Permit Variation Application Report
IQE Silicon Compounds Ltd

January 2024

IQE ENVIRONMENTAL PERMIT VARIATION APPLICATION REPORT EPR/AB3893FZ/V003

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INTRODUCTION

This document is IQE Limited’s technical submission to support the application for a Variation of Permit referenced AB3893FZ.

The Installation is currently described in Schedule 1 of the Environmental Permitting (England and Wales) Regulations 2016 (EPR16) as follows:

Section 4.2 Inorganic Chemicals

Part A (1)

(c) Unless falling within any other Section, any manufacturing activity (other than the application of a glaze or vitreous enamel) involving the use of, or the use or recovery of, any compound of any of the following elements—(ii) arsenic.

where the activity may result in the release into the air of any of those elements or compounds or the release into water of any substance listed in paragraph 7 (1) of Part 1 of this Schedule

The activity comprises manufacture of advanced electronic and opto-electronic Group III - Group V semiconductor structures using a process known as Metal-Organic Chemical Vapour Deposition (MOCVD).

The proposed change comprises an increase of the number of reactors from 20 to 92 and to introduce new raw materials to retain maximum operational flexibility and to meet customer expectations and specifications. These proposed changes will result in the following changes to the Newport Semiconductor Facility:

- increases in raw material storage and use of existing raw materials;
- addition of new raw materials;
- installation of additional chillers and fans;
- generation and discharge of aqueous emissions; and
- installation of additional release point to air and abatement plant.

These changes result changes to raw material use, wastes generated and increases in emissions, which have been described and assessed in this report. This application is for a permit variation to enable the expansion of the operations at the installation and permit these changes.

This application is submitted to Natural Resources Wales (NRW), which regulate EPR16 Environmental Permits for Schedule 1 A(1) activities in Wales. NRW has published Environmental Permit Variation Application Forms, which have been completed and submitted with this report. This supporting document presents information which supplements what is provided in the application forms and as a result of pre-application discussions with NRW.

This application supporting document describes the proposed changes and is divided into the sections shown in Table 0-1.

Table 0-1 Structure of the Supporting Document

Section number	Section	Content
0	Introduction	General background information including the purpose of the application.
1	Non-Technical Summary	Non-technical summary of the application and the supporting document for the proposed changes to operation.
2	Process Description	A detailed description of the proposed changes to the Installation.
3	Techniques for Process and Emissions Control and BAT Assessment	Techniques proposed for the proposed changes to minimise emissions and information on the Operator's approach to managing the permitted activities. This includes information on the Environmental Management System, as well as information on raw materials, waste, noise, accident prevention and energy management.
4	Impact on the Environment	Reports on the identification and assessment of environmental impacts from the proposed changes to the operation of the Installation. The risk assessment is summarised in this section with detailed modelling reports included in the appendices where required.
5	Proposed Monitoring and Controls	Identifies the proposed changes to emissions from the activities carried out at the Installation and identifies the process and other monitoring arrangements, techniques and systems that will be in place at the Installation to prevent, or where not practicable, minimise emissions.
Appendix A	Drawings: Installation Boundary Site Plan Process Flow Diagrams Illustration of GaN Process – commercially confidential	
Appendix B	Company Certificate	
Appendix C	Pre-Application Minutes	
Appendix D	Revised Accident Management Plan	
Appendix E	Air Quality Assessment	
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1. Non-Technical Summary

1.1 Introduction

IQE Silicon Compounds Limited ("the Operator") is a leading global manufacturer of advanced wafer products and wafer services to the semiconductor industry. The wafer products are used by major global companies to produce chips which enable a wide range of high-tech applications. The Operator manufactures advanced electronic and opto-electronic Group III - Group V semiconductor structures to customer specification, using a process known as Metal Organic Chemical Vapour Deposition (MOCVD). Increasing demand for the Operator's materials and demand for more complex products mean that it is necessary for the Operator to expand its operations at the Newport Semiconductor Facility from 20 reactors to 92 reactors. This change will require a variation to the existing Permit, referenced EPR/AB3893FZ, as required by EPR16.

This expansion will enable the Installation to increase capacity from 14,000 wafers to produce up to 334,000 wafers for compound semiconductors annually for use in electronic devices.

1.1 Proposed Changes to Operations

There are currently 20 reactors included in the Operator's permit and this application seeks increasing production output, which will involve the installation of an additional 72 reactors. This will require the following changes to the Installation and its permit:

- a small increase in the installation's footprint and therefore the installation boundary will change;
- increases in raw material use and storage;
- addition of new raw materials;
- installation of additional chillers and fans;
- generation and discharge of aqueous emissions;
- four new boilers and two new emergency generators;
- increases in wastes generated;
- increases in emissions to air; and
- installation of additional releases point to air and abatement plant.

The variation application will seek to include the permanent operation of the oxidation furnace and the reactors used for R&D and Testing purposes. These changes will be described, and potential impacts assessed, in the Permit Variation Application documentation.

A review was carried out regarding the operation of four small existing boilers which concluded that they should be added to the permit. Emissions are released via a common existing stack (A11) which should be included in the permit.

1.2 Changes to Schedule 1 Permitted Activities

The full profile of Schedule 1 listed Activities and Directly Associated Activities (DAAs) included in this application, including current and proposed activities, is provided in Table 1-1 below. New activities are highlighted.

Table 1-1 Listed and Directly Associated Activities

Environmental Permitting (England and Wales) Regulations 2016 Schedule 1 Activity References	Description of specified activity
Chapter 4 Section 4.2 Inorganic Chemicals Part A (1) (c) Unless falling within any other Section, any manufacturing activity (other than the application of a glaze or vitreous enamel) involving the use of, or the use or recovery of, any compound of any of the following elements— (i) antimony; (ii) arsenic; (iii) beryllium; (iv) gallium; (v) indium; (vi) lead; (vii) palladium; (viii) platinum; (ix) selenium; (x) tellurium; (xi) thallium, where the activity may result in the release into the air of any of those elements or compounds or the release into water of any substance listed in paragraph 7 (1) of Part 1 of this Schedule.	92 reactors Ancillary plant and equipment Activity extends from the receipt of process gases to the wafer manufacturing process including emissions of exhaust gas, discharge of effluent from abatement plant and the water pre-treatment plant and disposal of waste. Operation of an oxidation furnace.
Directly Associated Activities	**Description of activity**
Directly Associated Activities	Operation of systems for the receipt and storage of process gases and raw materials.
	Operation of systems for the transmission of process gas from storage facilities to the reactors.
	Operation of systems for the receipt, storage, treatment by softening and reverse osmosis and use of water required for process needs.
	Operation of systems for the treatment of process gases via emission points A1, A4 plus four additional release points (process emissions). Release of extraction air from up to 6 gas storage bunkers (1 existing, 5 new) via existing extract A2 plus five additional release points. Local exhaust ventilation (LEV) fume extraction via emission point A3.
	Operation of systems for the collection and discharge of surface water via emission point W1 and process emissions via emission point S1.
	Operation of systems and facilities for the storage, handling and disposal of wastes.

Environmental Permitting (England and Wales) Regulations 2016 Schedule 1 Activity References	Description of specified activity
	Operation of cooling circuits for the provision of cooling water for process needs.
	Operation of two 5MWth emergency generators.
	Operation of five duty and three standby boilers to supply temperature control to the reactor areas.

The changes comprise a 'normal variation' as there are no changes to

1.3 Description of the Site and its Surroundings

The installation boundary will increase to allow for the additional plant and equipment. See Installation Boundary Drawing in Appendix A of this report.

1.4 Point Source Emissions to Air

Emissions to air will increase as a result of the proposed change. There will be additional point source emissions to air to serve the new reactor emissions, furnace and gas storage bunkers which are all abated prior to release. Changes are described below:

- A1 would serve the ten reactors plus the oxidation furnace emissions.
- A4 would serve 10No reactors via abatement during normal operation (change in chemistry compared with current operations).
- A new stack (A4a) which is located adjacent to A4 would serve 10No reactors via abatement during etch cycle.
- Four new process emission points (A5, A6, A7, A8) would serve 72 reactors via abatement.
- Two new emission points (A9 and A10) which would serve two emergency generators.
- One existing emission point which is newly added to the permit (A11) which would serve four small boilers (two duty, two standby) through a shared flue.
- Four new emission points (A12, A13, A14, A15) which would serve four small boilers (three duty, one standby) through individual flues.
- Five new gas storage bunkers with extracts.

1.5 Point Source Emissions to Water

There will be new effluent streams generated by the burner abatement plant cooling systems, additional effluent from water pre-treatment processes and from the oxidation furnace which will be released to water via sewer from release point S1.

Aqueous process emissions arise from the operation of the abatement plant, water pre-treatment processes and cooling system and are described in Section 2.10. There are no process emissions released directly into surface water drains. All aqueous emissions are of low toxicity and are discharged into the foul sewer system in accordance the sewerage undertaker, Welsh Water's discharge consent.

There will be no point source emissions to ground or groundwater.

Emissions points are shown on the Site Plan in Appendix A.

1.6 Fugitive Emissions

The proposed changes are unlikely to result in any material increase in fugitive releases to air, land or water due to the proposed controls.

As per the current arrangements, fugitive releases from gases stored on-site are prevented by robust storage systems and the installation of gas detection equipment. The gas storage bunker extracts are fitted with abatement equipment to remove accidental releases of process gases.

It is unlikely that offsite nuisance due to odour will occur as a result of the operation of the installation, currently or as a result of the proposed changes. Releases of potentially odorous gases are well below the odour thresholds.

There is no bulk storage of liquids on-site. There will be quantities of liquid ammonia, cooling system treatment chemicals and other maintenance fluids stored on-site as a result of the proposed changes. Release of fugitive emissions to land and water from stored materials is prevented through appropriate infrastructure and management controls.

A qualitative assessment has been carried out on foreseeable releases of fugitive emissions as a result of the proposed changes, which concludes that the risk to the environment is low in all scenarios considered.

1.7 Management and Control

There are no proposed changes to the management and control of the facility.

The Operator has implemented an Environmental Management System (EMS) certified to the standard of ISO14001:2015. The EMS includes all activities connected to the installation and will incorporate the proposed changes. Handling and distribution of the new reactor units, raw materials and other plant and equipment will be managed with the same high levels of control.

1.8 Raw Materials

There will be additional new raw materials which have been quantified and assessed in the permit variation application. Such additional raw materials comprise:

- new dopant gases comprising silane and propane;
- cooling water chemicals and additional maintenance materials;
- chlorine; and
- ammonia.

All potentially polluting materials will either be stored in secure locations within buildings or are provided with appropriate primary and secondary containment.

1.9 Waste Generation

There is minimal waste generated by the facility which comprises predominantly solid waste generated by the air emissions abatement equipment, packaging waste, and maintenance fluids such as oils. Any wastes generated are stored and disposed of to minimise environmental impact whilst adhering to the waste hierarchy. There will be an increase in the quantities of waste produced by the facility which will be proportionate to the expansion of operations.

Wastes generated as a result of the proposed change have been quantified in this application.

1.10 Energy Use

There will be an increase in energy use by the facility which will be proportionate to the expansion of operations.

Energy use arises from the operation of the reactors and ancillary pumps, combustion plant, fans and chillers. Where demand may vary, variable speed pumps and fans have been installed to minimise energy use.

1.11 Accidents and their Consequences

There are no proposed changes to the management and control of the facility.

The Installation is operated by a dedicated on-site team which has the required skills and experience to operate the Installation safely. The Operator employs an Accident Management Plan which meets the relevant NRW guidance. Potential accidents which may arise during the operation of the proposed Installation will be considered and assessed using three elements:

- identification of hazards;
- assessment of the risks (and possible consequences); and
- identification and implementation of techniques to reduce the risks of accidents (and contingency plans for any accidents that may occur).

Where new accident scenarios may occur as a result of the proposed changes, preventative measures have been included in line with the measures currently in place, which are described in the Accident Management Plan scenarios in Appendix D of this report.

1.12 Noise and Vibration

The proposed changes involve the installation of new plant and equipment including chillers and fans which will potentially change the noise profile in the local area. Revised predicted noise levels and impacts have been quantified in a Noise Assessment following the advice in BS4142 (see Appendix F) which concludes that the plant would not cause significant effect at the noise sensitive receptors..

1.13 Overall Environmental Impact

The potential for impact on the environment as a consequence of the proposed changes to the operation of the Installation has been assessed, taking into account the proposed activities and the presence of identified sensitive receptors. The main emissions to air are releases of process gases from the reactors and their impact at both human and ecological receptors has been assessed in Section 4.1 of this application and quantified within the Air Quality Assessment which is included in Appendix E.

The assessment concludes that despite an overall increase in emissions the installation will not have a significant impact on the environment.

Aqueous process emissions arise from the operation of the abatement plant, water pre-treatment processes and cooling system and are described in Section 2.10. There are no emissions released directly into surface water drains. All aqueous emissions are of low toxicity and are discharged into the foul sewer system in accordance the sewerage undertaker, Welsh Water’s discharge consent.

Emissions to water from W1 comprise of uncontaminated surface water only.

1.14 Emissions and Monitoring

Emissions from the installation, as amended by this variation application, have been quantified. Process monitoring controls including gas detection will be in place to prevent accidental releases from the new release points using the same robust methods as the existing release points. Proposed monitoring is described in Section 5.

1.15 Installation Issues

The Installation will continue to be operated by a single operator. The installation boundary will increase to allow for the additional plant and equipment. See Installation Boundary drawing in Appendix A of this report.

1.16 Planning Permission

The changes to operation will require changes relating to the installation's planning consent. An application will be submitted to the local authority.

1.17 Application Information

Type of Application

Installation Permit Variation Application

Permit Variation Application Reference Number

EPR/AB3893FZ/V003

Installation Name

Newport Semiconductor Facility

Installation Address

IQE Silicon Compounds Limited

Imperial Park

Celtic Way

Newport

NP10 8BE

Company Registration Number

03986643

Installation Grid Reference

ST28227 84462

Pre-Application Discussion

A pre-application meeting was held with NRW on 4 October 2023 via MS Teams. The meeting report is included in this application in Appendix C.

Legal Status of Operator

There is no change to the legal status of the Operator. The operator is a limited company, trading as IQE Silicon Compounds Limited. The Companies House certificate have been provided in this application in Appendix B.

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2. Process Description

2.1 Introduction

This section provides a description of the proposed changes to the Newport Semiconductor Facility, including its purpose, plant items, and modes of operation.

2.2 General Description of the Current Facility

The installation's permit currently includes the following activities:

- 20 reactors each provided with a chemisorption abatement unit to minimise process emissions;
- two flues with each flue serving abated emissions from ten reactors;
- gas storage bunker with one flue installed, which includes chemisorption abatement units to abate potential accidental releases;
- local exhaust ventilation (LEV) fume extraction which is released via one flue;
- pre-treatment of water by softening and reverse osmosis;
- cooling circuits and other ancillary plant and equipment;
- storage and distribution of raw materials including pressurised and liquefied gases; and
- foul and surface water drainage linking the Installation to existing infrastructure.

There were recent changes to current operations which were allowed to be carried out on a temporary basis without varying the permit as they were determined to comprise Research, Development and Testing activities under EPR2016:

- Operation of 10 of the existing 20 reactors using a different chemistry (gallium nitride or GaN).
- Use of the additional raw materials.
- Change in the proposed abatement technology for the 10 reactors to include plasma abatement.

In addition, a request to operate a small oxidation furnace on a temporary basis, as a minor operational change, was approved by NRW on 4 October 2023.

2.3 Proposed Changes

The proposed changes comprise an increase of the number of reactors from 20 to 92 over a phased approach:

- Phase 1 (current operation): Manufacture of wafers on 10 reactors.
- Phase 2 (currently covered by temporary R&D exclusion): Manufacture of wafers on 10 reactors plus R&D and Testing activities using 10 reactors employing a change of chemistry.
- Phase 3 (the subject of this application): Manufacture of wafers on 10 existing reactors plus 82 new reactors which includes full-scale manufacturing using the 10 reactors used for R&D and testing in Phase 2, plus an additional 72 reactors.

This proposed increase in production will result in the following changes to the Newport Semiconductor Facility:

- a small increase in the installation's footprint and therefore the installation boundary will change;
- increases in raw material use and storage;

- addition of new raw materials;
- four new small boilers (three duty, one standby)
- two new generators
- installation of additional chillers and fans;
- generation and discharge of aqueous emissions;
- increases to wastes generated;
- increases in emissions to air; and
- installation of additional releases point to air and abatement plant.

The variation application will seek to include the permanent operation of the oxidation furnace and the reactors used for R&D and Testing purposes. These changes will be described, and potential impacts assessed, in the Permit Variation Application documentation.

Following expansion, the facility will comprise (changes are highlighted):

- 92 reactors
- Six process gas flues (A1, A4 plus four new flues) serving abated emissions from the reactors and furnace.
- Four existing boilers (two duty, two standby) and four new small boilers (three duty, one standby)
- Two new generators
- One existing gas storage bunker flue plus five new gas storage bunkers each with a dedicated flue.
- One existing flue which serves the local exhaust ventilation (LEV) fume extraction (no change).
- Pre-treatment of water by softening and reverse osmosis (expansion of capacity).
- Cooling circuits and other ancillary plant and equipment (new cooling circuits are proposed).
- Storage and distribution of raw materials including pressurised and liquefied gases (changes to and increase in overall inventory).
- Foul and surface water drainage linking the Installation to existing infrastructure (increase in foul water drainage and surface water drainage system will be expanded).

The pace of change in technology within the semiconductor industry is rapid. IQE seeks to retain maximum operational flexibility to meet customer expectations and specifications and to meet these requirements, it is possible to operate a range of chemistries on the existing and new reactors. As such, IQE proposes the following operating variables which define the proposed approach to retaining flexibility within the Permit whilst meeting customer's demands.

- Reactors 1 to 10 will employ use of gallium arsenide (GaAs) or indium phosphide (InP) technologies as per the original application.
- Reactors 11-20 will employ use of gallium arsenide (GaAs) or (InP) technologies as per the original application, or use of gallium nitride (GaN) technology. Reactors 11-20 are a new generation compared to the original application and there are minor changes which affect raw material quantities and subsequently emissions. The impacts of this minor change are addressed in the permit application.
- Reactors 21-92 will employ GaN technology.

These processes are described in more detail in the sections below. They define the scope of the Application, and in particular, the scope of the Environmental Risk Assessment (ERA) and associated technical assessments in Section 4.

2.4 Overview of Manufacturing Processes

The Operator manufactures advanced electronic and opto-electronic Group III - Group V semiconductor structures to customer specification, using a process known as MOCVD. This process involves the growth of semiconductors using substrates in a wafer form and the epitaxial deposit of material onto these substrates using carrier gases. Small quantities of gaseous dopants (hydrogen with a low concentration of silane and propane) are also introduced to produce the desired crystals.

In the MOCVD process, a gas stream is passed over a heated wafer (typically at temperatures between 400°C - 1300°C depending on the material to be deposited). Each of the existing and new 92 reactors in which MOCVD is undertaken will be in a bay. Inputs to the process are supply gases, metal-organics and wafers, which are manually loaded into the reactors. The reaction operates at temperatures up to 1200°C, producing finished wafers and process exhaust gases.

There is limited scope to optimise or change the process since the strict product quality requirements require a specific process to be undertaken. As per current operations, the reactors will operate 24 hours per day, seven days per week.

Table 2-1 below summarises the operation of the reactors and their chemistries.

Table 2-1 Operation of 92 Reactors

Reactor	1-10	11-20	21-92
Technology	GaAs, InP	GaAs, InP, GaN	GaN
Emissions	GaAs: Arsine InP: Phosphine	GaAs: Arsine InP: Phosphine GaN: Ammonia (normal operation), chlorine (during etch)	Ammonia (normal operation), chlorine (during etch)
Abatement (see Section 2.7)	Chemisorption	GaN: plasma abatement during normal operation, Chemisorption during etch. GaAs, InP: Chemisorption	Plasma abatement during normal operation, Chemisorption during etch.
Emission Points	A1	A4, A4a (during GaN etch cycle)	A5, A6, A7, A8

Under normal operation, units 11-92 will employ a GaN-based technology. Gallium (Ga) in the form of trimethylGallium (TMGa) and a source of nitrogen, ammonia (NH_3), together with a high purity carrier gas (hydrogen) flow into the reactor chamber.

The chamber temperature is set at 400-1300°C. When the gases are introduced, the high temperatures break down the TMGa to release Ga and the NH_3 to release N, the atoms are free to adhere to the surface of the substrate in the chamber, in this case silicon, which in turn produces the GaN material needed for this process. See Appendix A.4 for illustration.

The process requires accurate control of deposited layer thickness and lattice parameters (ratios of molecules) to give a perfect crystal structure on the Silicon substrate.- Other materials that can typically be used to engineer the properties of the GaN based structures could include combinations of trimethylaluminum (TMAl), trimethylindium (TMIn), Silane and propane.

