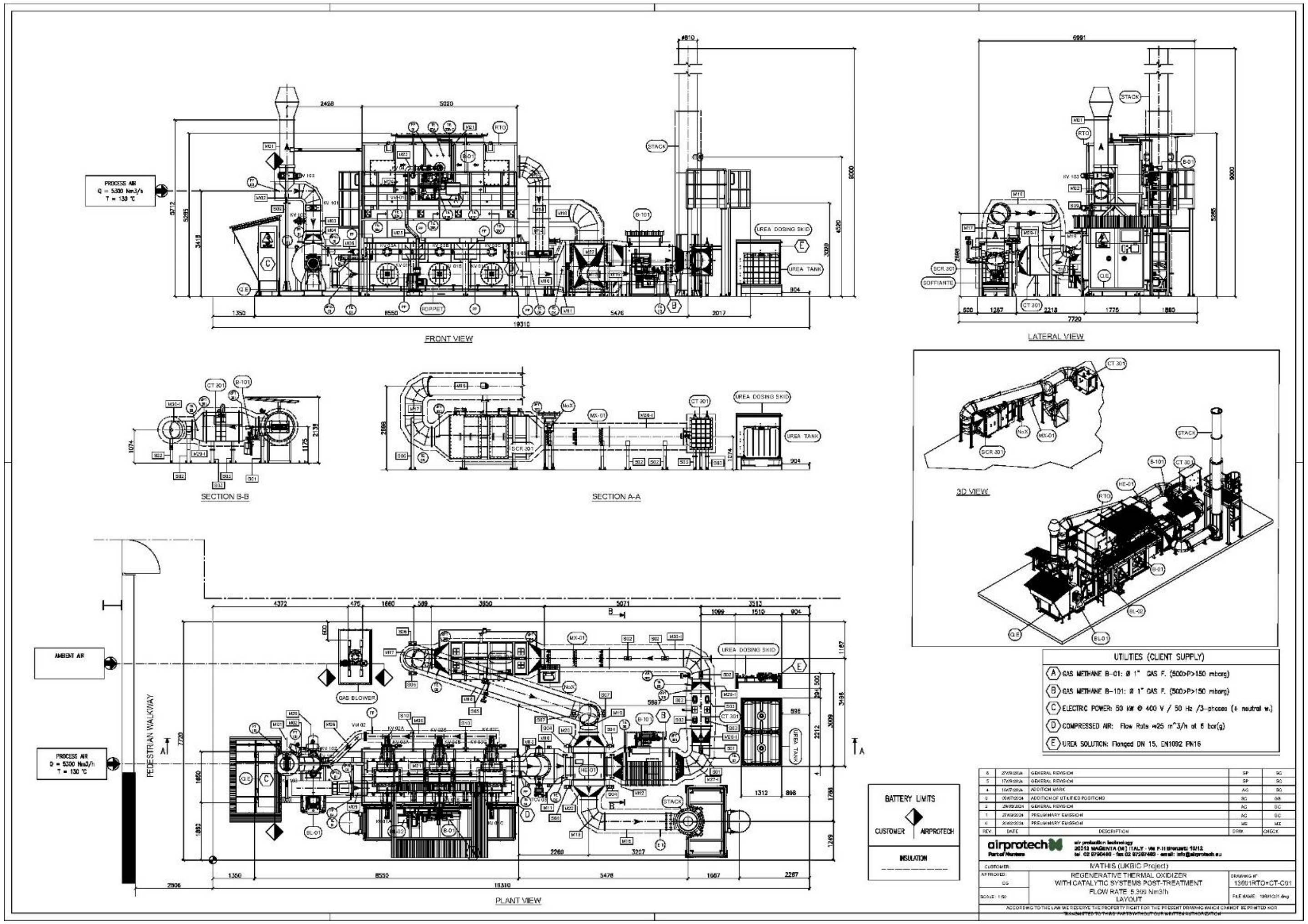


## Figure B-2 - Flue Layout

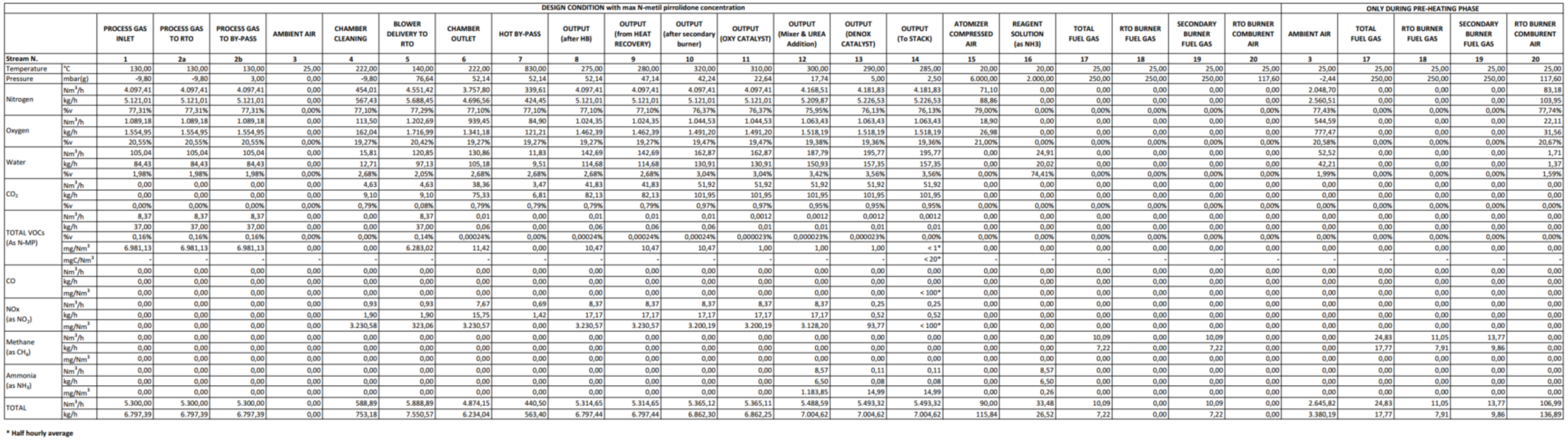


# Appendix C. Technical Specifications (A2)

Figure C-1 - Layout (13601C01 rev6 Layout)