Units 1-10 will continue to employ GaAs (and potentially InP) technologies as per the previous permit variation application. Units 11-20 may be adapted to employ GaAs and potentially InP technologies as per the previous permit variation application.

A process flow diagram is provided in Appendix A.

2.5 Oxidation Furnace

The proposed changes would require the use of an oxidation furnace as illustrated in Figure 2-2 below.

The Koyo VF 1000B oxidation furnace is a research-level tool capable of thermal oxidation of semiconductor wafers under a 'wet' atmosphere. Physical dimensions are 1500mm x 1000mm x 2080mm (w x d x h) and all gases, process and purge, are extracted through the top of the tool.

The moisture is supplied by a steam generation unit held within the tool and fed with deionised water at a maximum flow rate of 3.6 cc/minute. The tool itself is purged with both nitrogen gas and air from the environment in which it is placed.

Figure 2-2 Oxidation Furnace

The process itself involves the oxidation of thin layers of gallium arsenide, aluminium arsenide and compounds of these two grown epitaxially by the MOVPE process on GaAs substrates. The oxidation chamber occupies the upper chamber of the left side of the tool.

The process exhaust passes through a heat exchanger before joining the extract and in addition to the gaseous by-products there will be condensed water, and both of these are likely to include arsenide-containing compounds.

Calculations have been performed to determine the maximum mass flow rates of the arsenide-containing compounds in the air (see Air Emissions Assessment in Appendix E). Water emissions are negligible and will be released to sewer.

The new oxidation furnace will result in a very slight increase in arsine emissions released via A1.

2.6 Combustion Plant

2.6.1 Emergency Generators

The primary purpose of the engines is to provide electrical backup to the site's National Grid electricity connection and is designed to provide electricity in the event of a national grid supply failure. This is an essential requirement for the Operator as the facility is reliant on electrical supply to maintain both production equipment and essential abatement plant. In a power failure scenario, the engines would automatically fire-up to provide the requisite power to the installation.

The emergency engines are fuelled by diesel rather than natural gas from the National Grid so that IQE maintains an independent power supply. Whilst it is possible to store gas onsite, this would present a serious fire / explosion risk. As well as being safer, diesel generators are also generally sturdier and more reliable, have longer lifespans, are more fuel efficient and have lower CO_2 emissions. For these reasons, diesel is the best fuel option for the emergency engines on-site. The engines will be used in the following scenarios:

- emergency use; and
- testing and maintenance.

Design and operation aspects will be employed to minimise emissions, as described in Section 2.6.4.

2.6.2 Boilers

The boilers provide space heating for the reactor units and for employees. They will be natural gas fired and fitted with low NOx burners compliant with Euro 6 standards. All boilers are below the regulatory thresholds within MCPD.

Design and operation aspects will be employed to minimise emissions, as described in Section 2.6.4.

2.6.3 Summary of Proposed Combustion Plant

Table 2-3 below describes the combustion plant which will be installed at the Installation.

Table 2-3 Combustion Plant

Combustion Plant	Existing or New	Purpose	Size MWth	Fuel	Flue configuration	Installation Date	MCPD Aggregation Rule Application [1]	Application of MCPD and SG requirements
4No existing boilers (2 duty, 2 standby)	Existing	Provide required temperature for reactors and for employee space heating. Continuous operation.	0.533 each	Natural Gas	Shared flue (A11)	September 2017	Aggregation rule does not apply to 'existing' plant [2]	These boilers are out of scope of MCPD as they are below the regulatory threshold.
4No new boilers (3 standby, 1 standby)	New	Provide required temperature for reactors and for employee space heating. Continuous operation.	0.804 each	Natural Gas	Individual flues (A12, A13, A14, A15)	Planned for 2024 onwards in phased approach	Aggregation rule does not apply. Flues must be separate to allow individual maintenance activities to be carried out. Boilers are not installed together but will be installed individually as expansion of facility progresses in planned phases.	These boilers are out of scope of MCPD as they are below the regulatory threshold.
2No Emergency Generators	New	Provide emergency power in an outage	5 each (100% load)	Natural Gas	Individual flues (A9, A10)	Planned for 2024	Separate flues therefore aggregation rule does not apply.	Specified generator requirements do not apply in full as generators are operated <50hrs per year and they are part of a Schedule 1 listed activity. MCPD emission limits do not apply as they are operated for <500 hrs per year.

Combustion Plant	Existing or New	Purpose	Size MWth	Fuel	Flue configuration	Installation Date	MCPD Aggregation Rule Application [1]	Application of MCPD and SG requirements
Note 1: MCPD Article 4 Aggregation: A combination formed by two or more **new medium combustion plants** shall be considered to be a single medium combustion plant for the purposes of this Directive and their rated thermal input shall be added together for the purpose of calculating the total rated thermal input of the plant, where: — the waste gases of such medium combustion plants are discharged through a common stack, or — taking into account technical and economic factors, the waste gases of such medium combustion plants could, in the judgement of the competent authority, be discharged through a common stack. Note 2: MCPD Article 3 Definitions: 'existing combustion plant' means a combustion plant put into operation before 20 December 2018 or for which a permit was granted before 19 December 2017 pursuant to national legislation provided that the plant is put into operation no later than 20 December 2018. As the boilers are below 1MWth individually, they have not been aggregated and are therefore out of scope.								

2.6.4 Combustion Plant Design and Maintenance

2.6.4.1 Preventative Maintenance

For all combustion plants, plant design features and planned preventative maintenance (PPM) are important primary measures to maintain optimum emissions in line with the manufacturer's performance specification for the combustion units.

Maintenance is a key component of operational control at the installation, particularly for ensuring air emissions and energy efficiency are maintained at the required levels. Maintenance activities may be either planned or reactive (i.e., in response to breakdowns or performance deterioration resulting from a fault).

IQE has a robust programme of PPM in place for all critical plant and equipment which includes using a computerised system to schedule inspections and activity and record defects. Spare parts are maintained on-site. PPM is included in the overarching EMS and will include the additional plant and equipment.

All regular maintenance is completed to the timescales specified by the equipment manufacturer, as optimised by best industry practices and operating experience.

A high level of preventative maintenance is carried out to avoid unscheduled down time, maximising the plant availability and its ability to control emissions and maintain an efficient level of operation between overhauls. It is an important component of the measures to keep the combustion units at peak efficiency and optimum emissions performance.

2.6.4.2 NOx Control

The primary pollutant of concern for the combustion plant is NOx. The most important oxides of nitrogen with respect to releases from combustion processes are nitric oxide (NO), nitrogen dioxide (NO_2) (together comprising NOx) and nitrous oxide (N_2O). Nitric oxide forms over 95% of the total NOx in emissions from most types of combustion plant.

The boilers employ low NOx burners which comply with 'Euro 6' standards. IQE use only grid-supplied natural gas in the boilers.

The generators only operate for 50 hours per annum for testing and maintenance therefore overall NOx emissions will be minimal. NOx levels comply with TA Luft standards.

2.6.4.3 SO_2 Control

In combustion processes, the fuel is the source of sulphur in emissions. Therefore, SO_2 emissions from the boilers are controlled via the primary technique of fuel selection. IQE use only grid-supplied natural gas in the boilers which is low in sulphur.

Low-sulphur fuel which contains 0.1% (1,000 ppm) sulphur is used in the generators. This meets the requirements of the SCOLF 2007 of 0.1% (1,000 ppm) for diesel fuel. The generators only operate for 50 hours per annum for the purpose of testing and maintenance therefore overall SO_2 emissions will be minimal.

2.6.4.4 Particulates and Metals Control

In combustion processes, the fuel is the source of particulates in emissions. Therefore, particulate emissions from the boilers are controlled via the primary technique of fuel selection. IQE use only grid-supplied natural gas in the boilers which is low in particulates.

UK specification low-sulphur fuel is used in the generators; the process of producing low sulphur fuels removes ash, which will reduce particulate emissions. The generators only operate for 50 hours per annum for the purpose of testing and maintenance therefore overall particulate emissions will be minimal.

2.6.4.5 CO Control

CO emissions from the boilers are minimised by combustion efficiency techniques, such as optimising boiler and generator design, operation and maintenance.

2.6.4.6 VOC Control

Emissions of VOCs from the boilers and engines will be controlled in the same way as CO emissions, i.e., via combustion efficiency techniques.

2.6.4.7 CO_2 Control

CO_2 is not a pollutant which is specified for control under the MCPD. However, all measures for the reduction of fuel use, i.e., those measures described above for the optimisation of combustion efficiency, will inherently reduce CO_2 emissions. The global warming potential of the combustion plant is discussed in Section 4.

2.6.4.8 Halogens and Dioxins

Halogens in the form of hydrogen chloride (HCl) and hydrogen fluoride (HF) are produced from the combustion of fuel if it contains chlorine and fluorine. The quantities produced by combustion of natural gas and diesel are low due to the very low concentrations of fluorine and chlorine in the fuel, which are tightly controlled by the fuel specifications.

Dioxins can be produced by the combustion of any carbon containing fuel in the presence of trace quantities of chloride. Due to the low chloride levels in the fuel as described above and high combustion temperatures, dioxin levels will be negligible.

2.7 Changes to Emissions to Air

The currently permitted reactors produce a process exhaust gas that contains a mixture of substances comprising:

- arsine;
- phosphine;
- tributylphosphine;
- trimethylgallium;
- trimethylindium;
- trimethylaluminum;
- carbon tetrabromide;
- hydrogen sulphide;
- disilane;
- dimethylzinc
- dimethyltelluride
- bis-cyclopentadienyl magnesium
- inert gases (nitrogen and helium); and

- hydrogen.

The substances listed above are currently abated by the means of dry chemical absorption (chemisorb scrubbing) as described in the previous permit variation. No changes are proposed to the operation of the operational reactors, abatement or emissions.

Currently, the following release points are included in the Permit:

- A1 serving ten reactors via chemisorption abatement to abate process emissions.
- A2 which serves the gas storage units in the bunker via chemisorption abatement units to abate potential accidental releases, there are no routine process releases from this point.
- A3 which serves laboratory scale fume cupboards and comprises LEV.
- A4 serving ten G4 reactors via chemisorption abatement to abate process emissions.

The following changes and additions are proposed:

- A1 would serve the ten reactors plus the oxidation furnace emissions.
- A4 would serve 10No reactors via abatement during normal operation (change in chemistry compared with current operations).
- An additional stack (A4a) which is located adjacent to A4 would serve 10No reactors via abatement during GaN etch cycle only.
- Four new process emission points (A5, A6, A7, A8) would serve 72 reactors via abatement.
- Two new emission points (A9 and A10) which would serve two emergency generators.
- One existing emission point which is newly added to the permit (A11) which would serve four small boilers through a shared flue.
- Four new emission points (A12, A13, A14, A15) which would serve four small boilers through individual flues.
- Five new gas storage bunkers with extracts.

A review was carried out regarding the operation of four small existing boilers which concluded that they should be added to the permit. Emissions are released via a common existing stack (A11) which should be included in the permit., see Section 2.6.2.

2.7.1 Changes to Process Emissions to Air from Reactors

The additional reactors will use new as well as existing raw materials and as such, emissions will differ to those described in the permit. The following emissions may be generated by the new reactors when operating using GaN technology. Substances released to into the air from reactors 11-20 when employing GaAs or InP technologies are the same as those described in the original permit application, only the quantities will change.

- Dopant gases:
    - propane (new).
    - silane in hydrogen (1000ppm or 2000ppm) (new).
- Inert gases and hydrogen:
    - nitrogen (existing).
    - helium (existing).
    - hydrogen (existing).
- Reaction products comprising trace metal organics (existing).

- Chlorine (new).
- Ammonia (new).
- Combustion products from abatement system:
  - oxides of nitrogen (new).
  - carbon monoxide (new).
  - carbon dioxide (new).

2.7.1.1 Dopant Gases

New dopant gases will be used in addition to the current gases at the facility:

- Propane.
- Silane in hydrogen (1000ppm or 2000ppm).

The reactor flues will be fitted with detectors that will constantly operate to detect any leak of dopant gases. The detectors will immediately isolate all supplies to the affected reactor at the gas cabinet in the event of gas being detected.

Gases are to be supplied via double contained pipelines from a dopant gas cabinet located in the bay.

2.7.1.2 Hydrogen

Hydrogen is currently used in the manufacturing process as a carrier gas and will also be used in the same way in the additional reactors. Hydrogen will continue to be supplied from a hydrogen storage system comprising a trailer mounted cylinder located in the external yard.

2.7.1.3 Inert gases

The inert gases currently supplied to the facility comprise nitrogen and helium and will continue to be used and stored in the same way for the additional reactors. The nitrogen supply will be stored in a dedicated liquid nitrogen tank and will be produced to two grades:

- Process nitrogen – which will be used as a carrier gas and a process purging medium; and
- Technical nitrogen – for all other duties, typically pneumatic instrument supply, vent blending (to prevent overheating of the media and liquid accumulation, this is done automatically by the chemisorb scrubber system) and non-process purging.

Process nitrogen will be produced by passing technical nitrogen through gas purifiers to remove particulates and impurities. Purifiers will be installed on a duty/standby arrangement with the purification process taking place in-line, located outside the main building. The nitrogen tank will be provisioned with a pressure relief valve.

Technical nitrogen will be used for all systems not requiring process grade nitrogen.

As per current arrangements, helium will be stored in bottles and used for leak testing, which will take continue to take place routinely in accordance with the site's operational control procedures as part of the Safety Management System.

Argon is not currently stored or used on site. It will be used on the reactors which are using GaN technology as carrier gas. It will be stored in a cylinder on-site adjacent to the nitrogen cylinder.

2.7.1.4 Trace Metal Organics

There are changes to the trace metal organics stored and used on-site. Quantities of metal-organics input into the reactors as provided in Table 2-8. These materials are used at trace levels in very low quantities as quantified in this table. The fate of these substances is either that they are transferred onto the wafers which is the primary purpose of the MOCVD process (10-20% of the input materials), or deposited onto the reactor susceptors, reactor walls in the growth cells then trapped and contained in the reactor exhaust system (70-75% of the input materials), which must be periodically maintained to remove this deposition. Whilst over 80% of the input materials are used in the process or deposited within the equipment, and only extremely low levels enter the flue, the abatement will be in place to remove any trace residual levels which could potentially be emitted to atmosphere during the reaction phase of the operation.

As these materials are extremely valuable, in addition to protection of the environment and human health, there is a financial and resource minimisation driver to prevent release to atmosphere.

2.7.1.5 Chlorine

Chlorine is applied during the 'etch' cycle to chemically remove layers from the surface of a wafer during manufacturing, which results in the release of a process gas. This gas may contain chlorine and trace quantities of etch products such as metal organics which are removed by chemisorption abatement. See Section 2.7.2.

2.7.1.6 Ammonia

Ammonia is consumed by the process and supplies nitrogen atoms to the chemical reaction which takes place within the reactors when applying GaN technology. Whilst reactions are strictly controlled, any residual ammonia gas may be released into the atmosphere and therefore abatement is installed to treat the reaction gases. See Section 2.7.2.

2.7.2 Selection of Abatement Plant

Abatement plant is currently installed to prevent process releases of metal organics and other substances via emission point A1. No changes are proposed to the operation of the current reactors, abatement or emissions.

The new reactors when applying GaN technology will produce a different range of pollutant gases which will be abated in two stages:

1. Burner, comprising a plasma combustion system. The burner is specially engineered to handle the gas flows and related operating conditions of safety-critical process applications including MOCVD.
2. Chemisorption (as per existing technology), which is employed to treat process gases during the cleaning cycle. The chemisorption scrubber is specially engineered to handle the gas flows and related operating conditions of safety-critical process applications including MOCVD.

The existing chemisorption abatement will not sufficiently break down ammonia releases from the additional reactors when applying GaN technology, which employ a different chemistry to the existing reactors, therefore a review of abatement technologies was carried out. During the etch cycle, chlorine and other pollutants may be released, which also require abatement.

The following options were originally identified as potentially applicable for abatement of emissions:

1. carbon based chemical absorption;
2. filtration
3. wet scrubbing;
4. chemical absorption; and
5. burner technologies.

Table 2-4 below summarises abatement techniques which were considered and their advantages and disadvantages.

Table 2-4 Review of Abatement Technologies

Technique	Applicability	Advantages	Disadvantages	Removal Efficiency
1. Carbon based chemical absorption (e.g. charcoal)	Not applicable. Combustible materials are not suitable due to use of pyrophoric substances and presents significant fire risk.	NA	NA	NA
2. Filtration	No, not effective for abatement of gases	NA	NA	NA
3. Wet scrubbing	Yes, effective for abatement of gases	Effectively abates gaseous emissions, used for similar applications. High removal efficiency.	Technology requires bulk storage of chemicals such as sodium hypochlorite and sodium hydroxide. Creates effluent stream which presents additional environmental risk transferring pollutants from gaseous releases into water in addition to addition of potentially polluting treatment chemicals. High level of physical and procedural controls required to maintain correct chemical additions to ensure pollutants are removed from gaseous stream.	>99%
4. Chemisorption	Yes, effective for abatement of gases	Effectively abates gaseous emissions, used for similar applications and is designed specifically for MOCVD process emissions. Very high removal efficiency. No bulk storage of chemicals, no aqueous emissions.	Not effective in removing ammonia. Columns need to be periodically replaced (granular material is removed by abatement equipment manufacturer for regeneration off-site). High levels of physical and procedural controls are required	>99.99%
5. Burner technologies	Yes, effective for abatement of gases	Safe removal of hydrogen. New technologies employ high efficiency plasma	Not effective in removing chlorine. Generates particulate-containing waste gas. Releases carbon dioxide.	>99%

Technique	Applicability	Advantages	Disadvantages	Removal Efficiency
		conversion abatement which do not require natural gas. No need to replace or regenerate consumables, no solid or liquid wastes generated.		

The gases released are highly complex and contain materials which require specialist abatement technologies. The chosen technologies incorporate both Option 4, chemisorption scrubbers combined with Option 5, a burner technology. This is because ammonia will not be sufficiently removed by chemisorption and requires treatment by plasma abatement to fully treat emissions. However, during the etch cycle, it was determined that the chemisorption technology is the best option for the treatment of chlorine and trace metal organics, which are potentially released during the 'etch' process.

Both technologies represent BAT for the chemicals sector (see Section 3.8) and are described in more detail below.

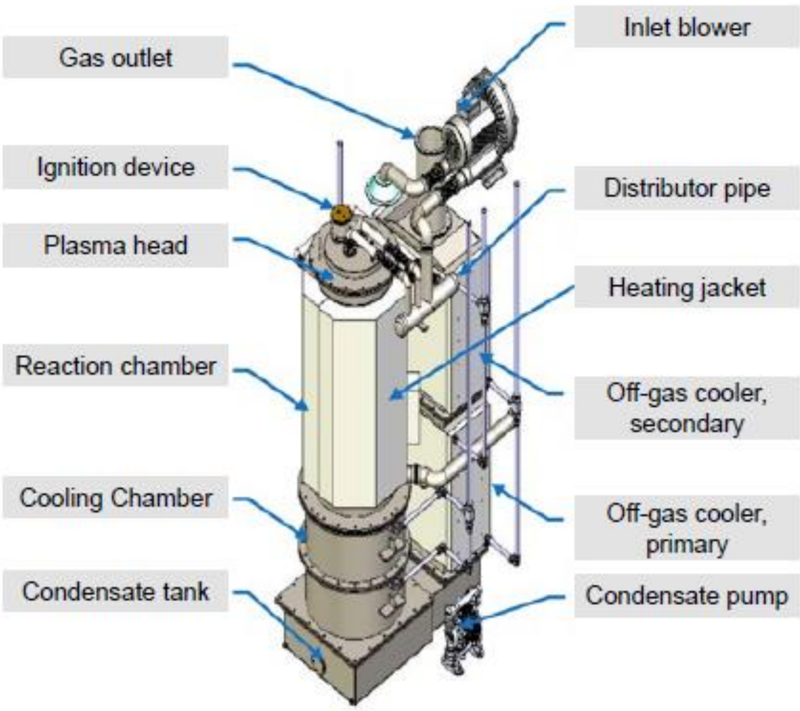
Abatement applied to reactor emissions for reactors 1-20 when operating using GaAs or InP technologies remains as described in the original permit application, which employs chemisorption.

2.7.3 Description of Proposed Abatement Technologies

2.7.3.1 Plasma Conversion Abatement

The plasma abatement plant uses two combustion technologies, comprising a heater jacket and a gliding plasma, to ensure optimal abatement. Most of the energy required for abatement of ammonia is supplied by the hydrogen content of the waste gas negating the need for the use of additional natural gas. As there is no combustion of fuel, the content of condensation water, and consequently emissions to water, are minimised. Figure 2-5 below illustrates the components within the plasma conversion abatement system.

Figure 2-5 Plasma Conversion Abatement System



Two tools will be served by one plasma conversion abatement unit.

The reactors have an interlock which prevents operation if the burner is not operating.

2.7.3.2 Chemisorption

The chemisorption scrubber columns will provide abatement during the etch cycle.

The chemisorption scrubber is specially engineered to handle the gas flows and related operating conditions of safety-critical process applications including MOCVD.

The chemisorption unit manufacturer's guarantee is that levels of chlorine will be released at levels below the workplace exposure limits of the components of each exhaust gas; however actual levels of these substances are projected to be below detectable levels as the reaction by the chemisorption process achieves complete breakdown of the pollutant gases.

The reaction of the waste gases with the chemisorb scrubber media is exothermic and produces water which is lost to flue exhausts as moisture laden nitrogen. Additional nitrogen can be added to prevent overheating of the media and liquid accumulation. This is achieved automatically by the chemisorption scrubber system. Each chemisorb unit comprises lead and lag chemisorption columns and a third back-up column to ensure continuous prevention of release of emissions.

It will have an inbuilt alarm and interlock that prevents continued operation of the reactor if the abatement becomes blinded or sub-optimal. This is achieved by multiple gas detection to identify when breakthrough has occurred so that operators can be alerted that the lead chemisorption column needs to be changed. Spare sealed chemisorb columns will be stored locally to chemisorb units and spent columns will be removed by the manufacturer in a sealed state. The gas detection system installed automatically stops the operation of the reactors. The chemisorb scrubbers are self-contained process units and do not require any external process control. Process alarms sound locally and will be reported to the control system for the attention of the operations team.

Each reactor will have one dedicated chemisorption abatement unit.

The Operator's Safety Management System will include procedures for routine changing of chemisorption columns and actions to be taken in the event of a column breakthrough.

2.7.3.3 Performance Guarantees

The abatement technologies are designed to reduce emissions of pollutants to the following performance guarantees shown in Table 2-6 below.

Table 2-6 Abatement Plant Performance Guarantees

Parameter	Process Phase	Abatement Technology	Performance Guarantee
Chlorine	Cleaning	Chemisorption	>99.9999%
Ammonia	Reaction	Burner	>99.99%
Trace metal organics	Reaction (negligible quantities) Etch	Burner (during operation of the reactor) Chemisorption (during etch cycle and when operating using GaAs and InP technologies).	>99%
Propane	Reaction	Burner	>99.9999%
Silane (1000ppm or 2000ppm silane in hydrogen)	Reaction	Burner	>99.9999%

For all substances, the annual throughputs are very low, as described in Table 2-8.

2.7.3.4 Summary of Fate of Emissions

Table 2-7 below describes the fate of each substance used in and potentially emitted from the reactors. For units 11-20 which may be utilised for GaN, GaAs or InP technologies, the chemisorption abatement will be in place for those reactors when operating using GaAs or InP technologies whereas ammonia abatement will be employed when using GaN technology. There are no changes to the chemisorption abatement described in the original permit application and variation employed to treat emissions from reactors 1-20 when operating using GaAs and InP technologies.

Table 2-7: Fate of Emissions

Parameter	Fate
Metal organics (existing, however some new raw materials)	Transferred onto the wafers (10-20% of input). Deposited onto the reactor susceptors, reactor walls in the growth cells and trapped and contained in the reactor exhaust system (70-75% of input). Removed from reactors during etch process where they are adsorbed onto chemisorption abatement.
Dopant gases: propane (new), silane (new).	Propane and ethylene would be thermally treated by plasma abatement.
Inert gases and hydrogen (existing)	Emitted through stacks
Chlorine (new)	Treated by chemisorption.

Parameter	Fate
Ammonia (new)	Ammonia would be thermally treated by plasma abatement.
Combustion products from abatement system: oxides of nitrogen (new). carbon monoxide (new). carbon dioxide (new).	Very low quantities released due to design of abatement equipment. Most of the energy required for abatement of ammonia is supplied by the hydrogen content of the waste gas.
Arsine (existing, but pollutant concentrations have changed)	Treated by chemisorption.
Arsine (existing, but pollutant concentrations have changed)	Treated by chemisorption.

2.7.3.5 Process Gas Stack Parameters

Modelling of the emissions from the proposed reactors and combustion plant has been undertaken using AERMOD PRIME software and is detailed in Appendix E. Process gas stack parameters are provided in this assessment.

2.8 Storage of Gases

There are no changes to the existing gas bunker, chemisorption abatement technology or the emission point (A2). However, the proposed changes will require the use of additional gases and an overall increase in inventory.

The five new bunkers will be designed to the same standard as the existing bunker to prevent accidental release of gases.

Extract ventilation will be provided from five gas bunkers to provide ventilation to the gas cabinets contained within. Extract fans will be located on the roofs of the gas bunkers and will exhaust air via individual flues. In the unlikely event of a cylinder failure within the bunker, a dedicated chemisorption scrubber is permanently in-situ. Upon an accidental release, the entire chemisorption column is replaced.

The approach to abatement of the additional stored gases is described below.

2.8.1 Chlorine Storage

Chlorine gas will be stored in gaseous form in gas cylinders in gas cabinets in bunkers, which are provisioned with chemisorption abatement equipment to absorb the contents of a cylinder in the event of a release. Quantities are provided in Table 2-8.

Chlorine distribution pipelines will be double contained.

2.8.2 Ammonia Storage

Ammonia will be stored within 10 pressurised liquid gas tanks each fitted with pressure relief valves. The tanks will be fitted with a vaporiser to transfer the ammonia from a liquid to a gas phase. Quantities are provided in Table 2-8.

Ammonia distribution pipelines will be double contained.

2.8.3 Dopant Gases

There will be new dopant gases used and stored on-site comprising silane in hydrogen and propane. Disilane will continue to be used in reactors 1-20 when running GaAs and InP technologies and is distributed within double contained pipework.

Dopant gases are stored within the reactor bays within the main manufacturing building and within gas bunkers.

Currently, there is one gas bunker on-site. An additional five gas bunkers will be installed to house dopant gases. The bunkers will be fitted with a chemisorption abatement system of capture any accidental releases of gases.

The existing abatement technology comprising chemisorption is installed to capture gases from both within the reactor bays and the gas bunkers and will be replicated for the additional storage arrangements.

Propane distribution pipelines will be double contained.

The maximum amount of dopant gas stored on-site will increase, see Table 2-8.

2.8.4 Inert Gases and Hydrogen

Hydrogen will be stored on a hydrogen trailer as per current arrangements. In addition to nitrogen and helium, which are currently used stored and used on-site, argon will also be used, stored and distributed on-site. Helium will continue to be stored in cylinders and nitrogen will continue to be stored in the service yard in a $9m^3$ cylinder. Storage arrangements for argon comprise a $9m^3$ cylinder in the service yard alongside the existing nitrogen cylinder.

Inert gases and hydrogen are used intermittently. They are not pollutants of concern and no further controls to abate potentially accidental releases are proposed. Quantities are provided in Table 2-8.

2.8.5 Trace Metal-Organics

As per current operations, smaller volumes of raw materials comprise the metal-organics. These substances are stored externally within enclosed storage bunkers, within the building in sealed bubbler containers and within the reactor bays. The main building and bunkers will be surfaced with concrete hardstanding. Quantities are provided in Table 2-8.

2.8.6 Storage of Other Raw Materials

Small quantities of maintenance and laboratory fluids are currently used and stored on-site. These materials are stored in a dedicated storage facility within the building which is provided with secondary containment and situated on concrete hardstanding.

There are no material changes to the methods applied to the storage, distribution and use of these raw materials, other than increase in the storage throughput of some materials. The technology applied to the existing infrastructure and processes will be replicated for the additional materials associated with the new reactors.

All combustion plant oil deliveries and collections are arranged by IQE. Such deliveries and collections are carried out on hardstanding, under supervision, and spillage containment equipment is available should an incident occur.

Full details of materials stored, including any changes, are provided in Table 2-8.

2.8.7 COMAH Implications

The Installation is currently regulated under the COMAH Regulations as a Lower Tier site. The full inventory of materials which may be present on-site described in this application (see Table 2-8) for all 92 reactors is likely to exceed COMAH upper tier thresholds. However, this threshold won't be reached until the later stages of development which isn't likely to take place within the next 12 months. Prior to this point, the Competent Authorities (NRW and the HSE) will be approached and documentation prepared to transition from Lower Tier to Upper Tier.

The Operator is well versed in COMAH Regulations and fully understands the additional requirements once the upper tier thresholds are exceeded.

2.9 Storage Arrangements for Potentially Polluting Materials

Table 2-8 below provides details of the changes in raw material use and information on the use, quantity, storage, properties, fate and environmental impact of each material stored and used on-site. Raw materials for reactors 1-20 when GaAs and InP technologies are used remain unchanged from the previous permit variation application. Only additional or increased use in raw materials is shown.

Table 2-8 Storage Arrangements for Potentially Polluting Materials

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
Hydrogen Gas – increase in throughput	Existing	500 tonnes	<6 tonnes	Cylinders	NA (gas)	Reactors	Emitted via reactor emission points	Negligible if released	No alternatives available, specific formulation in product. Negligible environmental impact
Liquid Nitrogen – increase in throughput	Existing	7000 tonnes	60m^3 tank	Cylinders in service yard	NA (gas)	Reactors carrier gas and process purging medium, pneumatic instrument supply, vent blending (to prevent overheating of the media and liquid accumulation) and non-	Emitted via reactor emission points	Negligible if released	No alternatives available, specific formulation in product. Negligible environmental impact

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
						process purging			
Helium Gas – increase in throughput	Existing	Intermittent use	Variable, depending on demand	Cylinders	NA (gas)	Pressure testing/leak detection	Emitted via reactor emission points	Negligible if released	No alternatives for pressure testing
Argon liquid gas	New	48.5 tonnes	20 tonnes	9m^3 cylinder	NA (gas)	Carrier gas	Emitted via reactor emission points	Negligible if released	No alternatives available, specific formulation in product. Negligible environmental impact.
Silane in hydrogen (1000ppm or 2000ppm) – increase in throughput	Existing	0.4 tonnes	0.017 tonnes	56 cylinders within cabinets in bunker and building	NA (gas)	Reactors	Treated by plasma abatement then emitted via reactor emission points	Negligible if released	No alternatives available, specific formulation in product. Negligible environmental impact.

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
Bis(cyclopentadienyl)magnesium	New	10kg	10kg	Stored in sealed bubbler containers	Containment provided by bubbler containers	Reactors	Consumed within product, treated by chemisorption then emitted via reactor emission points	Pyrophoric Corrosive Environmental hazard	No alternatives available, specific formulation in product
Trimethylgallium – increase in throughput	Existing	2.5 tonnes	0.58 tonnes	Stored in sealed bubbler containers	Trimethylgallium	Trimethylgallium	Consumed within product, treated by chemisorption then emitted via reactor emission points	Pyr. Liq. 1 Water-react. 1 Skin Corr. 1B	No alternatives available, specific formulation in product
Trimethylaluminium – increase in throughput	Existing	1.5 tonnes	0.340 tonnes	Stored in sealed bubbler containers	Containment provided by bubbler containers	Reactors	Consumed within product, treated by chemisorption then emitted via reactor	Pyr. Liq. 1 Water-react. 1 Skin Corr. 1B	No alternatives available, specific formulation in product

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
							emission points		
Diethylzinc	New	10kg	10kg	Stored in sealed bubbler containers	Containment provided by bubbler containers	Reactors	Consumed within product, treated by chemisorption then emitted via reactor emission points	Flammable Corrosive Environmental hazard	No alternatives available, specific formulation in product
Bis(cyclopentadienyl) iron	New	2kg	2kg	Stored in sealed bubbler containers	Containment provided by bubbler containers	Reactors	Consumed within product, treated by chemisorption then emitted via reactor emission points	Flammable solids Acute toxicity, Oral Acute toxicity, Inhalation Reproductive toxicity Specific target organ toxicity - repeated exposure, Inhalation Liver	No alternatives available, specific formulation in product.

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
								Long-term (chronic) aquatic hazard	
Forming gas (5% argon in hydrogen)	New	2 tonnes	0.360 tonnes	Stored within gas cylinders	NA (gas)	Reactors	Emitted via reactor emission points	Negligible if released	No alternatives available, specific formulation in product. Negligible environmental impact.
Liquid ammonia for reactors	New	250 tonnes	62 tonnes	4No 24.7m³ ISO tanks 6No 0.9m³ ISO tanks Tanks have high and high high levels alarms.	Bunded to 110% capacity. PRVs installed on tanks.	Used in reactors as a source of nitrogen.	Treated by plasma abatement then emitted via reactor emission points	Corrosive Toxic Very toxic to aquatic life with long lasting effects. Flammable	No alternatives available, specific formulation in product
Chlorine	New	2.6 tonnes	0.5 tonnes	10 cylinders within	NA (gas)	Used in etch process.	Treated by chemisorption then emitted	Oxidizing gases	No alternatives available,

Material and Changes	**Existing or new**	**Proposed Typical Annual Throughput for Additional Reactors per annum**	**Maximum Quantity Stored for Additional Reactors tonnes per annum**	**Storage Arrangement**	**Secondary Containment**	**Use**	**Fate**	**Environmental Impact**	**Alternatives / BAT Justification**
				cabinets in bunker			via reactor emission points	Compressed gas Acute toxicity (inhalation) Skin corrosion Serious eye damage Aquatic hazard (acute)	required for etch process.
Propane	New	13.2 tonnes	1.3 tonnes	28 cylinders within cabinets in bunker and building	NA (gas)	Dopant gas	Treated by plasma abatement then emitted via reactor emission points	Flammable Pressurised gas Global warming impact	No alternatives available, required as transport fuel
Biocide liquid for new cooling system	New	As determined by cooling system treatment programme	As determined by cooling system treatment programme	Tank or proprietary containers	Bunded to 110% capacity	Process Cooling Water	Process cooling water system, where contents are periodically by authorised	Hazardous to the environment and human health if released unabated	No alternatives available, biocide is required to minimise bacteria

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
							waste contractor		levels which could impact process
Scale and corrosion inhibitor for new cooling system	New	As determined by cooling system treatment programme	As determined by cooling system treatment programme	Tank or proprietary containers	Bunded to 110% capacity	Process Cooling Water	Process cooling water system, where contents are periodically by authorised waste contractor	TBC	Required specifically to protect the materials in this cooling circuit, no suitable alternatives
30% Glycol (ethylene glycol) – increase in use	Existing	<1 tonne	< 1 tonne	Tank or proprietary containers	Bunded to 110% capacity	Chilled water system	Chilled water system, where contents are periodically by authorised waste contractor	Negligible based on low throughput	No alternatives available, glycol is required to prevent freezing which could damage the chilled water circuit
Water consumption -	Existing	Additional 300,000	NA	NA	NA	Process cooling water	145,000 tonnes are	Dilute quantities of	Low impact. No

Material and Changes	Existing or new	Proposed Typical Annual Throughput for Additional Reactors per annum	Maximum Quantity Stored for Additional Reactors tonnes per annum	Storage Arrangement	Secondary Containment	Use	Fate	Environmental Impact	Alternatives / BAT Justification
increase in use		tonnes – cooling water.				and chilled water circuits	lost as evaporation. 50,000 tonnes are lost as blowdown.	coolant and treatment chemicals will be present, negligible impact	alternatives, essential to process
Granular material for abatement equipment	Existing material, generation of waste will increase.	5040 tonnes	Variable	Stored in proprietary containers within building.	NA	Used in air abatement equipment	Returned to abatement equipment supplier for regeneration	Propriety technology, non-flammable, non-combustible	Low impact. No alternatives, essential to process
Wafers	Existing material, increase in production volume	334,000 wafers	Variable	Stored in proprietry packing	NA	Product	Product	NA	No alternatives available, required as main product

2.10 Water Use and Emissions to Water

The following processes are the primary users of water and generate aqueous emissions.

2.10.1 Water Pre-Treatment Process

As per the original application, pre-treatment of mains water to the required purity is achieved through the following sequential steps:

- filtration using a particulate filter;
- carbon filter;
- water softener; and
- reverse osmosis (RO).

Treated water (permeate) from the RO plant is stored in a tank prior to use by the process cooling water systems and humidifiers. Discharge from the RO plant and water softener is sent to foul sewer. The RO plant membranes are not cleaned in-situ, they are replaced and cleaned off-site, therefore no effluent is generated from cleaning operations.

2.10.2 Process Cooling Water Systems

The process cooling water systems will be expanded to provide the necessary heat removal for the additional 72 reactors and ancillary plant and equipment.

Cooling will be provided by a Chilled Water System for various process and Heating, Ventilation, and Air Conditioning (HVAC) requirements. HVAC cooling is provided to the AHUs for conditioning and tempering of the various spaces. HVAC cooling will be provided by air-cooled chillers located on existing external roof plant space, adjacent existing air-cooled chiller plant.

Process cooling will be provided by water cooled chillers located in a plant room at ground floor level, linked to nine (eight duty, one standby) cooling towers located in a new external plant yard. The cooling systems will be treated with biocide and scale and corrosion inhibitors in very dilute quantities. Blowdown from the cooling system will be discharged to sewer under the existing consent issued by the sewerage undertaker.

It is proposed that HVAC cooling is separated from process cooling, since they require different water temperatures. This will enable the plant to operate at maximum efficiency and makes best use of available external plant space.

2.10.3 Plasma Abatement Aqueous Releases

A small emission to water is generated by the plasma abatement system comprising condensate comprising 9224m^3 per annum. The manufacturer of the abatement plant confirmed that the water contains no polluting substances as it is condensate arising from the thermal process. This will be confirmed during early operation of the reactors and as a precaution, it will be discharged to sewer under the existing consent issued by the sewerage undertaker.

2.10.4 Furnace Aqueous Releases

A small amount of condensate (approximately 0.5 litres per cycle at a rate of 0.003 litres per minute) is generated during the operation of the furnace. Effluent will initially be collected in a bunded integral bulk container (IBC) and removed from site by an authorised waste contractor. However, once the furnace is operated under the permit, the intention is to discharge this emission into the sewer.

3. Techniques for Process and Emissions Control and BAT Assessment

3.1 Introduction

It was demonstrated in the original application for permit referenced EPR/AB3893FZ, that the proposed techniques represented application of the Best Available Techniques (BAT). In the absence of specific BAT guidance for the semi-conductor sector, reference was made to:

- Commission Implementing Decision (EU) 2022/2427 of 6 December 2022 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for common waste gas management and treatment systems in the chemical sector (notified under document C(2022) 8788) 'WGC BATc'; and
- Commission Implementing Decision (EU) 2016/902 of 30 May 2016 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common waste water and waste gas treatment/management systems in the chemical sector 'CWWWG BATc'.

NRW guidance documents have also been considered where there are additional techniques not covered by the above BATcs:

- How to comply with your Environmental Permit, Additional Guidance for the Inorganic Chemicals Sector (EPR 4.03), NRW, September 2014 'EPR 4.03'
- How to comply with your Environmental Permit, National Resources Wales, Version 8, October 2014;

Based on the conclusion in the original application for permit referenced EPR/AB3893FZ, that the controls in place represent BAT, this section:

- describes the main techniques that will be used to prevent, or where not practicable, minimise emissions as a consequence of the operation of the changes to the Installation; and
- demonstrates how the proposed manufacturing unit continues to apply BAT by prevention of emissions as a priority, or where emissions are minimised by treatment prior to release.

The BAT Assessment is therefore focussed on the changes to the proposed processes and techniques which relate to the additional reactors which employ GaN technology.

3.2 Applicable BAT Requirements

A review of the documents listed the has been carried out and the applicability of the BATc requirements are summarised in Table 3-1 below. Applicable BATcs are highlighted.