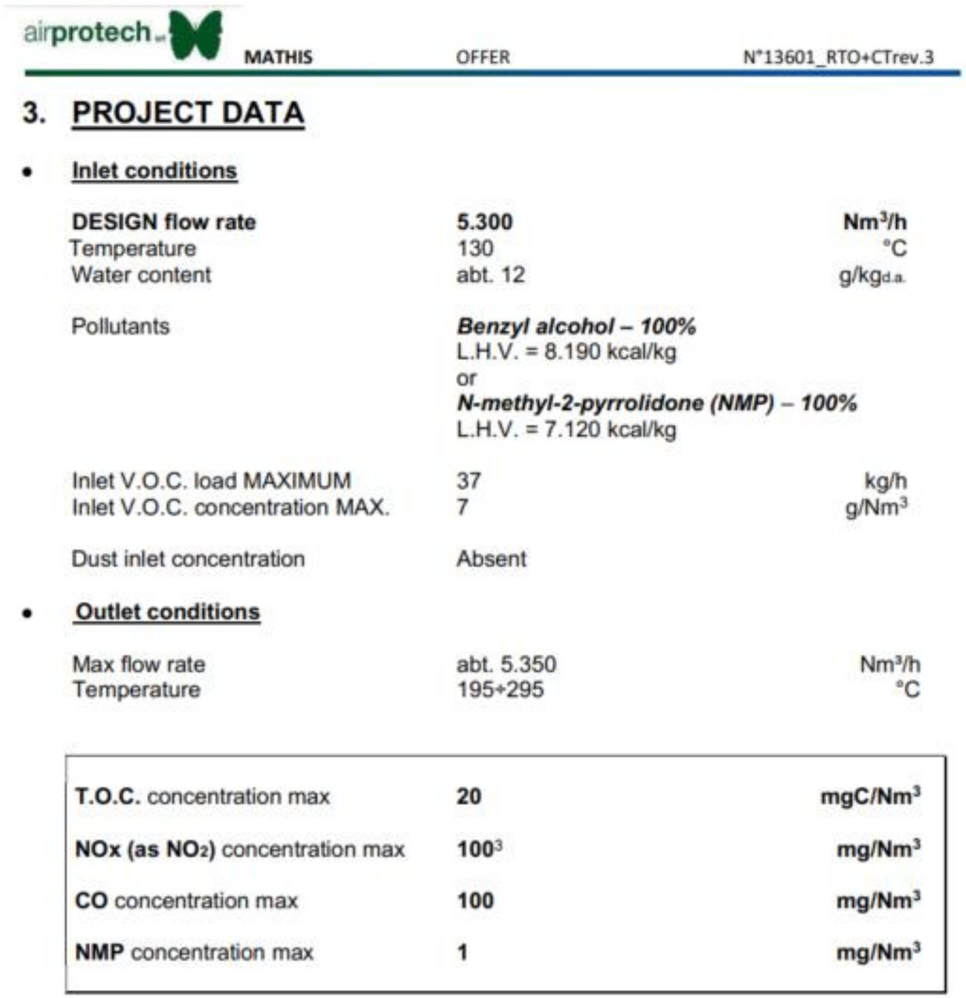
## Figure C-2 – PFD Diagram (EFIL-D-1446_13601RTO-CTY02_PFD_Rev0_01)