Table 3-1 Listed and Directly Associated Activities

Subject Title	BAT Reference	Applicability	Comment
WGC BATc			

Subject Title	BAT Reference	Applicability	Comment
Environmental Management Systems	BAT 1	Yes	Generally applicable. WGC BATc and CWWWG BATc include similar requirements, which will be addressed in BAT Assessment.
Inventory of waste gas streams	BAT 2	Yes	Generally applicable.
OTNOC [1]	BAT 3	Yes	Generally applicable.
Use of abatement	BAT 4	Yes	Generally applicable.
Combine emission points	BAT 5	Yes	Generally applicable.
Design of abatement	BAT 6	Yes	Generally applicable.
Process monitoring (air)	BAT 7	Yes	Generally applicable
Emissions Monitoring (air)	BAT 8	Yes	Generally applicable
Use of combustion unit for organic compounds	BAT 9, 10, 11	No	Not applicable, no sources of organic compounds.
PCDD/F emissions to air from thermal treatment of waste gases containing chlorine	BAT 12	No	Not applicable, chlorine-containing gases are not thermally treated as they are treated by chemisorption.
Dust and particulate metal emissions and BAT-AELs	BAT 13, 14	No	Not applicable, no dust-generating processes.
Recovery of inorganic compounds	BAT 15	No	Releases are negligible and chemically bonded to other elements, and as such, it is not possible to capture and re-use pollutants.
Thermal abatement	BAT 16	Yes	Generally applicable. Abatement comprises plasma technology.
NOx abatement	BAT 17	No	Not applicable, NOx emissions are minimal due to abatement technology selection and do not require abatement to meet Bat-AELs (where applicable).
Abatement	BAT 18	Yes	Generally applicable.
VOC emissions	BAT 19, 20, 21, 22, 23,	No	Not applicable, no sources of VOCs.
Sector-specific techniques	BAT 24 to BAT 33.	No	Applicable to other processes.
Process furnaces/heaters	BAT 36, 37	Yes	Generally applicable. Abatement comprises plasma technology.
CWWWG BATc			
Environmental Management Systems	BAT 1	No	Whilst BAT 1 is applicable to the process, there are comparable

Subject Title	BAT Reference	Applicability	Comment
			controls described in WCG BAT 1. Excluded from assessment.
Inventory of waste water and waste gas streams	BAT 2	No	Whilst BAT 2 is applicable to the process, there are comparable controls described in WCG BAT 2. Excluded from assessment.
Process Monitoring (water)	BAT 3	Yes	Generally applicable.
Emissions Monitoring (water)	BAT 4	Yes	Generally applicable.
Diffuse Emissions - VOCs	BAT 5	No	Not applicable, no sources of VOCs.
Odour Emissions	BAT 6	No	Not applicable, minimal odour sources.
Water use and effluent generation	BAT 7, 8, 9, 10	Yes	Partially applicable, however effluent volumes are very low, released to sewer and would not benefit from treatment.
Effluent treatment and associated BAT-AELs	BAT 11, 12, 14	No	Not applicable. Effluent volumes are very low, released to sewer and would not benefit from treatment.
Waste	BAT 13	Yes	Generally applicable.
Emissions to air	BAT 15, 16	Yes	Generally applicable.
Emissions to air – flaring	BAT 17, 18	No	No flares will be installed.
Emissions to air – VOCs	BAT 19	No	Not applicable, no sources of VOCs.
Odour Management Plan	BAT 20, 21	No	Not applicable, minimal odour sources.
Noise	BAT 22, 23	Yes	Generally applicable.
EPR 4.03 (additional requirements only)			
Energy Efficiency	NA	Yes	Generally applicable
Raw Material Use	NA	Yes	Generally applicable
Storage and Handling of Raw Materials	NA	Yes	Generally applicable
How to Comply with Your Permit (additional requirements only)			
Emissions to air	NA	Yes	Generally applicable
Notes: 1 – OTNOC – Other than normal operating conditions.			

3.3 Management Techniques

The operator has implemented an EMS for the installation. There will be no structural changes to the management of the facility as a result of this Permit Variation Application. The same high standard of management will be applied to the expanded facility that is applied to the current facility.

The Accident Management Plan has been updated to incorporate controls applicable to the proposed changes, which is in Appendix D of this Report.

Table 3-2 below compares the operator's EMS with the standards stipulated in the WCG BATc.

Table 3-2 BAT 1: BATs for Environmental Management Systems

Technique	Details	Meets BAT?
BAT 1. In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features:		
i. commitment, leadership, and accountability of the management, including senior management, for the implementation of an effective EMS.	IQE Management are responsible for the overall effectiveness of the EMS and through clear leadership and commitment will promote continual improvement in all aspects of the EMS. Top Management will define the environmental policy and strategy and ensure that it is appropriate to the nature and scale of the organisations activities, products and services.	Yes
ii. an analysis that includes the determination of the organisation's context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment.	Risks and opportunities register and legal register are incorporated into the EMS as core components of the ISO14001:2015 standard.	Yes
iii. development of an environmental policy that includes the continuous improvement of the environmental performance of the installation.	The Environmental Policy outlines management commitments. The Policy is reviewed at least annually to maintain its relevance and it provides a strategy for environmental objectives.	Yes
iv. establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements.	Setting objectives and performance indicators are incorporated into the EMS as core components of the ISO14001:2015 standard.	Yes
v. planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve	These elements are incorporated into the EMS as core components of the ISO14001:2015 standard.	Yes

Technique	Details	Meets BAT?
the environmental objectives and avoid environmental risks.	The Operator will identify and, where appropriate, document the environmental operating controls required at its facility and ensure that they are suitable and sufficient to minimise the environmental impact from plant activities. The Operator will establish, implement and maintain the processes required to prepare for, and respond to, potential emergency situations. The Operator will respond in such a way as to prevent or mitigate the environmental impact of any such event should it occur.	
vi. determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed.	These elements are incorporated into the EMS as core components of the ISO14001:2015 standard.	Yes
vii. ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g. by providing information and training).	The Operator will ensure that all persons performing tasks for it, or on its behalf, are deemed competent on the basis of having appropriate education, training, skills and experience. The Operator will ensure it has appropriate systems and procedures in place to identify key skills and competency requirements and for ensuring that plans are in place to provide, assess and record the provision of such training.	Yes
viii. internal and external communication.	The EMS is reviewed at least annually to maintain its relevance and it provides a strategy for environmental objectives.	Yes
ix. fostering employee involvement in good environmental management practices.	This requirement is delivered through training, regular communications and tool box talks to deliver good environmental practices.	Yes
xi. effective operational planning and process control.	This element is incorporated into the EMS as a core component of the ISO14001:2015 standard.	Yes
xii. implementation of appropriate maintenance programmes;	PPM system in place.	Yes

Technique	Details	Meets BAT?
xiii. emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations;	Accident Management Plan in place with emergency protocols for identified accident scenarios,	Yes
xiv. when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning;	These elements are incorporated into the EMS as core components of the ISO14001:2015 standard. Closure plan in place, which will be updated to include new processes and equipment.	Yes
xv. implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations.	Monitoring is described in Section 5. The Operator will make suitable arrangements for the monitoring and measurement of its activities that could have a significant environmental impact were such monitoring arrangements not in place. To ensure accuracy, reliability and consistency of measurements performed, all measurement equipment will be identified and its calibration and / or monitoring status be recorded.	Yes
xvi. application of sectoral benchmarking on a regular basis;	The EMS includes an obligation to strive for continual improvement, which includes reviewing new technologies.	Yes
xvii. periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;	The Operator will ensure that an annual audit schedule is maintained to monitor and evaluate all key activities undertaken that fall within the scope of the EMS. Records of such audits will be maintained within the EMS system as controlled documents.	Yes
xviii. evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur;	These elements are incorporated into the EMS as core components of the ISO14001:2015 standard.	Yes
xix. periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;	The Operator will periodically review the EMS at planned intervals to ensure its continuing suitability and effectiveness.	Yes

Technique	Details	Meets BAT?
	The results of the management review will be minuted and communicated within the organisation.	
xx. following and taking into account the development of cleaner techniques	The EMS includes an obligation to strive for continual improvement, which includes sectoral benchmarking.	Yes
xxi. an inventory of channelled and diffuse emissions to air.	See BAT 2.	Yes
xxiii. an integrated waste gas management and treatment strategy for channelled emissions to air	See BAT 4.	Yes
xxiv. a management system for diffuse VOC emissions to air.	Not applicable, no VOC emissions.	NA
xxv. a chemicals management system that includes an inventory of the hazardous substances and substances of very high concern used in the process(es); the potential for substitution of the substances that are listed in this inventory, focusing on those substances other than raw materials, is analysed periodically (e. g. annually) in order to identify possible new available and safer alternatives, with no or lower environmental impacts.	Inventory maintained as part of COSHH register. The EMS includes an obligation to strive for continual improvement, which includes sectoral benchmarking which includes the use of materials with a lower environmental impact.	Yes

It is concluded that the proposed techniques meet BAT 1 requirements.

3.4 Accident Management and OTNOC

The Accident Management Plan has been updated to identify accident scenarios and incorporate controls applicable to the proposed changes. This information is in Appendix D of this Report. The AMP scenarios include abnormal operating scenarios, including those defined as OTNOC in WCG BAT 3.

Table 3-3 below describes BAT 3 requirements and the Operator's proposed measures.

Table 3-3 BAT 3 OTNOC

Technique	Details	Meets BATc?
BAT 3. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air during OTNOC, BAT is to set up and implement a risk-based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following features.		
i. identification of potential OTNOC (e.g. failure of equipment critical to the control of channelled emissions to air, or equipment critical to the prevention of accidents or incidents that could lead to emissions to air ('critical equipment')), of	See AMP scenarios in Appendix D.	Yes

Technique	Details	Meets BATc?
their root causes and of their potential consequences.		
ii. appropriate design of critical equipment (e.g. equipment modularity and compartmentalisation, backup systems, techniques to obviate the need to bypass waste gas treatment during start-up and shutdown, high integrity equipment, etc.).	Robust, high integrity equipment is procured given the highly technical nature of the processes.	Yes
iii. set-up and implementation of a preventive maintenance plan for critical equipment (	PPM system in place. Maintenance is carried out on critical plant and equipment	Yes
iv. monitoring (i.e. estimating or, where this is possible, measuring) and recording of emissions and associated circumstances during OTNOC.	The Operator will have suitable arrangements in place to identify and address deviations from the expected norm which may compromise the overall effectiveness of the EMS or which may lead to an impact upon the environment. All incidents will be recorded.	Yes
v. periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted as recorded in point iv.) and implementation of corrective actions if necessary.	Alarms are in place to detect leaks with auto-shut-off valves to stop flow of pollutant gases. Where possible, OTNOC events will be monitored.	Yes
vi. regular review and update of the list of identified OTNOC under point i. following the periodic assessment of point v	See AMP scenarios in Appendix D. AMP is reviewed every four years or following an incident.	Yes
vii. regular testing of backup systems.	Emergency drills undertaken as part of Accident and Emergency procedures.	Yes

It is concluded that the proposed techniques meet BAT 3 requirements.

3.5 Energy Efficiency

The proposed changes involve changes to the energy use profile at the installation, such as use of the emergency diesel generator, new cooling systems, fans and abatement plant, which results in an increase in energy use.

3.5.1 Basic Energy Requirements

As per the original permit application referenced EPR/AB3893FZ, the following measures will also be incorporated into the selection, design and operation of the new fans and chillers:

- heating and cooling plant are high efficiency;

- where process demands vary, for example the cooling circuits, pumps and fans will be of variable speed and can therefore react to process demands optimising energy use;
- all plant and equipment in the Installation will be subject to the Operator's preventative maintenance programme. This will ensure it is maintained to maximise operational efficiency.

Table 3-4 below shows the revised predicted energy consumption per annum.

Table 3-4 Projected Energy Consumption

Energy delivered	Primary MWh (per annum)	Delivered, MWh (per annum)
Electricity	175,200	420,480
5 duty boilers	30,467	30,467
2 diesel generators [1]	500	500
Note 1: Operation of the diesel generators is based on an annual operation of 50 hours for the purpose of maintenance and testing.		

The Operator will continue to regularly review energy use and if opportunities to reduce energy consumption are identified as a result of the four-yearly (or more frequent) energy reviews, an Energy Efficiency Plan will be developed for the Installation.

The Operator proposes to enter into a Climate Change Agreement and is currently progressing through the application process.

3.6 Efficient Use of Raw Materials and Water

The proposed changes involve changes to raw materials. Table 3-5 compares the indicative BAT requirements for the Installation provided in NRW's guidance note S4.03 with techniques to be employed at the Installation. Storage and use of raw materials is provided in Table 2-8.

Table 3-5 Minimisation of Raw Materials and Water Use

Element	Justification
Maximise heat transfer between process streams where water is needed for cooling. Use a recirculating system with indirect heat exchangers and a cooling tower in preference to a once-through cooling system.	Cooling processes are open recirculated and closed-circuit systems therefore water use is minimal.
Where water is used in direct contact with process materials, recirculate the water after stripping out the absorbed substances.	Humidified water is in contact with process materials, it is not possible to recirculate water as it is lost to atmosphere. Cooling processes are open recirculated and closed-circuit systems.
Use cleaning techniques that reduce the quantity of water needed.	Water use at the Installation is low, however opportunities to reduce water use during cleaning will be implemented where possible.
Establish opportunities for reuse using pinch analysis.	Water use at the Installation is low. The main use is humidification and cooling where further opportunities for re-use are minimal.

Element	Justification
Reduce your use of all raw materials and intermediates.	Raw materials will be consumed in the process according to tightly controlled formulae to minimise resources and prevent emissions. Addition is automated by the run program. Application of materials is strictly controlled as the epilayers are deposited onto the surface of the substrate using software to in pre-determined quantities.
Substitute less harmful materials, or those which can be more readily abated and when abated lead to substances that are more readily dealt with.	Raw material selection is specific to the processes undertaken and alternatives are not currently available.
Understand the fate of by-products and contaminants and their environmental impact.	Emissions from the Installation are minimal due to the application of chemisorption technology. There is minimal generation of by-products due to the nature of the technology employed.

In line with current NRW requirements and guidance, the operator will carry out the following tasks:

- take appropriate measures to ensure that raw materials and water are used efficiently in the activities by carrying out routine resource efficiency audits;
- maintain records of raw materials and water used in the activities;
- review and record at least every 4 years whether there are suitable alternative materials that could reduce environmental impact or opportunities to improve the efficiency of raw material and water use; and
- take any further appropriate measures identified by a review.

There are no changes to the way that raw material use is minimised and controlled in line with Permit requirements. It can be concluded that following the expansion of operations, the Installation, as varied by this application, continues to meet indicative BAT requirements for raw material use laid out in NRW guidance 'EPR S4.03'.

3.7 Avoidance, Recovery and Disposal of Wastes

Following the proposed changes to operations, there are no changes to the techniques employed to minimise waste generation, the types of wastes, storage arrangements or fate. There are changes to the types and annual quantities produced of some wastes, proportionate to the expansion of operations. Table 3-6 provides details of wastes generated on-site following the changes in operation and their disposal routes:

Table 3-6 Wastes Generated by Proposed Newport Semiconductor Facility

Material	Annual volume/mass generated	Source	Storage	Fate	Alternatives / BAT Justification
Chemisorption granulate (not discarded, manufacturer removes from site for regeneration) – increase in volume of waste generated.	5040 tonnes per annum	Production process	Enclosed vessels within the main building which is situated on concrete hard standing with sealed construction joints	Returned to supplier for regeneration (re-used)	Waste hierarchy principles applied
Waste Oils – increase due to new combustion plant	<1 tonne per annum	Maintenance activities	Enclosed vessels within the main building which is situated on concrete hard standing with sealed construction joints	Removed by authorised waste contractor for recycling/re-use	Waste hierarchy principles applied
Maintenance rags and miscellaneous wastes – no change	<1 tonne per annum	Maintenance activities	Enclosed vessels within the main building which is situated on concrete hard standing with sealed construction joints	Removed by authorised waste contractor for recycling/re-use	Waste hierarchy principles applied

Material	Annual volume/mass generated	Source	Storage	Fate	Alternatives / BAT Justification
General waste – increase in waste generated	320 tonnes	Packaging materials, general/office waste	Enclosed vessels within the main building which is situated on concrete hard standing with sealed construction joints	Removed by authorised waste contractor for recycling (60%) and disposal to landfill (40%)[1]	Waste hierarchy principles applied
Solid precipitate from plasma abatement systems	2 tonnes	Abatement systems	Removed when rectors are maintained then stored in secure containers pending collection.	Removed by authorised waste contractor for disposal	Limited volumes inhibits recycling opportunities

Table 3-9 below describes BAT 13 requirements and the Operator's proposed measures.

Table 3-7 BAT 13 Waste

Technique	Details	Meets BATc?
BAT 13. In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.	A waste management plan will form part of the EMS and will be implemented prior to commencement of operations. The Operator will apply the Waste Hierarchy when determining recycling/disposal routes for all wastes generated. For example, the granular material in the chemisorption column is not 'discarded' as it is returned to the supplier for re-use. Due to the high value of the raw materials and gases, wastes are minimised as a result of process efficient optimisation.	Yes

It is concluded that the proposed techniques meet BAT 13 requirements.

[1] Based on IQE Europe Limited waste management data

3.8 Process Releases to Air

Process releases to air arise from the operation of the additional reactors, furnace and combustion plant. Emissions from the reactors are abated prior to release, as described in Section 2.7. The sections below present both WCG and CWWWG BATs for the minimisation of emissions to air and the Operator's proposed measures.

3.8.1 Emissions to Air - General

Table 3-8 below compares the indicative BAT requirements for Installations provided in the NRW guidance document 'How to comply with your Environmental Permit' and 'EPR 4.03' with technologies and measures proposed. It has been updated for the new emissions profile following implementation of the proposed changes.

Table 3-8 BAT Justification for Control of Emissions to Air

Technique	Justification
Measures Specified in 'How to Comply with your Environmental Permit'	
Identify the main chemical constituents of your emissions, including the separate compounds that make up your emissions of volatile organic compounds (VOCs) where practicable. Assess the dispersion capability of your vent and chimney heights and make an assessment of the fate of the substances emitted to the environment.	The main chemical constituents of the emissions have been described in Section 2.7. Impacts of pollutant gases have been modelled using AERMOD PRIME software (see Appendix E). Despite using very conservative criteria, this model has shown that the abated releases from the proposed reactors will have an insignificant impact on the environment.
You need to identify all control measures you use to manage emissions from your activities. You must list these measures and contingency plans in your management system and procedures.	Abatement is proposed to minimise pollutants. Details of the abatement are included in management procedures detailing tasks to be undertaken in the event of failure.
Measures specified in EPR 4.03	
You should where appropriate: 1. Formally consider the information and recommendations in the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector, February 2003, as part of the assessment of BAT for point-source releases to air, in addition to the information in this note. [1] 2. The benchmark values for point source emissions to air listed in Annex 1 should be achieved unless we have agreed alternative values. [1] 3. Identify the main chemical constituents of the emissions, including VOC speciation where practicable. 4. Assess vent and chimney heights for dispersion capability and assess the fate of the substances emitted to the environment.	1. See Sections below. 2. BAT will be demonstrated by installation of chemisorption abatement units installed to each of the reactors. Release concentrations at the exit of the flues are predicted to be non-detectable and even at the conservative values provided by the manufacturer predicted levels are several orders of magnitude below any benchmark values. 3. Chemical constituents have been determined for the increase in reactors and are presented in Section 2.7 4. Air dispersion modelling has been completed for the new emissions profile following an increase in the

Technique	Justification
	number of reactors (see Appendix E) –emissions were calculated to have an insignificant impact despite conservative emissions data used as input to the model.
Note 1: Approach to setting limits has been updated since the publication of S4.03. BAT-AELs has been derived from CWWWG and WCG BATcs	

It is concluded that the proposed techniques meet NRW's 'How to Comply' and S4.03 requirements.

3.8.2 Inventory of Emissions to Air

Table 3-9 below describes WGC BAT 2 requirements and the Operator's proposed measures.

Table 3-9 BAT 2 Inventory of Air Emissions

Technique	Details	Meets BATc?
BAT 2. In order to facilitate the reduction of emissions to air, BAT is to establish, maintain and regularly review (including when a substantial change occurs) an inventory of channelled and diffuse emissions to air, as part of the environmental management system (see BAT 1), that incorporates all of the following features:		
i. information, as comprehensive as is reasonably possible, about the chemical production process(es), including: a. chemical reaction equations, also showing side products. b. simplified process flow sheets that show the origin of the emissions.	Product formulations are highly commercially sensitive and do not form part of this application. However, processes are carefully controlled under Site Operating Procedures.	Yes
ii. information, as comprehensive as is reasonably possible, about channelled emissions to air, such as: a. emission point(s); b. average values and variability of flow and temperature; c. average concentration and mass flow values of relevant substances/parameters and their variability (e.g. TVOC, CO, NOX, SOX, Cl2, HCl); d. presence of other substances that may affect the waste gas treatment system(s) or plant safety (e.g. oxygen, nitrogen, water vapour, dust); e. techniques used to prevent and/or reduce channelled emissions to air; f. flammability, lower and higher explosive limits, reactivity; g. monitoring methods (see BAT 8); h. presence of substances classified as CMR 1A, CMR 1B or CMR 2; the presence of such substances may for example be assessed according to the criteria of Regulation (EC)	a. Emissions are described in this section, and in Section 5. b, c, d, g. Routine monitoring will be carried out as described in Section 5. e. Abatement will be installed, see Section 3.8. f. Hazardous properties are well understood and mitigation is in place to prevent incidents. See Appendix D. h. COSHH register of materials stored and used on-site is maintained as part of safety and environmental management systems. CLP information is included within this register.	Yes

Technique	Details	Meets BATc?
No 1272/2008 on classification, labelling and packaging (CLP).		
iii. information, as comprehensive as is reasonably possible, about diffuse emissions to air, such as: a. identification of the emission source(s); b. characteristics of each emission source (e.g. fugitive or non-fugitive; static or moving; accessibility of the emission source; included in an LDAR programme or not); c. the characteristics of the gas or liquid in contact with the emission source(s), including: 1. physical state; 2. vapour pressure of the substance(s) in the liquid, pressure of the gas; 3. temperature; 4. composition (by weight for liquids or by volume for gases); 5. hazardous properties of the substance(s) or mixtures, including substances or mixtures classified as CMR 1A, CMR 1B or CMR 2; d. techniques used to prevent and/or reduce diffuse emissions to air; e. monitoring (see BAT 20, BAT 21 and BAT 22).	a to d. Sources of diffuse emissions to air are limited to gas leaks, which are highly unlikely to occur due to the controls in place. Such controls include robust storage arrangements and procedures, gas detection, abatement interlocks with processes and routine inspections. Gas properties are well understood by the operator. See Section 3.10. e. Not applicable, no VOC sources on-site.	Yes

It is concluded that the proposed monitoring arrangements meet WCG BAT 2 requirements, where applicable.

3.8.3 Monitoring of Waste Gas Stream Process Parameters

Table 3-10 below describes BAT 7 requirements and the Operator's proposed measures.

Table 3-10 BAT 7 Monitoring of Process Parameters

Technique	Details	Meets BATc?
BAT 7. BAT is to continuously monitor key process parameters (e.g. waste gas flow and temperature) of waste gas streams being sent to pretreatment and/or final treatment.	Waste gas flow and temperature will be monitored continuously.	Yes

It is concluded that the proposed monitoring arrangements meet WCG BAT 7 requirements.

3.8.4 Monitoring of Emissions to Air - Reactors

Proposed monitoring of emissions to air are described in Section 5 and comprise the following pollutant sources from the abated reactor emissions:

- Ammonia

- Carbon monoxide
- Oxides of nitrogen
- Chlorine (during etch process)

In addition, there are negligible releases from the furnace, which are similar to those already released via A1.

Emissions to air and abatement plant is described in Section 2.7.

Table 3-11 presents the proposed monitoring arrangements, in accordance with WCG BAT 8.

Table 3-11 BAT 8: Monitoring of Emissions to Air from Furnaces (A

Parameter	BAT monitoring frequency	Standard	Details	Proposed monitoring	Meets BATc?
Ammonia (NH_3)	6-monthly	EN 21877	The minimum monitoring frequency may be reduced to once every year or once every 3 years if the emission levels are proven to be sufficiently stable.	Six-monthly then once every three years from emission points A4, A5, A6, A7 and A8.	Yes
Carbon monoxide (CO) [1]	Once every 6 months	EN 15058	Frequency of 6 months applies to any stack with a CO mass flow of <2kg/h. CO emissions are well under this value in all stacks (see Air Quality Assessment in Appendix E).	None required.	Yes
NOx, expressed as NO^2	Annual	BS ISO 14792	Frequency of 6 months applies to any stack with a NOx mass flow of <2.5kg/h. NOx emissions are well under this value in all stacks (see Air Quality Assessment in Appendix E).	None required.	Yes
Elemental chlorine (Cl_2)	Once every year	No EN standard available	The minimum monitoring frequency may be reduced to once every 3 years if the emission levels are proven to be sufficiently stable.	Annually then once every three years from emission points A4a, A5, A6, A7 and A8.	Yes

It is concluded that the proposed monitoring arrangements meet WCG BAT 8 requirements, where applicable.

3.8.5 Monitoring of Emissions to Air – Combustion Plant

Boiler plant is below MCPD regulatory thresholds therefore no monitoring is proposed (see Section 2.6).

Generators are operated for less than 50 hours per year for testing and maintenance purposes and similarly, are not subject to monitoring requirements under MCPD or Specified Generator requirements.

3.8.6 Emissions Management and Abatement of Emissions to Air

Table 3-12 below describes WCG BAT requirements relating to emissions management and abatement of emissions to air and the Operator's proposed measures.

Table 3-12 WCG BAT 4, 5, 6, 16, 36 and 37 Emissions Management

Technique	Details	Meets BATc?
BAT 4. In order to reduce channelled emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes, in order of priority, process-integrated recovery and abatement techniques.	Adsorption will be employed during etch process to adsorb chlorine emissions. Abatement of routine gases emitted from reactors, which include ammonia, is achieved by plasma technology. See Section 2.7.	Yes
BAT 5. In order to facilitate the recovery of materials and the reduction of channelled emissions to air, as well as to increase energy efficiency, BAT is to combine waste gas streams with similar characteristics, thus minimising the number of emission points.	Emissions from reactors, following abatement, are combined prior to release through extract flues to minimise the number of emission points.	Yes
BAT 6. In order to reduce channelled emissions to air, BAT is to ensure that the waste gas treatment systems are appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), operated within their design ranges, and maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	Abatement plant is specifically designed for GaN and similar process applications and has a proven track-record for reliability and safety. PPM programme is currently in place, which will include new plant and equipment. Maintenance of abatement plant and associated equipment will be carried out in accordance with manufacturer's instructions.	Yes
BAT 16. In order to reduce channelled emissions to air of CO, NOX and SOX from thermal treatment, BAT is to use technique c. and one or a combination of the other techniques given below:		
a. Choice of fuel	Most of the energy required for abatement of ammonia will be supplied by the hydrogen content of the waste gas. See Section 2.7.	Yes
b. Low-NOX burner	Plasma technology generates minimal NOx emissions. See Air Emissions Assessment in Appendix E.	Yes
c. Optimisation of catalytic or thermal oxidation	Plasma technology generates minimal combustion-type emissions. See Air Emissions Assessment in Appendix E.	Yes
d. Removal of high levels of NO_X precursors	Ammonia emissions are minimised by process efficiencies to reduce raw material use. Emissions of NOx are negligible. See Air Emissions	Yes

Technique	Details	Meets BATc?
	Assessment in Appendix E. Abatement of routine gases emitted from reactors, which include ammonia, is achieved by plasma technology. See Section 2.7.	
e. Absorption	Adsorption will be employed during etch process to adsorb chlorine emissions.	Yes
f. Selective catalytic reduction (SCR)	Not applicable, emissions of NOx are negligible. See Air Emissions Assessment in Appendix E.	NA
g. Selective noncatalytic reduction (SNCR)	Not applicable, emissions of NOx are negligible. See Air Emissions Assessment in Appendix E.	NA
BAT 18. In order to reduce channelled emissions to air of inorganic compounds other than channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions), channelled emissions to air of CO, NOX and SOX from the use of thermal treatment, and channelled emissions to air of NOX from process furnaces/heaters, BAT is to use one or a combination of the techniques given below. **Selection of abatement is described in Section 2.7.**		
a. Absorption	Not employed, adsorption technology is employed during etch process to adsorb chlorine emissions.	NA
b. Adsorption	As above, adsorption is employed during etch process to adsorb chlorine emissions. See Section 2.7.	Yes
c. Selective catalytic reduction (SCR)	Not applicable, emissions of NOx are negligible. See Air Emissions Assessment in Appendix E.	NA
d. Selective noncatalytic reduction (SNCR)	Not applicable, emissions of NOx are negligible. See Air Emissions Assessment in Appendix E.	NA
e. Catalytic oxidation	Not employed. Abatement of routine gases emitted from reactors, which include ammonia, is based on plasma technology. See Section 2.7.	NA
f. Thermal oxidation	Abatement of routine gases emitted from reactors, which include ammonia, is based on plasma technology. See Section 2.7.	Yes
BAT 36 [additional requirements to BAT 16]. In order to prevent or, where that is not practicable, to reduce channelled emissions to air of CO, dust, NOX and SOX, BAT is to use technique c. and one or a combination of the other techniques given below.		
c. Optimised combustion	Combustion emissions are very low due to use of plasma technology. Most of the energy required for abatement of ammonia is supplied by the hydrogen content of the waste gas. See Section 2.7.	Yes

Technique	Details	Meets BATc?
d. Absorption	As above, adsorption is employed during etch process to adsorb chlorine emissions. See Section 2.7.	Yes
BAT-AELs associated with use of thermal oxidation	Not applicable. Plasma abatement is individually and on aggregate below 1MWth.	NA
CWWWG BATc		
BAT 15. In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.	Reactor emissions are enclosed and treated prior to release, see Section 2.7.	Yes
BAT 16. In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques.	Reactor emissions are enclosed and treated prior to release, see Section 2.7.	Yes

It is concluded that the proposed techniques meet BAT requirements, where applicable.

3.8.7 Emissions to Air BAT-AELs

BAT-AELs and associated monitoring are presented in Section 5, however the basis for the BAT-AELs is presented below in Table 3-13.

Table 3-13 Proposed Air Emission Limits and Monitoring Methods

Emission point ref. & location	Source	Parameter	Limit (including unit)	Basis for Proposed Limit
A1	G4 Reactors 1-10 Furnace	Arsine Phosphine	None set	Existing permit Insignificant emissions from reactors and furnace.
A2	Gas Storage Bunker	No routine releases	None set	Existing permit (no change)
A3	LEV	No routine releases	None set	Existing permit (no change)
A4 [1]	Reactors 11-20 (normal operation emissions)	Arsine Phosphine	None set	Existing permit Insignificant emissions from reactors and furnace.
		Ammonia	None set, the BAT-AEL does not apply to minor emissions (i.e. when the NH_3 mass flow is below e.g. 50 g/h). The mass flow for individual flues and	WCG BATc Table 1.6

Emission point ref. & location	Source	Parameter	Limit (including unit)	Basis for Proposed Limit
			aggregated emissions is well below 50g/h (see air emissions assessment in Appendix E.	
		NOx	5-130mg/Nm^3	WCG BATc Table 1.4. No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E).
		CO	No limit set	WCG BATc Table 1.4
		CO_2	No limit set	NA
A4a [1]	Reactors 11-20 (etch cycle emissions)	Chlorine	No limit set. The BAT-AEL does not apply to minor emissions (i.e. when the mass flow of the substance concerned is below e.g. 5g/h). The mass flow for individual flues and aggregated emissions is well below 5g/h (see air emissions assessment in Appendix E.	WCG BATc Table 1.6
A5 (reactors 21-38) A6 (reactors 39-56 A7 (reactors 57-74) A8 (reactors 75-92	Reactors 21-92 (each flue discharges emissions during normal operation and etch cycle)	Ammonia	No limit set, as above.	WCG BATc Table 1.6
		NOx	5-130mg/Nm^3	WCG BATc Table 1.4. No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E).
		CO	No limit set, as above.	WCG BATc Table 1.4
		CO_2	No limit set, as above.	NA
		Chlorine	No limit set, as above.	WCG BATc Table 1.6

Emission point ref. & location	Source	Parameter	Limit (including unit)	Basis for Proposed Limit
A9, A10	2 Emergency Generators	NOx CO CO_2 SO_2	<50 hours per annum, no limits or monitoring proposed.	MCPD requirements
A11 (existing boilers)	3 Boilers supplying heat for reactor units	NOx CO CO_2 SO_2	Below regulatory limit of 1MWth. Emissions are insignificant therefore no limits or monitoring proposed.	MCPD requirements
A12 to A15	4 Boilers supplying heat for reactor units	NOx CO CO_2 SO_2	Below regulatory limit of 1MWth. Emissions are insignificant therefore no limits or monitoring proposed.	MCPD requirements
Note 1: Emissions could comprise any of these substances depending on whether applying GaAs, InP or GaN technologies.				

It is concluded that the proposed techniques meet BAT requirements, where applicable.

3.9 Process Releases to Water (via Sewer)

Aqueous process emissions arise from the operation of the furnace, abatement plant, water pre-treatment processes and cooling system and are described in Section 2.10. There are no process emissions released directly into surface water drains. All aqueous emissions are discharged into the foul sewer system in accordance with the Installation's consent issued by the sewerage undertaker, Welsh Water.

The sections below present the CWWWG BATs for the minimisation of emissions to water and the Operator's proposed measures.

3.9.1 Inventory of Emissions to Water

Table 3-9 below describes CWWWG BAT 2 requirements and the Operator's proposed measures.

Table 3-14 CWWWG BAT 2 Inventory of Water Emissions

Technique	Details	Meets BATc?
BAT 2. In order to facilitate the reduction of emissions to water [and air][2] and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water [and waste gas streams], as part of the environmental management system (see BAT 1), that incorporates all of the following features:		

[2] Waste Gas streams are described separately in Section 3.8

Technique	Details	Meets BATc?
(i) information about the chemical production processes, including: (a) chemical reaction equations, also showing side products; (b) simplified process flow sheets that show the origin of the emissions; (c) descriptions of process-integrated techniques and waste water/waste gas treatment at source including their performances;	Emissions to water are minimal. Process flow sheets are available and show aqueous releases. No waste water treatment proposed on-site; emissions are released into sewer.	**Yes**
(ii) information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, such as: (a) average values and variability of flow, pH, temperature, and conductivity; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. COD/TOC, nitrogen species, phosphorus, metals, salts, specific organic compounds); (c) data on bioeliminability (e.g. BOD, BOD/COD ratio, Zahn-Wellens test, biological inhibition potential (e.g. nitrification));	Not applicable. No waste water treatment proposed on-site; emissions are released into sewer.	NA

It is concluded that the proposed techniques meet CWWWG BAT 2 requirements, where applicable.

3.9.2 Monitoring of Waste Water Stream Process Parameters

Table 3-9 below describes CWWWG BAT 3 requirements and the Operator's proposed measures.

Table 3-15 CWWWG BAT 3 Inventory of Water Emissions

Technique	Details	Meets BATc?
BAT 2: For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pretreatment and influent to final treatment).	Waste water streams are limited to reject RO water from pre-treatment processes, cooling water blowdown and a small amount of condensate from the plasma abatement system. No routine monitoring is proposed, however initial monitoring will be carried out to confirm assumptions in this application. If required, key process will be monitored in the waste water, including flow, pH and temperature.	Yes

It is concluded that the proposed techniques meet CWWWG BAT 3 requirements, where applicable.

3.9.3 Monitoring of Emissions to Water (via sewer)

The final effluent comprises the following pollutant sources:

- Cooling water from the new cooling systems.
- Effluent from the burner abatement system.
- Furnace emissions.
- Pre-treatment of process water.

No monitoring of aqueous emissions is proposed as emissions are released to sewer where they are treated prior to discharge into a waterbody.

3.9.4 Water Use and Effluent Generation

Table 3-16 below describes CWWWG BAT 7, 8, 9 and 10 requirements and the Operator's proposed measures.

Table 3-16 BAT 7, 8, 9 and 10 Waste Water Requirements

Technique	Details	Meets BATc?
BAT 7. In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance the reuse of waste water within the production process and to recover and reuse raw materials.	Water use is monitored on-site. New plant will be subject to existing standards.	Yes
BAT 8. In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams that require treatment.	Process and surface water effluent streams are segregated by separate drainage systems.	Yes
BAT 9. In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).	There are limited potential releases of polluting emissions into water. Liquids are provisioned with localised secondary containment preventing release into the drainage system. See Table 2-8.	Yes
BAT 10. In order to reduce emissions to water, BAT is to use an integrated waste water management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below.		
(a) Process-integrated techniques. [1]	Effluent is generated in low volumes and is discharged to sewer prior to release into a waterbody.	Yes
(b) Recovery of pollutants at source	There are no opportunities to recover pollutants, which are in very low concentrations in the final effluent.	Yes
(c) Waste water pretreatment	Scrubber water is treated within abatement system.	Yes
(d) Final waste water treatment	Effluent is generated in low volumes and is discharged to	Yes

Technique	Details	Meets BATc?
	sewer prior to release into a waterbody. Scrubber water is treated within abatement system.	
Note 1: These techniques are further described and defined in other BAT conclusions for the chemical industry, however there is no published chemical industry BATc for this Installation.		

It is concluded that the proposed techniques meet CWWWG BAT 7, 8, 9 and 10 requirements, where applicable.

3.10 Diffuse Emissions from Storage and Handling of Materials

Diffuse emissions may arise from the storage and handling raw materials and wastes as described in Section 2.8.7. Table 3-17 below describes the measures specified in S4.03 relating to the storage and handling of materials and the Operator's proposed measures.

Table 3-17 Storage and Handling of Materials

Indicative BAT	Justification
Measures specified in S4.03	
Store reactive chemicals in such a way that they remain stable, such as under a steady gas stream, for example. If chemical additions are necessary then tests should be carried out to ensure the required chemical composition is maintained. Inhibitors may also be added to prevent reactions.	Inventory of liquids is limited to small volumes of maintenance fluids which are stored in drums. Containment arrangements are described in Table 2-8. Gases are stored under controlled conditions as described in Section 2.3.
Vent storage tanks to a safe location.	There are no bulk liquid containing tanks on-site aside from liquid nitrogen and fire suppressant water, inventory of liquids is limited to small volumes of maintenance fluids. Containment arrangements are described in Table 2-8.
Use measures to reduce the risk of contamination from large storage tanks. In addition to sealed bunds, use double-walled tanks and leak detection channels.	There are no bulk liquid containing tanks on-site aside from ammonia, liquid nitrogen and fire suppressant water, inventory of liquids is limited to small volumes of maintenance fluids. Containment arrangements are described in Table 2-8.
Use HAZOP studies to identify risks to the environment for all operations involving the storage and handling of chemicals and wastes. Where the risks are identified as significant, plans and timetables for improvements should be in place	A HAZOP study will be carried out which will include identification and management of risks to the environment.

It is concluded that the proposed techniques meet S4.03 requirements, where applicable.

3.11 Odour

A review of impact of potentially odorous releases from the gases which will be used and stored at the Newport Semiconductor Facility has been undertaken and is presented in Section 4.4. It is considered unlikely that odour releases will cause an offsite nuisance arising from the proposed operation of the Newport Semiconductor Facility.

Materials are only used within the main process building or within enclosed vessels. Release of emissions are via is via 18.4m flues aiding dispersion. Abatement is installed to minimise release of potentially odorous gas. Release concentrations are well below odour thresholds. Since the outset of operation of the facility, no odour complaints have been received.

It is therefore concluded that odour is not a priority emission for the installation and no further measures, beyond those implemented to control emissions to air, are required to be installed.

3.12 Noise and Vibration

Operations on-site include minimal external noise sources as most plant and equipment is contained within the main process building. Externally, there are chillers and fans and the new wet cooling systems.

Noise emissions have been calculated and the results and conclusions are presented in the Noise Assessment in Appendix F. The report make the following conclusions:

"New plant has been proposed to the IQE site at Imperial Park in Newport to expand the current operation. The baseline sound environment has been measured and the assessment methodology has been established. An acoustic model was built to predict the specific sound levels at the surrounding noise sensitive receptors.

A BS 4142 worst case assessment of the impact of sound from the proposed plant at the nearest noise sensitive receptors has been undertaken, with reference to the baseline conditions at the sensitive receptors and manufacturer sound data where available. Three scenarios, including normal operation, emergency, and generator testing, were assessed.

The assessment indicates that the proposed plant would have negligible to minor adverse impact at all noise sensitive receptors during normal operation. Considering the exceedance of the rating level over the background sound level is low and the proposal does not introduce new type of noise sources to the area, the plant would not cause significant effect at the noise sensitive receptors.

In case of an emergency, the noise may have up to moderate adverse impact on the closest noise sensitive receptors. Considering the emergency situations are rare, the plant is unlikely cause significant effect at the noise sensitive receptors.

The rating level during generator testing may also cause moderate adverse impact. However, the testing is only scheduled once a month for less than one hour. The impact is not considered significant during generator testing. As the impacts are not significant, no further mitigation would be required."

Table 3-18 CWWWG BAT 22 and BAT 23 Minimising Noise Emissions

Technique	Details	Meets BATc?
BAT 22. In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:	BAT 22 is only applicable where 'The applicability is restricted to cases where noise nuisance can be expected or has been substantiated.' Based on the conclusions of the noise assessment, noise nuisance is not anticipated therefore this BATc does not apply.	NA
BAT 23. In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below.		
(a) Appropriate location of equipment and buildings	The noise assessment (Appendix F) included that the development is unlikely to cause significant effect based on the proposed layout of equipment and buildings.	Yes
b) Operational measures (c) Low-noise equipment (d) Noise-control equipment (e) Noise abatement	The noise assessment (Appendix F) included that the development is unlikely to cause significant effect, and no further mitigation measures would be required.	Yes

It is concluded that the proposed techniques meet BAT requirements, where applicable.