| | | DESIGN CONDITION with max N-metil pirrolidone concentration | | | | | | | | | | | | | | | | | | | | ONLY DURING PRE-HEATING PHASE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PROCESS GAS INLET | PROCESS GAS TO RTO | PROCESS GAS TO BY-PASS | AMBIENT AIR | CHAMBER CLEANING | BLOWER DELIVERY TO RTO | CHAMBER OUTLET | HOT BY-PASS | OUTPUT (after HB) | OUTPUT (from HEAT RECOVERY) | OUTPUT (after secondary burner) | OUTPUT (OXY CATALYST) | OUTPUT (Mixer & UREA Addition) | OUTPUT (DENOX CATALYST) | OUTPUT (To STACK) | ATOMIZER COMPRESSED AIR | REAGENT SOLUTION (as NH3) | TOTAL FUEL GAS | RTO BURNER FUEL GAS | SECONDARY BURNER FUEL GAS | RTO BURNER COMBURENT AIR | AMBIENT AIR | TOTAL FUEL GAS | RTO BURNER FUEL GAS | SECONDARY BURNER FUEL GAS | RTO BURNER COMBURENT AIR |
| **Stream N.** | | **1** | **2a** | **2b** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **3** | **17** | **18** | **19** | **20** |
| Temperature | °C | 130,00 | 130,00 | 130,00 | 25,00 | 222,00 | 140,00 | 222,00 | 830,00 | 275,00 | 280,00 | 320,00 | 310,00 | 300,00 | 290,00 | 285,00 | 20,00 | 20,00 | 25,00 | 25,00 | 25,00 | 25,00 | 25,00 | 25,00 | 25,00 | 25,00 | 25,00 |
| Pressure | mbar(g) | -9,80 | -9,80 | 3,00 | 0,00 | -9,80 | 76,64 | 52,14 | 52,14 | 52,14 | 47,14 | 42,24 | 22,64 | 17,74 | 5,00 | 2,50 | 6.000,00 | 2.000,00 | 250,00 | 250,00 | 250,00 | 117,60 | -2,44 | 250,00 | 250,00 | 250,00 | 117,60 |
| Nitrogen | Nm$^3$/h | 4.097,41 | 4.097,41 | 4.097,41 | 0,00 | 454,01 | 4.551,42 | 3.757,80 | 339,61 | 4.097,41 | 4.097,41 | 4.097,41 | 4.097,41 | 4.168,51 | 4.181,83 | 4.181,83 | 71,10 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 2.048,70 | 0,00 | 0,00 | 0,00 | 83,18 |
| | kg/h | 5.121,01 | 5.121,01 | 5.121,01 | 0,00 | 567,43 | 5.688,45 | 4.696,56 | 424,45 | 5.121,01 | 5.121,01 | 5.121,01 | 5.121,01 | 5.209,87 | 5.226,53 | 5.226,53 | 88,86 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 2.560,51 | 0,00 | 0,00 | 0,00 | 103,95 |
| | %v | 77,31% | 77,31% | 77,31% | 0,00% | 77,10% | 77,29% | 77,10% | 77,10% | 77,10% | 77,10% | 76,37% | 76,37% | 75,95% | 76,13% | 76,13% | 79,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 77,43% | 0,00% | 0,00% | 0,00% | 77,74% |
| Oxygen | Nm$^3$/h | 1.089,18 | 1.089,18 | 1.089,18 | 0,00 | 113,50 | 1.202,69 | 939,45 | 84,90 | 1.024,35 | 1.024,35 | 1.044,53 | 1.044,53 | 1.063,43 | 1.063,43 | 1.063,43 | 18,90 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 544,59 | 0,00 | 0,00 | 0,00 | 22,11 |
| | kg/h | 1.554,95 | 1.554,95 | 1.554,95 | 0,00 | 162,04 | 1.716,99 | 1.341,18 | 121,21 | 1.462,39 | 1.462,39 | 1.491,20 | 1.491,20 | 1.518,19 | 1.518,19 | 1.518,19 | 26,98 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 777,47 | 0,00 | 0,00 | 0,00 | 31,56 |
| | %v | 20,55% | 20,55% | 20,55% | 0,00% | 19,27% | 20,42% | 19,27% | 19,27% | 19,27% | 19,27% | 19,47% | 19,47% | 19,38% | 19,36% | 19,36% | 21,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 20,58% | 0,00% | 0,00% | 0,00% | 20,67% |
| Water | Nm$^3$/h | 105,04 | 105,04 | 105,04 | 0,00 | 15,81 | 120,85 | 130,86 | 11,83 | 142,69 | 142,69 | 162,87 | 162,87 | 187,79 | 195,77 | 195,77 | 0,00 | 24,91 | 0,00 | 0,00 | 0,00 | 0,00 | 52,52 | 0,00 | 0,00 | 0,00 | 1,71 |
| | kg/h | 84,43 | 84,43 | 84,43 | 0,00 | 12,71 | 97,13 | 105,18 | 9,51 | 114,68 | 114,68 | 130,91 | 130,91 | 150,93 | 157,35 | 157,35 | 0,00 | 20,02 | 0,00 | 0,00 | 0,00 | 0,00 | 42,21 | 0,00 | 0,00 | 0,00 | 1,37 |
| | %v | 1,98% | 1,98% | 1,98% | 0,00% | 2,68% | 2,05% | 2,68% | 2,68% | 2,68% | 2,68% | 3,04% | 3,04% | 3,42% | 3,56% | 3,56% | 0,00% | 74,41% | 0,00% | 0,00% | 0,00% | 0,00% | 1,99% | 0,00% | 0,00% | 0,00% | 1,59% |
| CO$_2$ | Nm$^3$/h | 0,00 | 0,00 | 0,00 | 0,00 | 4,63 | 4,63 | 38,36 | 3,47 | 41,83 | 41,83 | 51,92 | 51,92 | 51,92 | 51,92 | 51,92 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | kg/h | 0,00 | 0,00 | 0,00 | 0,00 | 9,10 | 9,10 | 75,33 | 6,81 | 82,13 | 82,13 | 101,95 | 101,95 | 101,95 | 101,95 | 101,95 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | %v | 0,00% | 0,00% | 0,00% | 0,00% | 0,79% | 0,08% | 0,79% | 0,79% | 0,79% | 0,79% | 0,97% | 0,97% | 0,95% | 0,95% | 0,95% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% |
| TOTAL VOCs (As N-MP) | Nm$^3$/h | 8,37 | 8,37 | 8,37 | 0,00 | 0,00 | 8,37 | 0,01 | 0,00 | 0,01 | 0,01 | 0,01 | 0,0012 | 0,0012 | 0,0012 | 0,0012 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | kg/h | 37,00 | 37,00 | 37,00 | 0,00 | 0,00 | 37,00 | 0,06 | 0,00 | 0,06 | 0,06 | 0,06 | 0,01 | 0,01 | 0,01 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | %v | 0,16% | 0,16% | 0,16% | 0,00% | 0,00% | 0,14% | 0,00024% | 0,00% | 0,00024% | 0,00024% | 0,00024% | 0,000023% | 0,000023% | 0,000023% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% |
| | mg/Nm$^3$ | 6.981,13 | 6.981,13 | 6.981,13 | 0,00 | 0,00 | 6.283,02 | 11,42 | 0,00 | 10,47 | 10,47 | 10,47 | 1,00 | 1,00 | 1,00 | < 1* | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | mgC/Nm$^3$ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 20* | - | - | - | - | - | - | - | - | - | - | - |
| CO | Nm$^3$/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | kg/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | mg/Nm$^3$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | < 100* | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| NOx (as NO$_2$) | Nm$^3$/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,93 | 0,93 | 7,67 | 0,69 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 0,25 | 0,25 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | kg/h | 0,00 | 0,00 | 0,00 | 0,00 | 1,90 | 1,90 | 15,75 | 1,42 | 17,17 | 17,17 | 17,17 | 17,17 | 17,17 | 0,52 | 0,52 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | mg/Nm$^3$ | 0,00 | 0,00 | 0,00 | 0,00 | 3.230,58 | 323,06 | 3.230,57 | 0,00 | 3.230,57 | 3.230,57 | 3.200,19 | 3.200,19 | 3.128,20 | 93,77 | < 100* | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Methane (as CH$_4$) | Nm$^3$/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 10,09 | 0,00 | 10,09 | 0,00 | 0,00 | 24,83 | 11,05 | 13,77 | 0,00 |
| | kg/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 7,22 | 0,00 | 7,22 | 0,00 | 0,00 | 17,77 | 7,91 | 9,86 | 0,00 |
| | mg/Nm$^3$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Ammonia (as NH$_3$) | Nm$^3$/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8,57 | 0,11 | 0,11 | 0,00 | 8,57 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | kg/h | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 6,50 | 0,08 | 0,08 | 0,00 | 6,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| | mg/Nm$^3$ | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 1.183,85 | 14,99 | 14,99 | 0,00 | 0,26 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| TOTAL | Nm$^3$/h | 5.300,00 | 5.300,00 | 5.300,00 | 0,00 | 588,89 | 5.888,89 | 4.874,15 | 440,50 | 5.314,65 | 5.314,65 | 5.365,12 | 5.365,11 | 5.488,59 | 5.493,32 | 5.493,32 | 90,00 | 33,48 | 10,09 | 0,00 | 10,09 | 0,00 | 2.645,82 | 24,83 | 11,05 | 13,77 | 106,99 |
| | kg/h | 6.797,39 | 6.797,39 | 6.797,39 | 0,00 | 753,18 | 7.550,57 | 6.234,04 | 563,40 | 6.797,44 | 6.797,44 | 6.862,30 | 6.862,25 | 7.004,62 | 7.004,62 | 7.004,62 | 115,84 | 26,52 | 7,22 | 0,00 | 7,22 | 0,00 | 3.380,19 | 17,77 | 7,91 | 9,86 | 136,89 |