4. Impact on the Environment

4.1 Introduction

An Environmental Risk Assessment has been compiled to determine the environmental risks posed by the increase in operations at the installation, and to ensure that there remain no significant impacts on the environment and human health.

In accordance with EA Guidance, now presented on the .gov website (as adopted by NRW) 'Risk assessments for specific activities: environmental permits', last updated 21 November 2023, the following assessments have been carried out:

- Air Quality;
- Global Warming Potential;
- Surface Water;
- Odour emissions;
- Site Waste;
- Fugitive releases; and
- Accidents.

Techniques to minimise the environmental impacts associated with the facility are described in Section 2 and compared with environmental standards in Section 3.

There are no changes to the controls or emissions relating to the operation of the currently permitted reactors 1-20 when applying GaAs or InP technologies, other than a slight change in arsine and phosphine releases from emission points A1 and A4. The slight increase in emissions is quantified and assessed in the AQA in Appendix E.

The ERA is focussed on the changes to the proposed processes and techniques which relate to the additional reactors which employ GaN technology and the operation of the furnace.

4.2 Important and Sensitive Receptors

The sensitive properties and residential receptors which may be affected by the Newport Semiconductor Facility are those in the population centres of Duffryn which lies around 500m to the east of the Installation, Maes-Glas which lies 2km to the east and the smaller village of St Brides 2.5km to the south.

There are schools and community establishments in the Duffryn and Maes-Glas urban area close to the eastern boundary of the Installation. The closest human receptors are non-residential, adjacent to the site to the north at the NGD building and additional industrial units to the west of Celtic Way, some 50m from the Installation boundary. Further to the north, is the A48 around 350m from the site with additional office and industrial facilities on the northern side of the A48.

All European and International ecologically designated sites and nationally designated sites have been considered within 15 km of the Installation boundary, as well as national and local non-statutory local wildlife sites within 2 km. The site is not subject to any environmentally sensitive designations. It is located around 0.6km north of the Gwent Levels-St Brides Site of Special Scientific Interest (SSSI).

The Severn Estuary has a number of statutory designated areas located 3.5km south east of the site boundary. These include a Special Protection Area (SPA), Special Area of Conservation (SAC), Ramsar Site and SSSI.

Key receptors that have the potential to be impacted by emissions from the site are summarised in Table 4-1 below including both ecological and human receptors. Locations of nearby ecological sensitive receptors were investigated using the NRW's website and magic.gov. The following types of designated ecological sites were checked for their presence within 2km of the Installation and 10km from the Installation (European Designations):

- National Nature Reserve (NNR);
- Site of Special Scientific Interest (SSSI);
- Ramsar Site;
- Special Protection Area (SPA); and
- Special Area of Conservation (SAC).

Table 4-1: Sensitive Receptors

Receptor	Type	Distance (m) from Installation	Direction
NGD	Commercial	30m (adjacent)	N
Target Group	Commercial	300m	NE
Imperial Park Commercial Units	Commercial	340m	E
Pencarn Avenue	Residential	360m	N
Aviation Training Institute	Education	400m	ESE
Greggs Bakery and Café	Hospitality	460m	N
Celtic Springs Commercial Units	Commercial	500m	N
Powis Close	Residential	510m	SE
The Dragonfly Public House	Hospitality	520m	N
Tredegar House	Hospitality	810m	NNE
Severn Estuary Ramsar Site, SAC, SPA	Ecological	2,800m	E & SE
Newport Wetlands NNR	Ecological	3,670m	SE

The site is adjacent to Flood Zone 1 (low probability of flooding) according to information available from NRW.

4.1 Assessment of Process Emissions to Air

Air emissions are described in Section 2.7. In summary, following expansion, projected emissions, except for inert gases and hydrogen, are anticipated to be released well below detectable levels even at the highly conservative manufacture's guarantees. Throughputs of raw materials with potentially polluting impacts are very low, as described in Table 2-8.

Metalorganics are used at trace levels in very low quantities. The fate of these substances is either that they are transferred onto the wafers as the main purpose of the MOCVD process (10-20% of input), or deposited onto the reactor susceptors, reactor walls in the growth cells and trapped and contained in the reactor exhaust system (70-75% of input), which must be periodically maintained to remove this deposition. During the etch process, there is the potential for metalorganics to be released into the flue, however chemisorption abatement will be installed to minimise releases.

Residual trace levels of pollutants will be minimised through the high performance of the abatement technology, the implementation of rigorous Operator controls and the operation of the abatement equipment in line with manufacturer's recommendations.

Where BAT-AELs are provided in WCG BATc, pollutant levels are orders of magnitude lower than these values and well below the thresholds which stipulate when limits should be applied based on the manufacturer's guarantees (see Table 2-6).

Metalorganics, silane (in hydrogen) and propane have been excluded from the Air Quality Assessment as it is reasonable to conclude that ground level concentrations are highly likely to be negligible. This is in line with the approach taken in previous applications.

Table 4-2 below summarises the potential releases and the approach to assessing each pollutant.

Table 4-2: Fate of Process Emissions and Approach to Assessment

Parameter	Fate	Approach to Assessment
Metal organics (existing, however some new raw materials)	Transferred onto the wafers (10-20% of input). Deposited onto the reactor susceptors, reactor walls in the growth cells and trapped and contained in the reactor exhaust system (70-75% of input). Removed from reactors during etch process where they are adsorbed onto chemisorption abatement.	Input quantities are very low and final concentrations in flue, post abatement will be negligible, therefore metalorganics have been screened out of requiring assessment.
Dopant gases: Disilane (existing), propane (new), ethylene (new), silane (new).	Propane and ethylene would be thermally treated by plasma abatement.	The annual usage of these gas is very low, used in very dilute quantities and used intermittently therefore dopant gases have been screened out of requiring assessment.
Inert gases and hydrogen (existing)	Emitted through stacks	No controls necessary, not substances of concern. Inert gases have been screened out of requiring assessment.
Chlorine (new)	Treated by chemisorption.	Included in assessment.
Ammonia (new)	Ammonia would be thermally treated by plasma abatement.	Included in assessment.

Parameter	Fate	Approach to Assessment
Combustion products from abatement system: oxides of nitrogen (new). carbon monoxide (new). carbon dioxide (new).	Very low quantities released due to design of abatement equipment. Most of the energy required for abatement of ammonia is supplied by the hydrogen content of the waste gas.	Included in assessment.
Arsine	Treated by chemisorption.	Included in assessment to determine impacts from changes to quantities emitted.
Phosphine	Treated by chemisorption.	Included in assessment to determine impacts from changes to quantities emitted.

Dispersion modelling has been undertaken using AERMOD PRIME software to determine the impacts of the emissions from the following sources.

- 92 reactors with emissions released from stacks A1, A4, A4a, A5, A6, A7 and A8.
- Two emergency generators A9 and A10 (TBC)
- Two existing duty boilers which share a common flue (A11)
- Three new duty boilers with individual flues (A12, A13, A14, A15)

Two scenarios were included in the assessment to cover the anticipated operation of the reactors, and a theoretical worst-case scenario which includes operation of reactors 11- 20 when applying GaAs or InP technologies. This is to allow flexibility to the operator to produce a range of products within the scope of the permit.

The assessment is included in Appendix F which concludes as follows:

"The findings of this study of the emissions to atmosphere from the proposed installation of 82 new reactors, with associated abatement technology and combustion plant, show that there would not be a significant impact on human health and the environment during normal and emergency operation."

No dispersion modelling was carried out in relation to emissions from point A2 (existing storage bunker) or from the new storage bunkers as there are no routine process releases and emissions arising would be accidental. No dispersion modelling was carried out in relation to emissions from point A3 (LEV) as releases are negligible and were screened out from requiring assessment in previous applications. Releases to atmosphere from A3 comprises a laboratory scale fume LEV extract from acid baths, which are positioned within fume cupboards. Local exhaust ventilation is in place to protect operatives and emissions are projected to be negligible.

Emissions from standby boilers have not been included in the assessment as they would not be operated at the same time as the duty boilers.

4.2 Global Warming Potential

The global warming potential (GWP) of the facility has been re-calculated taking into the proposed changes in accordance with the EA's H1 Annex H Global Warming Potential and H1 Software Tool.

The total revised GWP score for the facility is 74,375,286 kg CO_2eq per annum which is derived from indirect carbon dioxide emissions from the estimated electricity consumption of the installation. This is based on the facility operating 92 G4 reactors for 8760 hours per year.

Table 4-3, below, shows the revised GWP score for process operations.

Table 4-3 Global Warming Potential

Energy	Source	Annual Rate MWh/year	Energy Conversion Factor	CO_2 Conversion Factor t/MWh	GWP per MWh tonnes CO_2eq/year
Carbon Dioxide Process: Indirect – use of electricity	Reactors	175,200	2.4	0.166	69,800
Carbon Dioxide Process: direct – natural gas	Natural gas fired boilers	23,424	1	0.19	4,451
Carbon Dioxide Process: direct – light fuel oil	Diesel generators	500	1	0.25	125

4.3 Emissions to Water Including via Sewer

Aqueous process emissions arise from the operation of the furnace, abatement plant, water pre-treatment processes and cooling system and are described in Section 2.10. There are no emissions released directly into surface water drains. All aqueous emissions are of low toxicity and are discharged into the foul sewer system in accordance with the Installation's consent issued by the sewerage undertaker, Welsh Water.

The impact from pre-treatment effluent has not been assessed quantitatively due to the low potential impact of the effluent and low quantities of effluent released to sewer. The constituents will be limited to dissolved minerals such as calcium and trace contaminants and will be approximately four times the concentration of the levels present in mains water. This approach was accepted by NRW as part of the determination process of the original permit application.

The impact from the cooling system blowdown is similarly low in toxicity containing only dilute quantities of scale and corrosion inhibitor and biocide. As the cooling water is released into the sewer the impacts on the receiving watercourse (the Severn Estuary following treatment at the sewage work) are likely to be minimal.

A small emission to water is generated by the plasma abatement system comprising condensate. The manufacturer of the abatement plant confirmed that the water contains no polluting substances as it is condensate arising from the thermal process. This will be confirmed during early operation of the reactors and as a precaution, it will be discharged to sewer under the existing consent issued by the sewerage undertaker.

A small amount of condensate (approximately 0.5 litres per cycle at a rate of 0.003 litres per minute) is generated during the operation of the furnace which will be discharged to sewer.

Effluent will be to discharge this emission into the sewer. Table 4-4 below presents the characteristics of this effluent stream. Use of the furnace is intermittent as it is only run when required.

Table 4-4: Furnace Effluent Characteristics

Parameter	Value
Peak flow rate (l/s)	0.00005
pH	5.0
Suspended solids	<5.0
Heavy solids	Absent
Arsenic	0.78mg/l
Aluminium – Total	<0.03mg/l
Aluminium - Dissolved	<0.03mg/l

It is concluded that aqueous emissions from the furnace are trivial and do not require further assessment, particularly when considering that they are discharged into a sewer.

There are no direct releases to water courses, other than uncontaminated surface water from the yard area via interceptor. No potentially polluting substances, other than gases are stored in this area so environmental risk is low.

It is proposed that no further assessment of emissions to water is required to demonstrate that impacts are likely to be negligible.

4.4 Odour emissions

The operation of the installation is not likely to generate an offsite nuisance from odour. However, some of the new materials stored on-site may generate low levels of odour. Chlorine and ammonia are potentially odorous, and therefore consideration must be made for the potential for them to cause nuisance.

Given the efficiency of the abatement equipment, the likely high dispersion rates provided by the velocity of the gas, and the stack height of 18.4, ground level concentrations of each substance are likely to be well below any odour thresholds.

It is therefore concluded that exhaust gases rectors will be treated then dispersed to such a high degree that they are highly unlikely to cause nuisance at local receptors.

4.5 Site Waste

Quantities of waste generated are described in Section 3.7 above. There are no changes to waste management techniques as a result of the increase in production.

4.6 Fugitive releases

4.6.1 Fugitive Releases to Land and Water

The site is not located over any Source Protection Zones, Groundwater Vulnerability Zones or aquifers. It is located adjacent to a Flood Zone 1 and not adjacent to a watercourse.

There is no bulk storage of potentially polluting liquids, therefore fugitive releases to land and water are unlikely to arise from chemical or oil spills and leaks. The inventory of potentially polluting substances does not present a significant risk to the environment, and with the controls described in Sections 2.8.7 and 3.10 in place, the risk is minimised.

Surface water from the site will be piped to the exiting surface water drainage system. All run-off from impermeable surfaces e.g., vehicular access road will pass through an oil interceptor fitted with silt probe. This will be inspected on a regular basis to check its integrity and be maintained to prevent overfilling.

Maintenance oils and other fluids will be stored and used on site in small quantities. Oils will be stored as described in Section 2.8.7. Deliveries of oil will be supervised by site operatives.

Spill kits will be available with materials suitable for absorbing and containing minor spills and site staff will be trained in their use and in the spill clean-up procedures.

4.6.2 Fugitive Emissions to Air

The potential fugitive emissions which may arise during operation of the proposed Installation, whilst extremely unlikely, would comprise process gases in the event of a leak.

To prevent release of process gas emissions, abatement is installed.

Leak detection is installed within storage bunkers and process areas to detect potential releases at the earliest opportunity. All process gases are fed from welded pipes. Flammable or toxic substances are provisioned with double contained pipework.

Full details of control measures to minimise fugitive emissions to air compared with requirements detailed in the relevant technical guidance notes is described in 2.8 above.

4.7 Accidents

The AMP has been updated to identify accident scenarios and incorporate controls applicable to the proposed changes. Activities will be managed and operated in accordance with the Operator's EMS, which will incorporate the Operator's updated Accident Management Plan.

Accident scenarios and management measures associated with the proposed changes have been summarised in the AMP in Appendix D.

4.8 Risk Assessments Summary

The tables below describe hazards and management measures and assess the main risks to the environment associated with the proposed changes.

Table 4-5 Noise Emissions (updated to include additional noise-generating equipment)

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
Loss of Noise Containment and mitigation measures	New chillers	Noise through the air	Local residents, workforce at local businesses, users of amenity sites	Low	Low	Medium	Plant maintenance, including PPM minimises noise generation and vibration. Operational procedure in place to deal with complaints about noise with records maintained.	Low
Loss of Noise Containment and mitigation measures	New fans	Noise through the air	Local residents, workforce at local businesses, users of amenity sites	Low	Low	Medium	Plant maintenance, including planned PPM minimises noise generation and vibration. Operational procedure in place to deal with complaints about noise with records maintained.	Low

Table 4-6 Fugitive Emissions to Air Including Odour (updated to include storage, distribution and use of new reactors and the operation of the furnace)

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
Release of pollutants within furnace exhaust gas	Release points to air (A1)	Air transport	Local residents, workforce at local businesses, users of amenity sites	Low	Low	Low	Very low concentrations of pollutants. Small-scale process, limited short-term releases. Operator controlled exhaust flow rates. Gas detection and alarms are in place to detect leaks. Process alarms sound locally and will be reported to the control system for the attention of the operations team. PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer’s instructions. Procedures and staff training. Procedural control of plant modification (MOC). Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes. Site security system (entry or sabotage). Design of appropriate access for emergency vehicles. Isolation of pipework and / or equipment.	Very low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Gas alarms and low-pressure switch.	
Loss of containment of gas causing toxic gas release (and odour impact)	Leaks of process gas from pipework, reactors, gas bunker and from a mechanical failure or cylinder failure	Air transport	Local residents, workforce at local businesses, users of amenity sites	Low	High	High	Burner/chemisorption to abate process emissions during wafer production. The chemisorb scrubber is specially engineered to handle the gas flows and related operating conditions of the MOCVD process. Chemisorption abatement will be installed to gas cabinets and process emissions from reactors. Spare sealed chemisorb columns will be stored locally to chemisorb units that are due a column change based on a time in service basis. An interlock will be provided to shut down the process if the exhaust fans fail. Operating procedures and staff training. Gas detection and alarms are in place to detect leaks with auto-shut-off valves to stop flow of pollutant gases. Process alarms sound locally and will be reported to the control system for the attention of the operations team. Maintenance and inspection routines: Leaks of process gas are prevented through inspection and maintenance, leak detection and repair and avoidance of over-pressurisation.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer’s instructions. Procedures and staff training. Procedural control of plant modification (MOC). Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes. Compliance measures in place which comply with requirements of DSEAR. Appropriate labelling of pipework. Appropriate crash barrier protection for process gas pipework. Bollards and curbing are in place to protect gas bunkers. Emergency shutdown system. Emergency plan. Site security system (entry or sabotage). Design of appropriate access for emergency vehicles.	

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Training and simulation/ testing of emergency systems. Isolation of pipework and equipment	
Release of ammonia gas from pipework or reactor from main exhaust	Release point to air (A4)	Air transport	Local residents, workforce at local businesses, users of amenity sites	Low	High	High	Burner in place to destroy emissions. Double contained pipework. Auto-shut-down linked to operation of abatement plant. Operator controlled exhaust flow rates. Process fans to remove exhaust gas. Standby fan to remove exhaust gas in event of primary fan failure. An interlock will be provided to shut down the process if the exhaust fans fail. Gas detection and alarms are in place to detect leaks with auto-shut-off valves to stop flow of pollutant gases. Process alarms sound locally and will be reported to the control system for the attention of the operations team. Leaks of process gas are prevented through inspection and maintenance, leak detection and repair and avoidance of over-pressurisation.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer’s instructions. Procedures and staff training. Procedural control of plant modification (MOC). Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes. Emergency shutdown system. Emergency plan. Site security system (entry or sabotage). Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and / or equipment. Gas alarms and low-pressure switch.	

Table 4-7 Fugitive Emissions to Water, Ground and Groundwater (updated to include storage, distribution and use of new reactors and the operation of the furnace)

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
Loss of containment of ammonia tank or associated pipework	Leaks from ammonia tank or pipework	Initially transport via the ground and drainage systems, then air transport	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	High	High	Physical prevention measures include double contained pipelines where required. An interlock will be provided to shut down the process if the exhaust fans fail. Operating procedures and staff training. Maintenance and inspection routines: Leaks are prevented through inspection and maintenance. PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer's instructions. Procedures and staff training. Procedural control of plant modification (MOC) Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes Compliance measures in place which comply with requirements of DSEAR.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Appropriate labelling of pipework Ammonia tank will be situated well away from roadways and provisioned with barriers to prevent accidental damage. Emergency shutdown system Emergency plan Site security system (entry or sabotage) Design of appropriate access for emergency vehicles Training and simulation/ testing of emergency systems Isolation of pipework and equipment.	
Loss of containment of condensate or associated pipework	Leaks from vessels or pipework	Transport via the ground and drainage systems	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	Low	Low	Very small volumes of condensate generated. Physical prevention measures include robust pipelines to transfer the condensate to drain. Operating procedures and staff training. Maintenance and inspection routines: Leaks are prevented through inspection and maintenance.	Very low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							PPM will be in place to ensure plant and equipment are maintained in accordance with the manufacturer's instructions. Procedures and staff training. Procedural control of plant modification (MOC). Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes. Appropriate labelling of pipework. Vessels will be situated well away from roadways and provisioned with barriers to prevent accidental damage. Site security system (entry or sabotage). Isolation of pipework and equipment.	

5. Proposed Monitoring and Controls

5.1 Introduction

This section describes the proposed monitoring and controls to minimise emissions to air considering BAT-AELs presented in the following documents:

- WCG BATc
- CWWWG BATc
- NRW's S4.03

5.2 Proposed Emission Limits and Monitoring - Air

Table 5-1 below presents the proposed emission limits and associated monitoring requirements for both existing and new point sources released into the air. Changes compared with the current permit are highlighted. See Section Table 3-13 for BAT justification of proposed limits.