*** Half hourly average**

Figure C-3 – Technical Document (EFIL-D-730_tech_Doc_RTO_5300_01)



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## 3. PROJECT DATA

- Inlet conditions

| | | |
|---|---|---|
| **DESIGN flow rate** | **5.300** | **Nm³/h** |
| Temperature | 130 | °C |
| Water content | abt. 12 | g/kgd.a. |
| Pollutants | ***Benzyl alcohol – 100%***<br>L.H.V. = 8.190 kcal/kg<br>or<br>***N-methyl-2-pyrrolidone (NMP) – 100%***<br>L.H.V. = 7.120 kcal/kg | |
| Inlet V.O.C. load MAXIMUM | 37 | kg/h |
| Inlet V.O.C. concentration MAX. | 7 | g/Nm³ |
| Dust inlet concentration | Absent | |

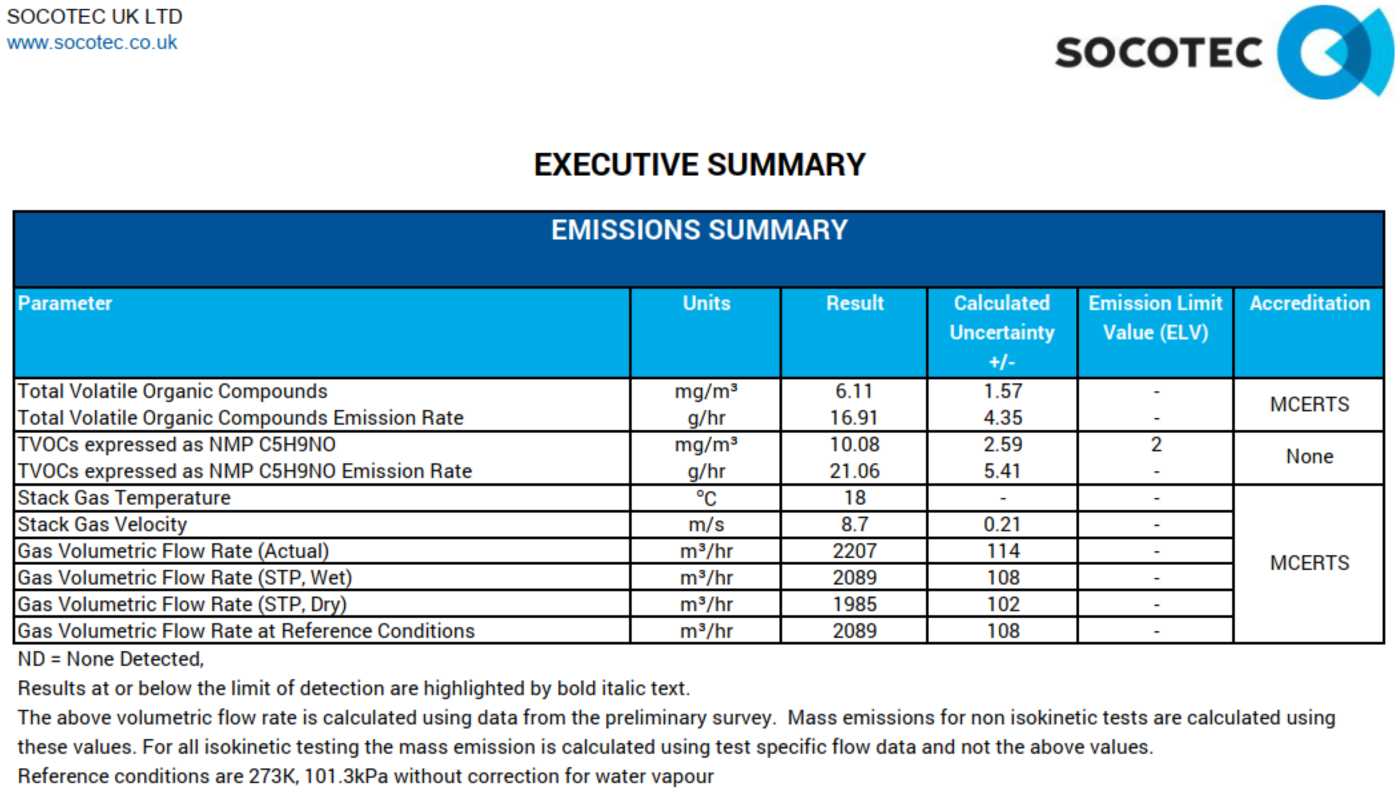
- Outlet conditions

| | | |
|---|---|---|
| Max flow rate | abt. 5.350 | Nm³/h |
| Temperature | 195÷295 | °C |

| | | |
|---|---|---|
| **T.O.C.** concentration max | **20** | **mgC/Nm³** |
| **NOx (as NO$_2$)** concentration max | **100**[3] | **mg/Nm³** |
| **CO** concentration max | **100** | **mg/Nm³** |
| **NMP** concentration max | **1** | **mg/Nm³** |

# Appendix D. Stack Emissions Sampling (A1)

**Figure D-1 – Report: 22$^{nd}$ May 2024 (LSW 240412 UKBIC Coventry Run 2 Report V3)**



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## EXECUTIVE SUMMARY

| EMISSIONS SUMMARY | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Units** | **Result** | **Calculated Uncertainty +/-** | **Emission Limit Value (ELV)** | **Accreditation** |
| Total Volatile Organic Compounds | mg/m$^3$ | 6.11 | 1.57 | - | MCERTS |
| Total Volatile Organic Compounds Emission Rate | g/hr | 16.91 | 4.35 | - | |
| TVOCs expressed as NMP C5H9NO | mg/m$^3$ | 10.08 | 2.59 | 2 | None |
| TVOCs expressed as NMP C5H9NO Emission Rate | g/hr | 21.06 | 5.41 | - | |
| Stack Gas Temperature | °C | 18 | - | - | MCERTS |
| Stack Gas Velocity | m/s | 8.7 | 0.21 | - | |
| Gas Volumetric Flow Rate (Actual) | m$^3$/hr | 2207 | 114 | - | |
| Gas Volumetric Flow Rate (STP, Wet) | m$^3$/hr | 2089 | 108 | - | |
| Gas Volumetric Flow Rate (STP, Dry) | m$^3$/hr | 1985 | 102 | - | |
| Gas Volumetric Flow Rate at Reference Conditions | m$^3$/hr | 2089 | 108 | - | |

ND = None Detected,

Results at or below the limit of detection are highlighted by bold italic text.

The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific flow data and not the above values.

Reference conditions are 273K, 101.3kPa without correction for water vapour

# Appendix E. NMP Results

**Table E-1 – Maximum 1-hour average NMP process contributions at human health receptors by emission source (A1 and A2)**

| ID | Description | A1 | | A2 | |
|---|---|---|---|---|---|
| | | PC (µg/m$^3$) | % of Total | PC (µg/m$^3$) | % of Total |
| D1 | Meadow Park School, Abbey Road | 0.052 | 99.0 | <0.001 | 1.0 |
| D2 | Tiverton School, Ashington Grove | 0.075 | 98.4 | 0.001 | 1.6 |
| D3 | Hill Fray Drive | 0.066 | 96.2 | 0.003 | 3.8 |
| D4 | Baginton Fields School, Shetland Road | 0.085 | 94.0 | 0.005 | 6.0 |
| D5 | Selsey Close | 0.074 | 94.1 | 0.005 | 5.9 |
| D6 | Montgomery Close | 0.050 | 97.8 | 0.001 | 2.2 |
| D7 | London Road, Stonehouse Estate | 0.041 | >99.9 | <0.001 | <0.1 |
| D8 | Baginton, Warwick | 0.060 | 99.1 | <0.001 | 0.9 |
| D9 | Stoneleigh Road | 0.157 | 96.9 | 0.005 | 3.1 |
| D10 | Andrews Close | 0.235 | >99.9 | <0.001 | <0.1 |
| D11 | Rowley Road | 0.272 | >99.9 | <0.001 | <0.1 |
| D12 | Coventry Road | 0.141 | >99.9 | <0.001 | <0.1 |
| D13 | Mylgrove | 0.048 | >99.9 | <0.001 | <0.1 |
| D14 | Fenside Avenue | 0.060 | 98.5 | <0.001 | 1.5 |
| D15 | Gregory Hood Road | 0.065 | 99.1 | <0.001 | 0.9 |
| D16 | Leaf Lane | 0.046 | >99.9 | <0.001 | <0.1 |
| D17 | Leaf Lane | 0.044 | >99.9 | <0.001 | <0.1 |