Table 5-1 Proposed Air Emission Limits and Monitoring Methods

Ref.	Source	Parameter	Limit (including unit)	Monitoring Frequency	Monitoring Method
A1	G4 Reactors 1-10 and oxidation furnace	Arsine Phosphine	None set	NA	NA
A2	Gas Storage Bunker	No routine releases	None set	NA	NA
A3	LEV	No routine releases	None set	NA	NA
A4	Reactors 11-20 (normal operation emissions)	Arsine Phosphine	None set	NA	NA
		Ammonia	None set	6-monthly then once every three years	EN 21877
		NOx	No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E). No monitoring is proposed.		NA
A4a [1]	Reactors 11-20 (cleaning cycle emissions)	Chlorine	None set	Annually, then once every three years	No EN standard available

Ref.	Source	Parameter	Limit (including unit)	Monitoring Frequency	Monitoring Method
A5	Reactors 21-38 (combined flue including normal operation and cleaning cycle emissions	Ammonia	None set	6-monthly then once every three years	EN 21877
		NOx	No limit is proposed as NOx emissions from thermal oxidiser are negligible (see Air Emissions Assessment in Appendix E). No monitoring is proposed.		NA
		Chlorine	None set	Annually, then once every three years	No EN standard available
A6	Reactors 39-56 (combined flue including normal operation and cleaning cycle emissions	Ammonia	None set	6-monthly then once every three years	EN 21877
		NOx	No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E). No monitoring is proposed.		NA
		Chlorine	None set	Annually, then once every three years	No EN standard available
A7	Reactors 57-74 (combined flue including normal operation and cleaning cycle emissions	Ammonia	None set	6-monthly then once every three years	EN 21877
		NOx	No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E). No monitoring is proposed.		NA
		Chlorine	None set	Annually, then once every three years	No EN standard available
A8	Reactors 75-92 (combined flue including normal operation and cleaning cycle emissions	Ammonia	None set	6-monthly then once every three years	EN 21877
		NOx	No limit is proposed as NOx emissions from abatement are negligible (see Air Emissions Assessment in Appendix E). No monitoring is proposed.		NA
		Chlorine	None set	Annually, then once every three years	No EN standard available
A9	Emergency Generator	NOx, CO, CO_2, SO_2	<50 hours per annum, no limits or monitoring proposed.		

Ref.	Source	Parameter	Limit (including unit)	Monitoring Frequency	Monitoring Method
A10	Emergency Generator	NOx, CO, CO_2, SO_2	<50 hours per annum, no limits or monitoring proposed.		
A11	Existing boilers supplying heat for reactor units	NOx, CO, CO_2	Below regulatory limit of 1MWth. Emissions are insignificant therefore no limits or monitoring proposed.		
A12 to A15	4No New boilers supplying heat for reactor units	NOx, CO, CO_2	Below regulatory limit of 1MWth. Emissions are insignificant therefore no limits or monitoring proposed.		
Note 1: Existing stack A4 has been modified to allow the emissions from the chemisorption abatement to be released in a separate flue (A4a) which is attached to existing flue A4.					

5.2.1 Commissioning Air Emissions Monitoring

During commissioning, one round of emissions monitoring will be carried out to confirm the assumptions made in this application, see Table 5-2. Monitoring arrangements for emissions to air will have regard to the following BATc documents and regulatory monitoring guidance, notably EA Guidance Monitoring stack emissions: measurement locations, Updated 14 December 2022 where relevant and appropriate.

Monitoring will be carried out in accordance with requirements of MCerts. MCerts qualified personnel, using MCerts certified monitoring equipment will be employed to monitor emissions.

Table 5-2 Air Emission Points and Site Monitoring Plan

Air Emission Point Reference	Source of emission	Parameter	Monitoring Standard	Range	Monitoring Frequency
A4	Process releases via flue	Arsine	Approved method in EA Guidance Monitoring stack emissions: techniques and standards for periodic monitoring, last updated 17 November 2022	<0.1mg/m^3	Initially during commissioning only. No routine monitoring is proposed.
A4	Process releases via flue	Phosphine		<0.1mg/m^3	
A4, A5, A6, A7, A8	Process releases via flue	Ammonia	EN 21877	<0.1mg/m^3	

Air Emission Point Reference	Source of emission	Parameter	Monitoring Standard	Range	Monitoring Frequency
A4a, A5, A6, A7, A8	Process releases via flue	Chlorine	No EN standard available	<0.1mg/m^3	
A4a, A5, A6, A7, A8	Process releases via flue	Chlorine	BS ISO 14792	<0.1mg/m^3	

In summary, the following factors demonstrate that emissions will be minimised and that a high level of control of emissions to air are in place:

- high performance chemisorption and plasma abatement equipment which is demonstrated to represent BAT;
- performance guarantees achieve emissions which are below BAT benchmarks (where available);
- ongoing monitoring of effectiveness of the abatement comprising end-point detection; and
- planned preventative maintenance in line with manufacturer's instructions, which will be incorporated in EMS and operating procedures.

Given that emissions were calculated to be insignificant in the Air Quality Assessment (see Appendix E, and that all raw materials have a very low throughput, it is proposed that the controls described above will provide adequate protection of the environment without the need for imposition of emission limit values or compliance monitoring. However, to confirm this, an initial round of monitoring is proposed as described above.

5.3 Emissions to Water

Aqueous process emissions arise from the operation of the abatement plant, water pre-treatment processes, furnace and cooling system and are described in Section 2.10. There are no emissions released directly into surface water drains. All aqueous emissions are of low toxicity and are discharged into the foul sewer system in accordance with the Installation's consent issued by the sewerage undertaker, Welsh Water.

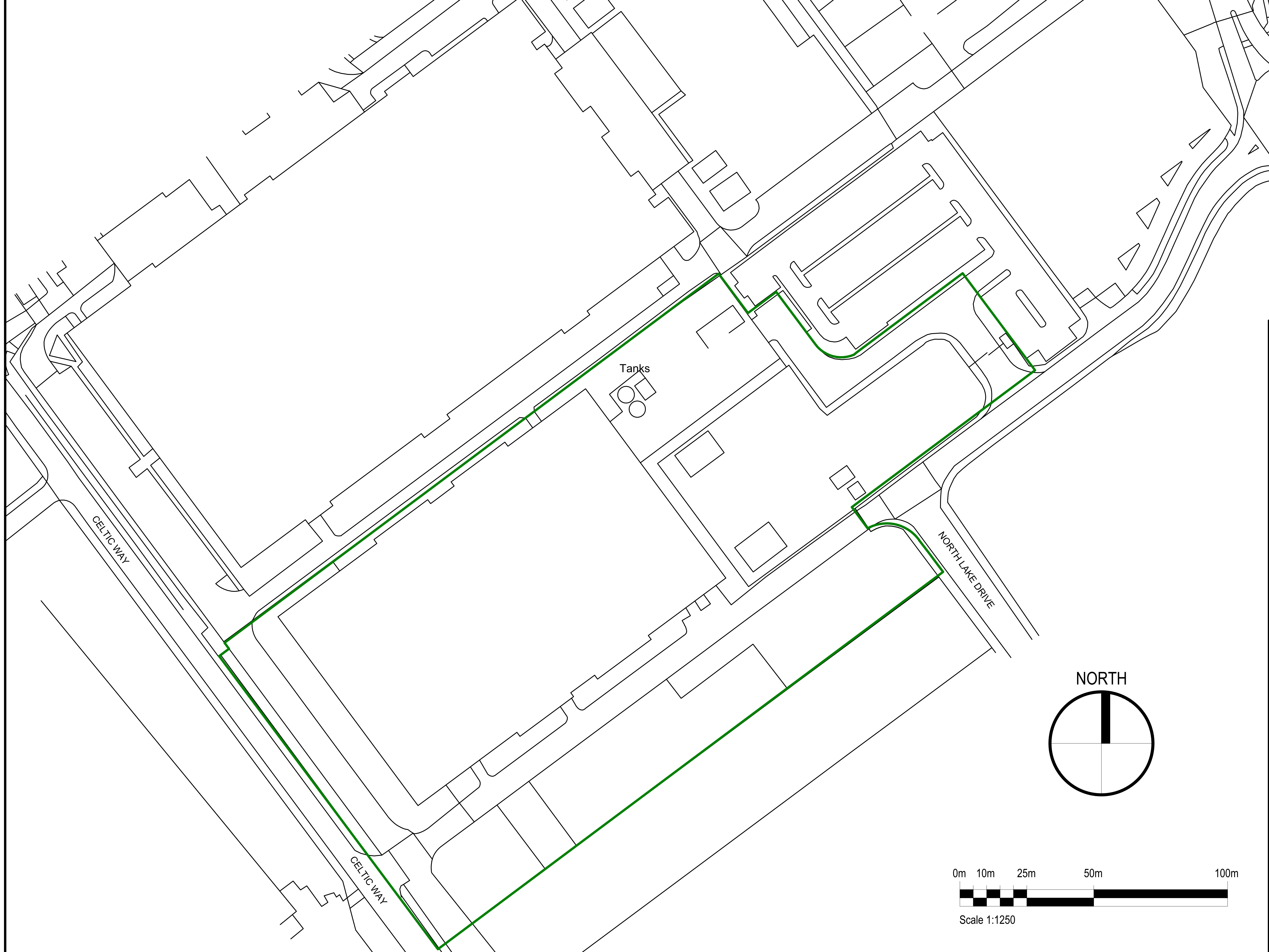
No routine monitoring of emissions to sewer is proposed as a result of the proposed changes.

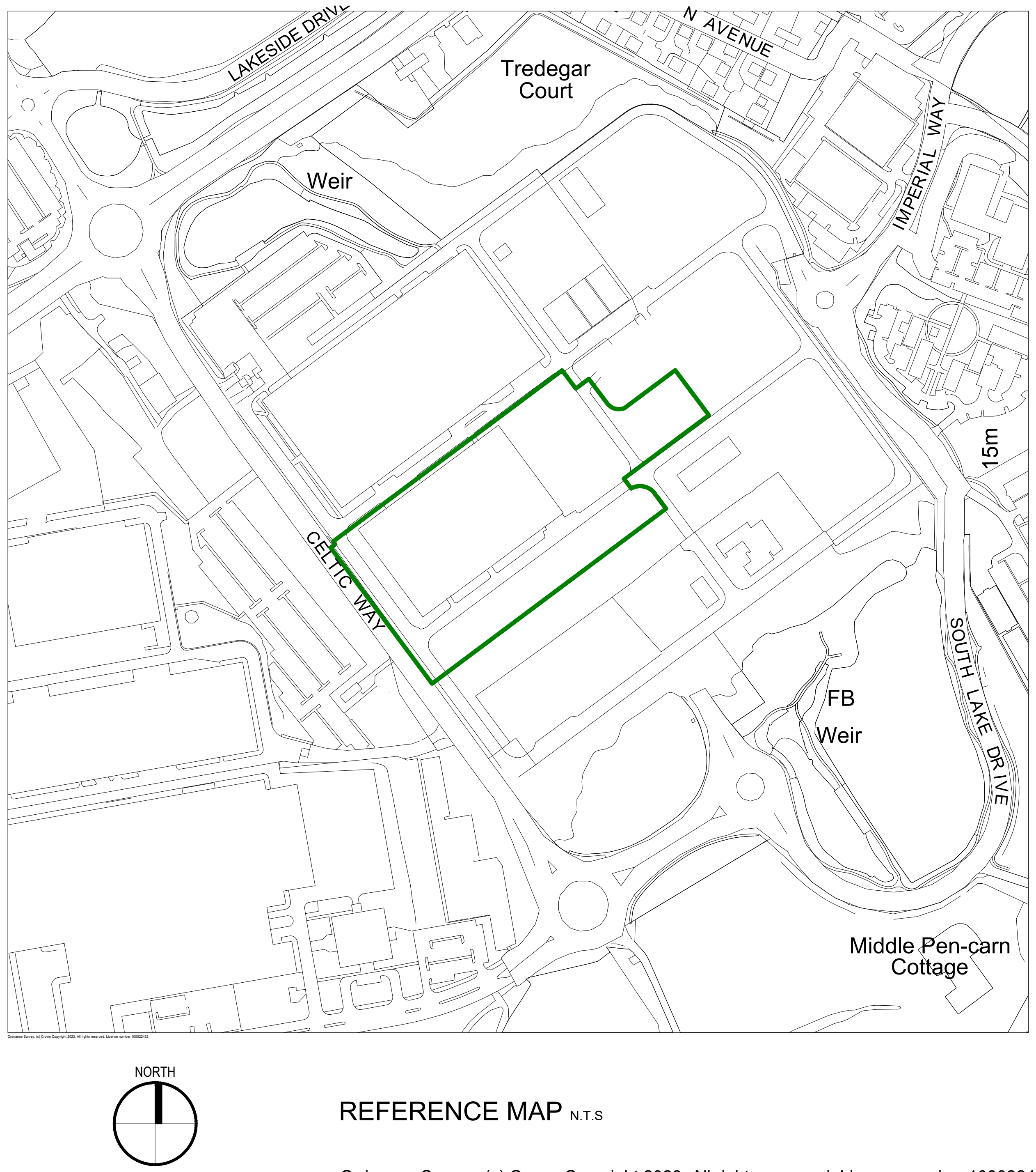
APPENDICES

Appendix A. Drawings

A.1 Installation Boundary and Site Location Plan

DO NOT SCALE





REFERENCE MAP N.T.S

GENERAL NOTES

1. ALL MEASUREMENTS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. RESPONSIBILITY IS NOT ACCEPTED FOR ERRORS MADE BY OTHERS SCALING FROM THIS DRAWING
3. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT FIGURED CONSTRUCTION ARCHITECTURAL, STRUCTURAL, MECHANICAL AND ELECTRICAL DRAWINGS AND SPECIFICATIONS.

KEY

ENVIRONMENTAL PERMIT BOUNDARY

Rev.	Date	Description	By	Chk'd	App'd
P1	13/10/2023	FOR PLANNING	LD	STC	XX

Drawing Status: FOR PLANNING

Suitability: S2

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Client: IQE

Project Title: ENVIRONMENTAL PERMIT APPLICATION

Drawing Title: SITE LOCATION PLAN

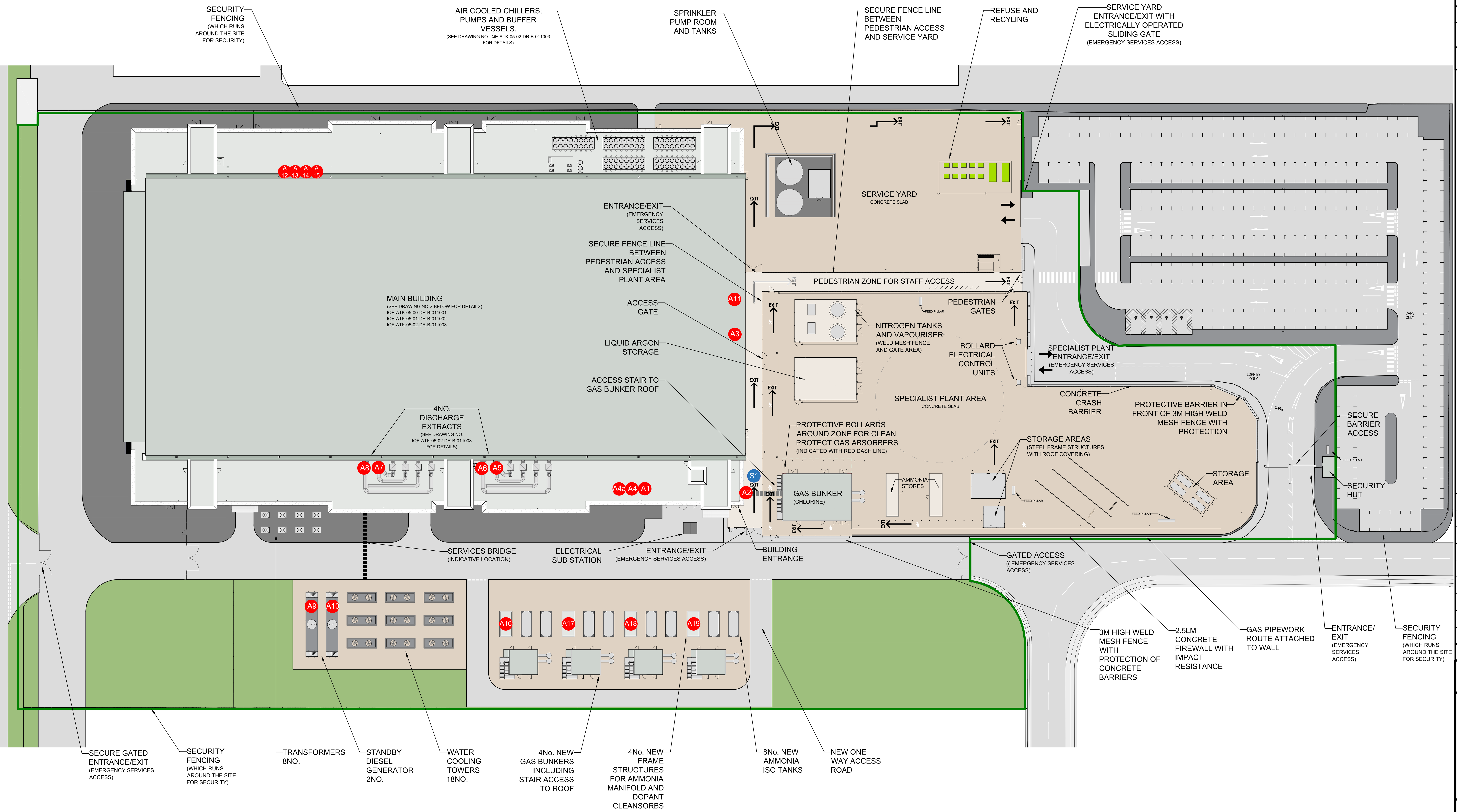
Scale	Designed	Drawn	Checked	Authorised
1:1250	LD	LD	STC	OE
Original Size	Date	Date	Date	Date
A2	13/10/23	13/10/23	13/10/23	XX

Drawing Number: IQE-ATK-05-XX-DR-B-021005

Revision: P1

A.2 Site Plan

CLASSIFICATION - Baseline (Low Risk)



EMISSION POINT KEY								
Emission Point	Source	Existing or New	Emission Point	Source	Existing or New	Emission Point	Source	Existing or New
A1	G4 Reactors 1-10 and Oxidation Furnace	Existing	A7	Reactors 57-74	New	A14	Boiler	New
A2	Gas Storage Bunker	Existing	A8	Reactors 75-92	New	A15	Boiler	New
A3	LEV	Existing	A9	Emergency Generator	New	A16	Gas Storage Bunker	New
A4	Reactors 11-20	Existing	A10	Emergency Generator	New	A17	Gas Storage Bunker	New
A4a	Reactors 11-20	New	A11	3 No. Boilers	Existing	A18	Gas Storage Bunker	New
A5	Reactors 21-38	New	A12	Boiler	New	A19	Gas Storage Bunker	New
A6	Reactors 39-56	New	A13	Boiler	New			

0m 5m 10m 20m 50m
Scale 1:500

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

CONSTRUCTION

NOT FOR CONSTRUCTION

MAINTENANCE/CLEANING

DECOMMISSIONING/DEMOLITION

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

GENERAL NOTES

1. ALL MEASUREMENTS IN MILLIMETRES UNLESS STATED OTHERWISE.
2. RESPONSIBILITY IS NOT ACCEPTED FOR ERRORS MADE BY OTHERS SCALING FROM THIS DRAWING
3. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT FIGURED CONSTRUCTION ARCHITECTURAL, STRUCTURAL, MECHANICAL AND ELECTRICAL DRAWINGS AND SPECIFICATIONS.