**Table E-2 – Breakdown of maximum annual average NMP process contributions at human health receptors by emission source (A1 and A2)**

| ID | Description | A1 | | A2 | |
|---|---|---|---|---|---|
| | | PC (µg/m$^3$) | % of Total | PC (µg/m$^3$) | % of Total |
| D1 | Meadow Park School, Abbey Road | 0.0012 | 92.5 | 0.0001 | 7.5 |
| D2 | Tiverton School, Ashington Grove | 0.0013 | 93.0 | 0.0001 | 7.0 |
| D3 | Hill Fray Drive | 0.0014 | 92.3 | 0.0001 | 7.7 |
| D4 | Baginton Fields School, Shetland Road | 0.0020 | 91.0 | 0.0002 | 9.0 |
| D5 | Selsey Close | 0.0017 | 90.4 | 0.0002 | 9.6 |
| D6 | Montgomery Close | 0.0010 | 91.2 | 0.0001 | 8.8 |
| D7 | London Road, Stonehouse Estate | 0.0007 | 89.6 | <0.0001 | 10.4 |
| D8 | Baginton, Warwick | 0.0006 | 92.8 | <0.0001 | 7.2 |
| D9 | Stoneleigh Road | 0.0016 | 93.1 | 0.0001 | 6.9 |
| D10 | Andrews Close | 0.0040 | 93.3 | 0.0003 | 6.7 |
| D11 | Rowley Road | 0.0042 | 94.6 | 0.0002 | 5.4 |
| D12 | Coventry Road | 0.0014 | 94.0 | <0.0001 | 6.0 |
| D13 | Mylgrove | 0.0005 | 92.3 | <0.0001 | 7.7 |
| D14 | Fenside Avenue | 0.0005 | 92.9 | <0.0001 | 7.1 |
| D15 | Gregory Hood Road | 0.0006 | 94.0 | <0.0001 | 6.0 |
| D16 | Leaf Lane | 0.0007 | 94.9 | <0.0001 | 5.1 |
| D17 | Leaf Lane | 0.0009 | 94.6 | <0.0001 | 5.4 |

# Appendix F. Concentration Isopleths

Figure F-1 - Maximum 1-hour mean NMP concentrations (μg/m³)

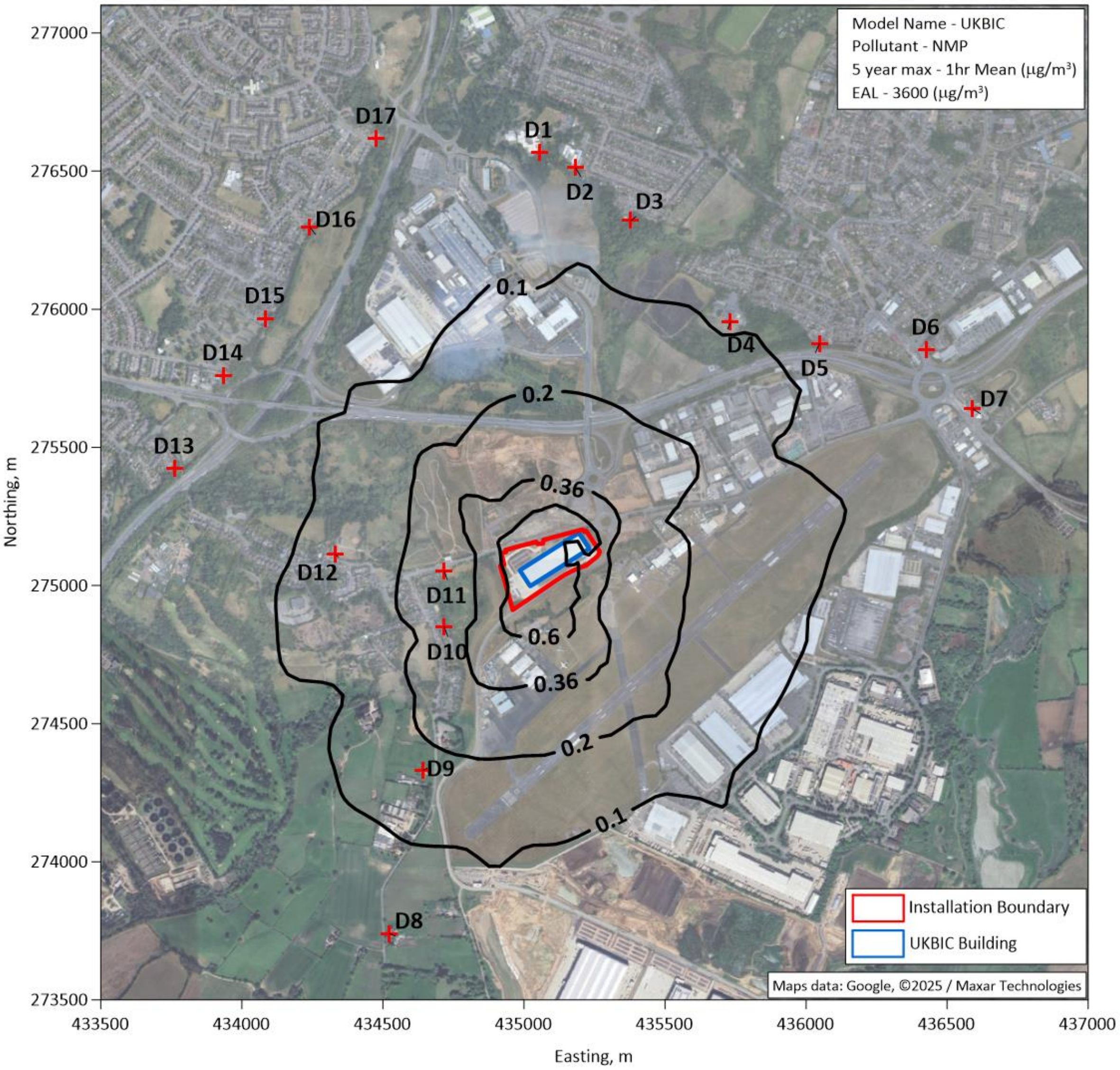


**Figure F-2 - Maximum Annual mean NMP concentrations (µg/m$^3$)**

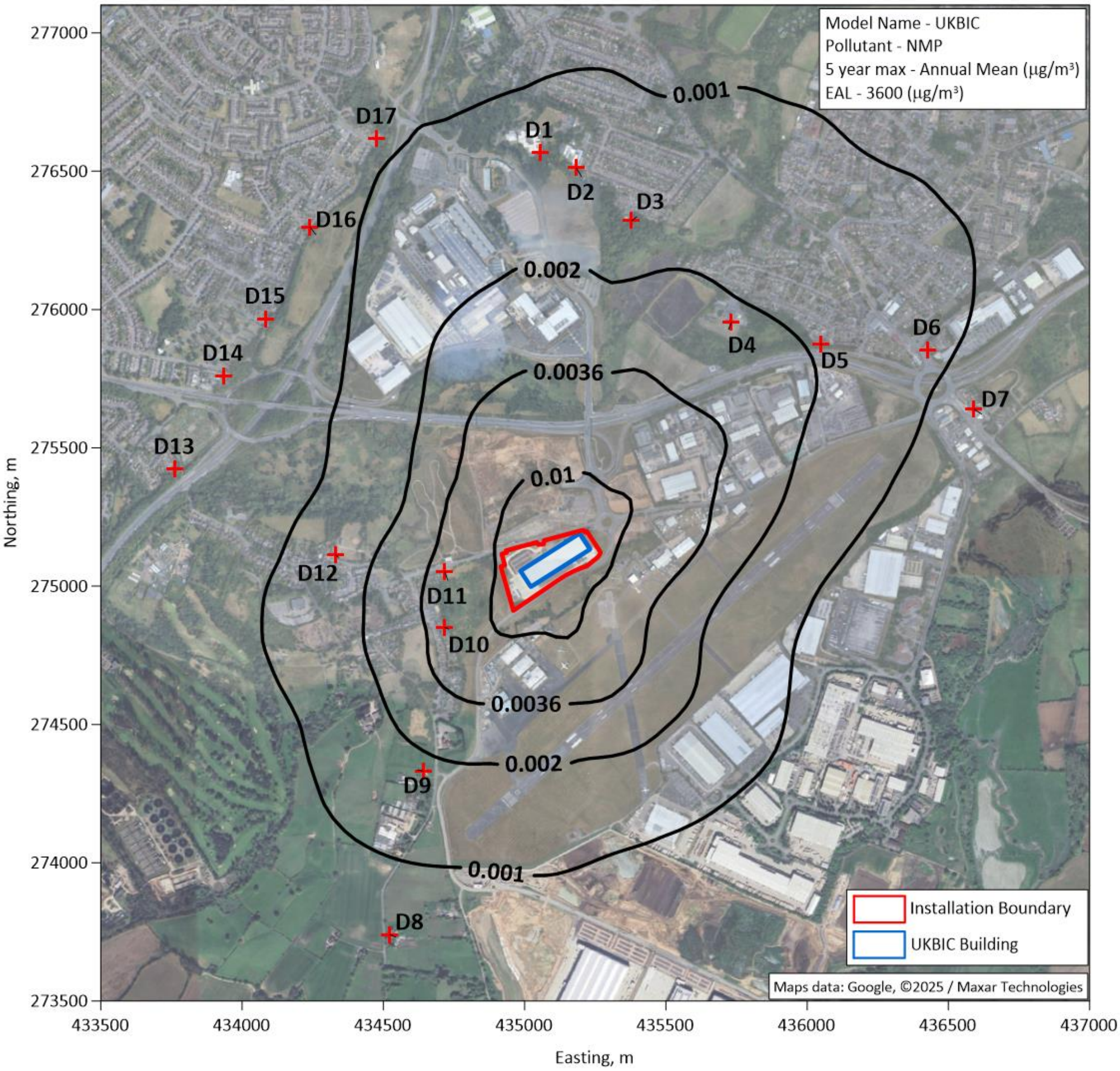
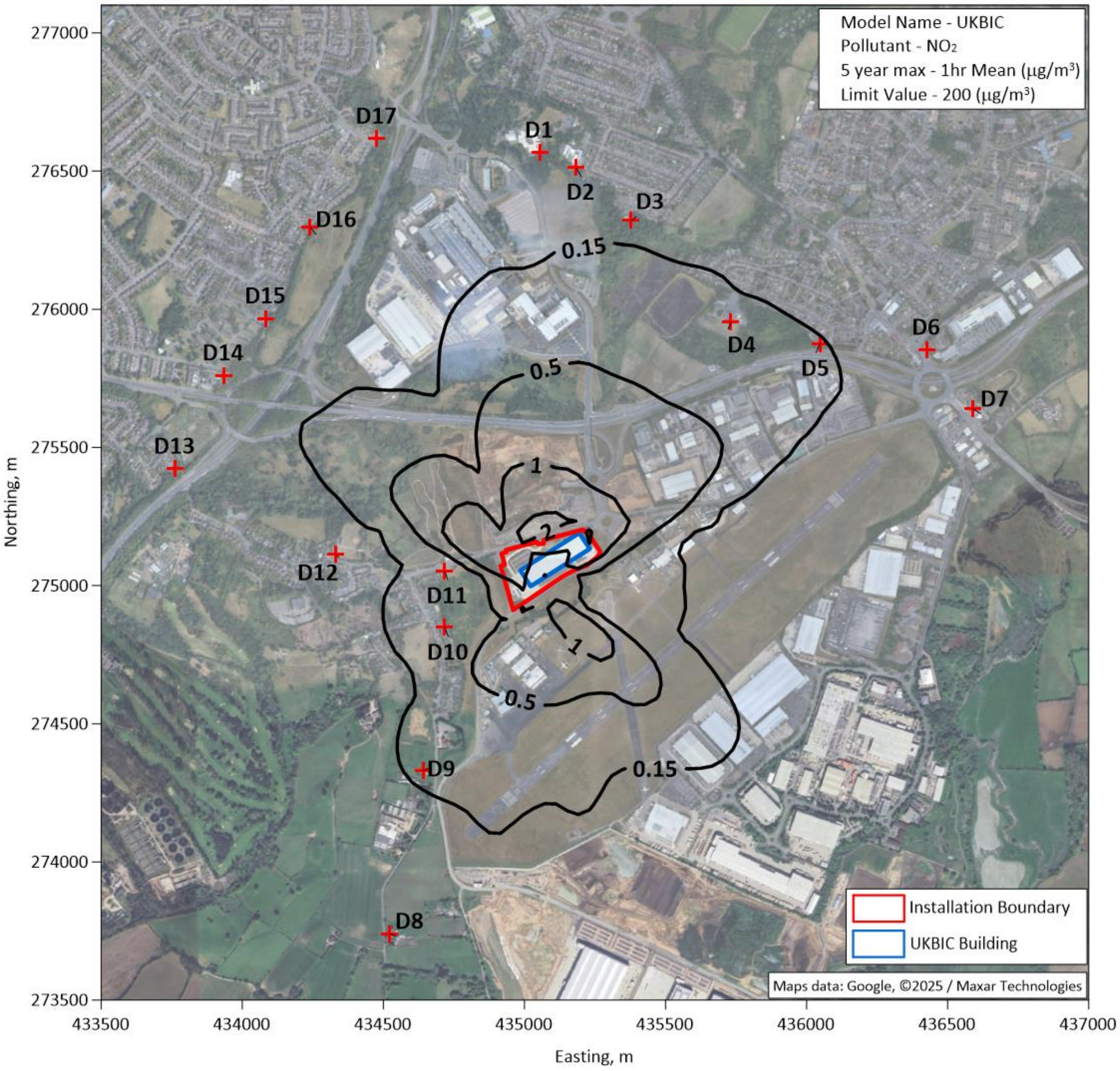
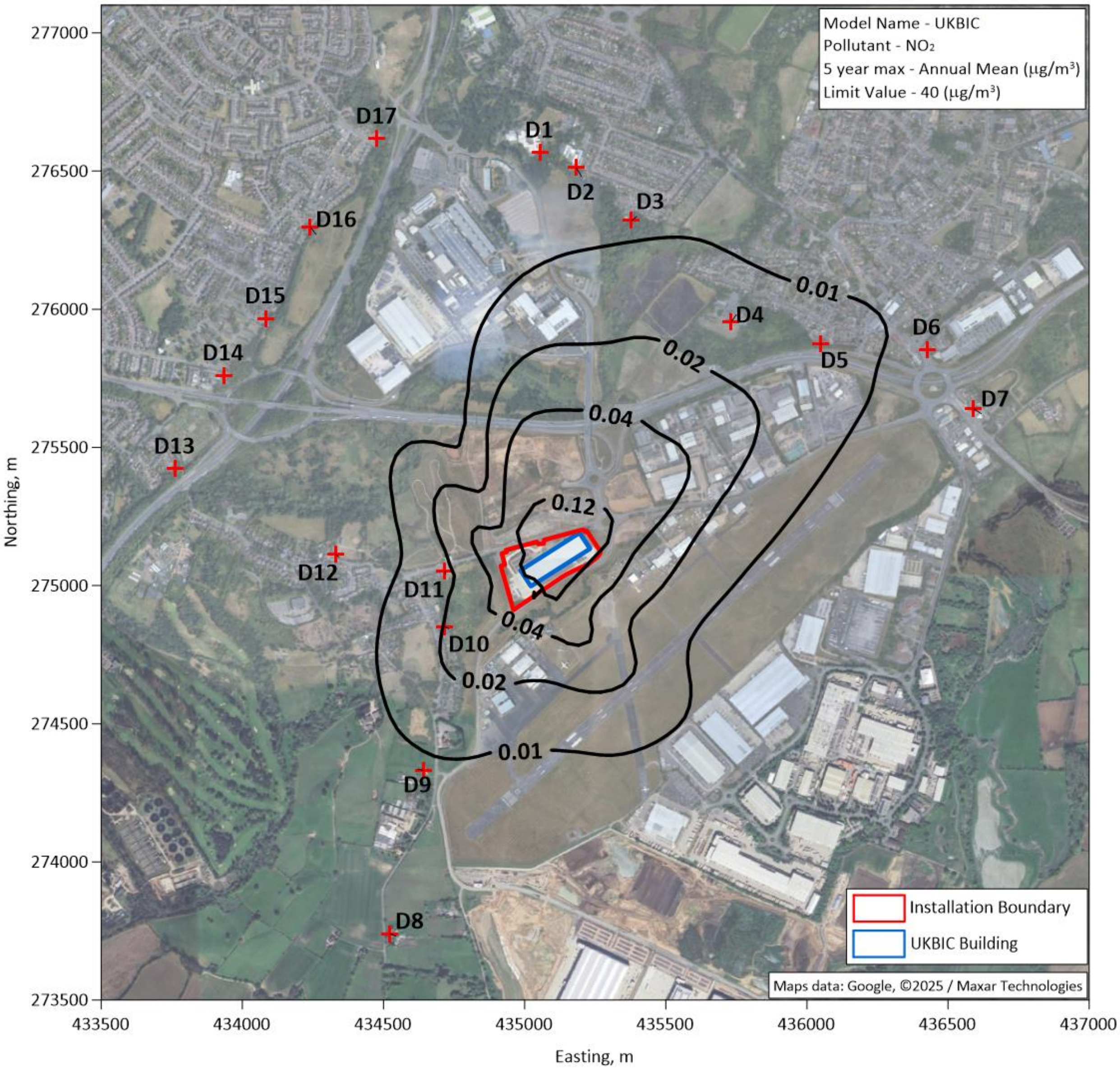


**Figure F-3 - Maximum 1-hour mean $NO_2$ concentrations (µg/m$^3$)**



## Figure F-4 - Maximum Annual mean $NO_2$ concentrations (µg/m$^3$)



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