NORTH

DRAFT

PERMIT APPLICATION BOUNDARY

Ordnance Survey National Gird Reference for Centre of the Site: ST 28267 84490

Rev.	Date	Description	By	Chk'd	App'd
P04	11/12/23	ISSUED TO CLIENT FOR REVIEW AND ACCEPTANCE	LD	STC	XX
P03	27/11/23	UPDATING FORMATTING ON DRAWING, UPDATING EMISSION POINTS - EARLY DRAFT	LD	STC	OE
P02	27/10/23	UPDATE OF MECHANICAL ELEMENTS- EARLY DRAFT SHARED FOR CO-ORDINATION	LD	STC	OE
P01	29/09/23	FOR PLANNING- EARLY DRAFT	LD	STC	OE

Drawing Status: FOR PLANNING
Suitability: S2

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Client: IQE

Project Title: ENVIRONMENTAL PERMIT APPLICATION

Drawing Title: PROPOSED SITE PLAN WITH EMISSION POINTS

Scale	Designed	Drawn	Checked	Authorised
1:500	LD	LD	STC	OE
Original Size	Date	Date	Date	Date
A1	30/08/23	30/08/23	12/12/23	XX

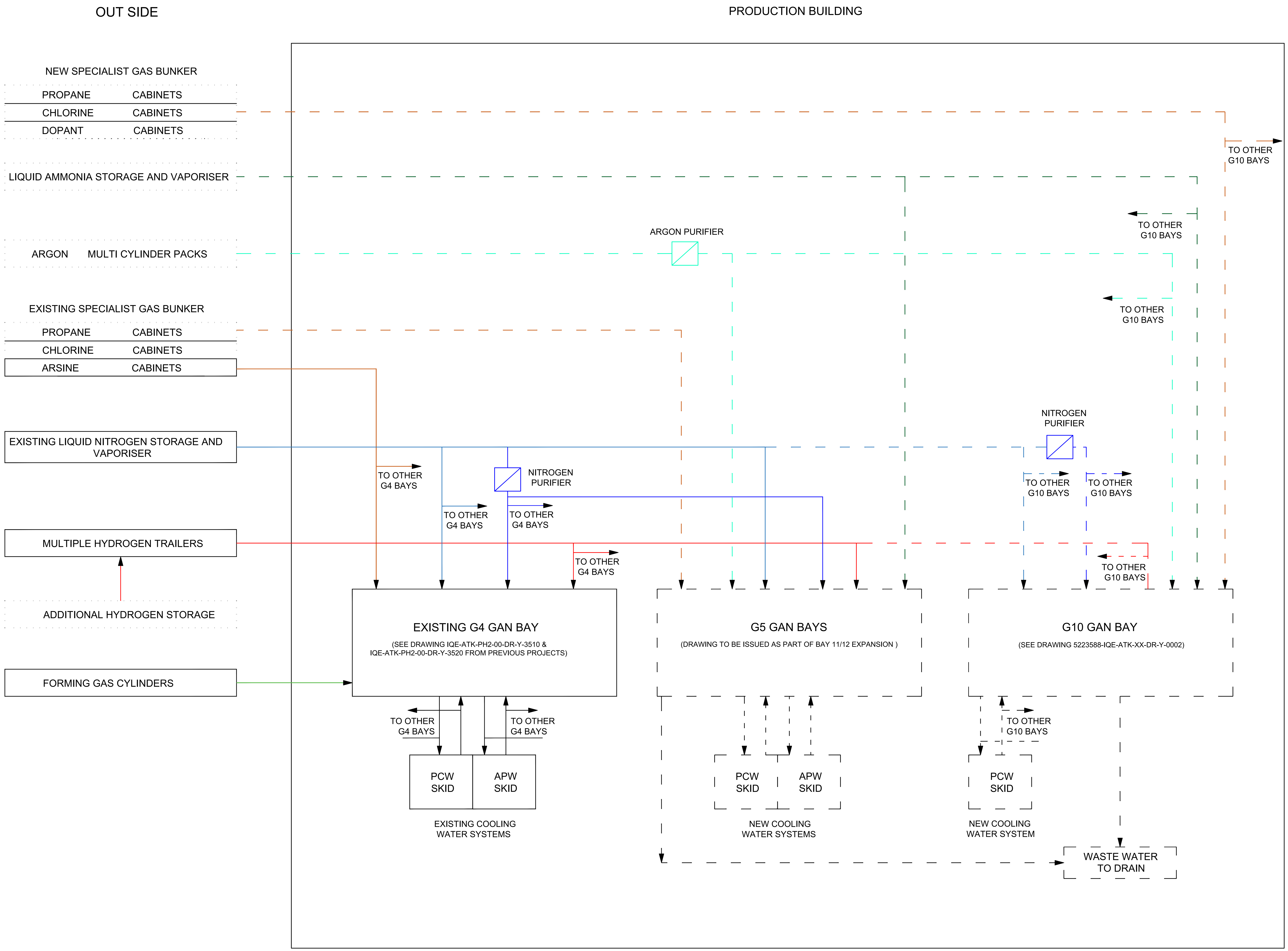
Drawing Number: IQE-ATK-05-XX-DR-B-021004
Revision: P04

Internal Project Number: 5223588

CLASSIFICATION - Baseline (Low Risk)

A.3 Process Flow Diagrams

DO NOT SCALE



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE STATED.
2. PCW - PROCESS COOLING WATER.
3. APW-ALUMINIUM CONTAINING PROCESS COOLING WATER.

KEY:

- - - - NEW DESIGN.

——— EXISTING INSTALL.

Rev.	Date	Description	By	Chk'd	App'd
1.0	08/09/2023	ISSUE FOR COMMENT	ST	RC	OE

Drawing Status: FOR COMMENT
Suitability: S0

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Client: IQE

Project Title: IQE NEWPORT 80 TOOLS ENVIRONMENTAL PERMITTING

Drawing Title: DISTRIBUTION BLOCK FLOW DIAGRAM

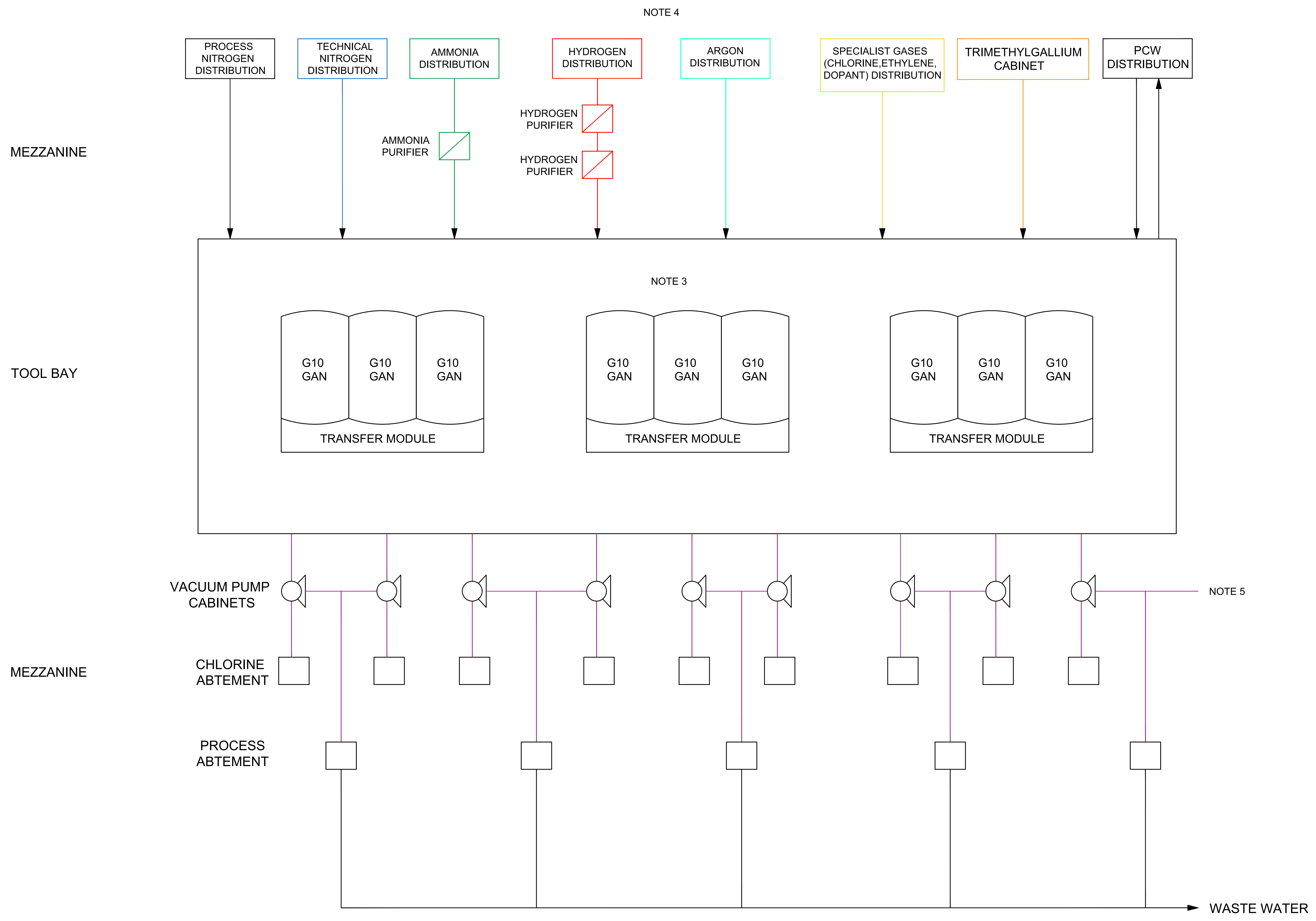
Scale	Designed	Drawn	Checked	Authorised
NTS	RC	ST	RC	OE
Original Size	Date	Date	Date	Date
A1	05/09/2023	06/09/2023	07/09/2023	08/09/2023

Drawing Number: 5222733-IQE-ATK-V2-XX-DR-Y-0001
Revision: 01

DO NOT SCALE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE STATED.
2. PCW - PROCESS COOLING WATER.
3. ALL INPUT GASES TO BE CONNECTED TO EVERY TOOL.
4. ALL INPUTS STREAMS FROM 5223588-IQE-ATK-XX-DR-Y-0001.
5. INPUTS STREAM FROM ADJACENT BAY.



Rev.	Date	Description	By	Chk'd	App'd
1.0	08/09/2023	ISSUE FOR COMMENT	ST	RC	OE

Drawing Status: FOR COMMENT

Suitability: S0

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Client: IQE

Project Title: IQE NEWPORT 80 TOOLS ENVIRONMENTAL PERMITTING

Drawing Title: GAN G10 BAY BLOCK FLOW DIAGRAM

Scale	Designed	Drawn	Checked	Authorised
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Original Size	Date	Date	Date	Date
A1	05/09/2023	06/09/2023	07/09/2023	08/09/2023

Drawing Number: 5223588-IQE-ATK-XX-DR-Y-0002

Revision: 01

Millimetres 0 10 100

A.4

Appendix B. Company Certificate

FILE COPY

CERTIFICATE OF INCORPORATION

ON CHANGE OF NAME

Company No. 3986643

The Registrar of Companies for England and Wales hereby certifies that

FILBUK 614 LIMITED

having by special resolution changed its name, is now incorporated

under the name of

IQE SILICON EPI LIMITED

Given at Companies House, Cardiff, the 16th June 2000

C03986643F

THE OFFICIAL SEAL OF THE
REGISTRAR OF COMPANIES

Appendix C. Pre-Application Minutes

▪ Meeting Report

Project:	IQE Permit Variation Application EPR/AB3893FZ/V003		
Subject:	Pre-application Meeting		
Meeting place:	MS Teams	Meeting no:	1
Date and time:	5 October 2023 11:00	Report Issued by:	Jane Hall
Present:	Luke Burton (LB)	Representing:	Natural Resources Wales
	Rodney Pelzel (RP) Scott McKinnon (SMcK) Andrew Mason (AM) Shane McDonald (SMcD)		IQE Silicon Compounds Limited
	Jane Hall (JH) Oliver Ellis (OE) Sam Giles (SG) Sarah Horrocks (SH) Maddalena De Lorenzo (MDeL)		Atkins

ITEM	DESCRIPTION	TOPIC LEAD
1	Introductions – all present introduced themselves.	ALL
2	Proposed expansion plans – IQE described the proposals, see the attached report for details. Timescales are critical to ensure that customer requirements are met. SMcK made a specific request to allow some flexibility in the future permit to allow minor operational changes without needing the vary the permit (see Item 5).	IQE
3	**Proposed Changes Included in Permit Application:** JH shared a presentation which covers the points raised in Items 3 & 4 of the meeting agenda (this information is included in the attached report). Permit boundary	IQE / Atkins

ITEM	DESCRIPTION	TOPIC LEAD
	The current boundary needs to be extended to allow a phased expansion plan. Transition from R&D Activities to Manufacturing Activities JH confirmed that the units currently in use for R&D and Testing activities would be transitioned into the permit as part of the application. 82 Additional GaN reactors (including 10 R&D reactors) IQE/Atkins described the proposed expansion plans and additional ancillary plant and equipment. Oxidation Furnace JH confirmed that the oxidation furnace, which is currently operated as a minor operational change to the permit on a temporary basis, would be transitioned into the permit as part of the application. Update and consolidation of conditions IQE intends to request a consolidation of the new permit conditions and previous variations.	
4	**Confirm Schedule 1 Listed Activities** JH presented a proposed list of activities, including a potential new activity for the GaN tools (see attached report). LB considers that it is likely that the GaN tools would fall under the same section of the regulations as the current G4 units but will seek clarification on this matter from NRW's permitting team. **NRW Action: LB to confirm Schedule 1 Listed Activities**	Atkins (JH)/NRW
5	**Managing minor operational changes** As previously raised in Item 1, SMcK thanked NRW for flexibility over recent developments on site. IQE requests that the permit variation application and issued permit allow for operational flexibility and enable IQE to make small changes to its processes without the need to vary the permit. LB advised that IQE should carefully check the permit during the 'Operator Review' of the draft permit prior to issue. He also advised that we consider whether all of the Directly Associated Activities (DAAs) need to be listed in the permit. Discussions over how this can be managed are ongoing, and it was suggested that a document could be shared to clarify the type of minor changes that can be carried out without varying the permit.	IQE
6	**Permit Application documentation:** Non-technical Summary Environmental Risk Assessment JH requested that NRW reviews the approach to assessing emissions to sewer prior to completion of the risk assessment. LB recommended that we engage with Welsh Water and work back from the discharge consent limits. He confirmed that our approach could be shared with NRW's permitting team prior to submission of the application. SH and MDeL presented their approach to assessing air emissions from the additional process stacks. The assessment will be based on previous studies	Atkins

ITEM	DESCRIPTION	TOPIC LEAD
	and use a similar approach to the new stack emissions by applying a 'worst case' scenario. The noise assessment will build on previous assessments and will assess changes in noise using BS4142. Operating Techniques and Monitoring Site Condition Report JH expressed a concern that there may be a requirement to produce a baseline assessment for this area including taking reference data from ground and groundwater beneath the site. This would potentially delay the submission of the application and significantly impact the project's viability. JH requested that a pre-operational condition is included in the permit to prevent use of this area until the baseline assessment is completed. This would allow the permit to be in place, satisfying customer requirements, but prevent operation until the conditions beneath the site are confirmed. LB raised the following points in response to this request: No operations would be allowed to commence until the pre-operational condition is approved. Both NRW and IQE would need to agree timescales for the submission of the baseline assessment (and approval). It would need to follow the SCR model from permit issue to completion of baseline report (i.e. inspect the site for contamination, maintain records of all activities). LB offered to review and sign-off a procedure to cover this period. Additional care and inspections would need to be carried out during construction activities to prevent and detect any potential ground contamination sources. There may need to be two installation boundaries included in the permit to cover the phased approach to expanding the site. **NRW Action: LB to confirm approach for Site Condition Report and Baseline Assessment with regards to the phased extension of installation boundary.** Accident Prevention and Management Plan LB confirmed that only the additional accident scenarios needed to be included in the Application to cover the gap between current and new activities.	
7	**Queries for Natural Resources Wales** Please confirm current permitting timescales. LB confirmed that there is currently a two-month delay in allocating permit applications to an officer. LB also confirmed that the application would be 'normal' unless the GaN reactors fall under a new section of EPR Schedule 1 (see Item 4). Confirm the status of inorganic chemicals BATc and appropriate guidance documents. LB confirmed that BAT will be determined by consulting the CWWWG BATc and 'How to comply with your environmental permit Additional information for: The Inorganic Chemicals Sector (EPR 4.03), NRW, September 2014.	Atkins

Follow-up email from Luke Burton, Lead Specialist, Industry Regulation, NRW dated 02/11/2023

Dear Jane, thank you for your email and attachment.

I'm in the process of formulating answers to your questions which will be captured in a formal pre-application note for IQE.

For the interim here are some summary updates on your questions:

Operational flexibility and to meet customer expectations and specifications.

I've discussed this matter with Anna Griffiths of our Installations Permitting Team and we've both reviewed options for providing the maximum flexibility within the permit whilst still meeting regulatory requirements. To this end we're engaging with NRWs chemical leads to harvest examples of where this has been done in other permits to allow for campaigns etc, which might assist IQEs permit application. Full confidentiality of your plans will be maintained through this process.

Sampling and obtaining baseline data in the new site area.

Based upon the description of the scenario you have provided, we are minded to cater for this eventuality by including a pre-operational condition in any potential permit. This will be supplemented by site inspections and the expectation that IQE update their Environmental Management System to reflect the non-operational nature of this area before gathering baseline data, as discussed in our meeting.

Point source emissions to [sewer] - Sample data and EA's H1 Screening Assessment guidance

For the purpose of assessing your emissions to sewer, we suggest supplementing your application with a cover letter explaining the H1 issue you have described. If it is not possible to use the H1 tool, please complete your screening assessment by comparing the data you have against the relevant Best Available Techniques (BAT) Associated Emissions Levels (AEL) (see below BAT note) and Dwr Cymru Welsh Water trade effluent discharge consent (TEDC) levels. Please provide a screening and risk assessment narrative against the AELs and TEDC with your application.

Best Available Techniques and BREF

I've asked our UK BAT Co-ordinator for a definite answer on the applicability of Best Available Techniques BREF for your activity, which I will confirm to you asap. At this stage (but not definitely) the most applicable are the *Common Wastewater Treatment* and *Waste Gas Treatment* BREFs.

Site inspection and formal pre-application meeting

As mentioned during the meeting, I'll arrange a site visit to inspect and discuss any further queries before issuing the formal pre-application note.

I hope the above gives some guidance for the interim and I'll work as quickly as possible to get you further definite answers.

Best regards,

Luke Burton

Arbenigwr Arweiniol / Lead Specialist

Rheoliad Diwydiant / Industry Regulation

Rhif ffôn / Phone number : 07920450986

Rhagenwau / Pronouns : ef / he

Appendix D. Additional Accident Management Plan Scenarios

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
Vehicle collision impacting ammonia tank	Leaks of tank or pipework	Initially transport via the ground and drainage systems, then air transport	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	High	High	Physical prevention measures include double contained pipelines where required. Procedures and staff training. Procedural control of plant modification (MOC). Design and construction carried out by competent person and inspected by competent person prior to start up. Compliance measures in place which comply with requirements of DSEAR. Appropriate labelling of pipework. Ammonia tank will be situated well away from roadways and provisioned with barriers to prevent accidental damage. Emergency shutdown system. Emergency plan. Site security system (entry or sabotage).	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and equipment.	
Vandalism impacting new plant and equipment	Process gas or ammonia tanks and associated pipework	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	High	High	High	Security systems in place including alarms, manned security gate and fencing (no change from current measures). Physical prevention measures include double contained pipelines where required. An interlock will be provided to shut down the process if the exhaust fans fail. Operating procedures and staff training. Ammonia tank will be situated well away from roadways and provisioned with barriers to prevent damage. Emergency shutdown system. Emergency plan. Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and equipment.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
Failure of plant	Reactors	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	High	High	High	The same high standard of environmental protection will be implemented as per current operations. Auto-shut-down linked to operation of abatement plant. Standby fan to remove exhaust gas in event of primary fan failure. An interlock will be provided to shut down the process if the exhaust fans fail. Gas detection and alarms are in place to detect leaks with auto-shut-off valves to stop flow of pollutant gases. Process alarms sound locally and will be reported to the control system for the attention of the operations team. Leaks of process gas are prevented through inspection and maintenance, leak detection and repair and avoidance of over-pressurisation. PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer's instructions. Procedures and staff training. Procedural control of plant modification (MOC).	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Design and construction carried out by competent person and inspected by competent person prior to start up. Preventative maintenance, inspection and test regimes. Emergency shutdown system. Emergency plan. Site security system (entry or sabotage). Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and / or equipment. Gas alarms and low-pressure switch.	
Vandalism impacting oxidation furnace or condensate collection tank	Oxidation Furnace	Air transport, transport via the ground and drainage systems	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward	Low	Low	Low	Small-scale process, limited releases. Security systems in place including alarms, manned security gate and fencing (no change from current measures). Operating procedures and staff training. Plant will be situated well away from roadways and provisioned with barriers to prevent damage. Emergency shutdown system. Emergency plan.	Very low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
			receiving waters				Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and equipment.	
Failure of oxidation furnace	Oxidation Furnace	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward receiving waters	Low	Low	Low	Small-scale process, limited releases. Gas detection and alarms are in place to detect leaks. Process alarms sound locally and will be reported to the control system for the attention of the operations team. On power loss, heaters will be off terminating the process and will not come back on until power is restored followed by manual reset. Other faults result in a return to base state at a furnace temperature which is significantly below that required for the reaction to take place. PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer's instructions. Procedures and staff training. Procedural control of plant modification (MOC).	Very low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
							Design and construction are carried out by a competent person and inspected by a competent person prior to start-up. Preventative maintenance, inspection and test regimes. Emergency shutdown system. Emergency plan. Site security system (entry or sabotage). Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and/or equipment. Gas alarms and low-pressure switches.	
Power failure resulting in loss of abatement	Processing plant	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward	Local residents, workforce at local businesses, users of amenity sites, site drainage and onward	Low	High	High	Resilient power supply. Standby generators. The same high standard of environmental protection will be implemented as per current operations. Auto-shut-down linked to operation of abatement plant. An interlock will be provided to shut down the process if the exhaust fans fail.	

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual risk
		receiving waters	receiving waters				Gas detection and alarms are in place to detect leaks with auto-shut-off valves to stop flow of pollutant gases. Process alarms sound locally and will be reported to the control system for the attention of the operations team. Leaks of process gas are prevented through inspection and maintenance, leak detection and repair and avoidance of over-pressurisation. PPM will be in place to ensure plant and equipment is maintained in accordance with the manufacturer's instructions. Procedures and staff training. Emergency plan. Design of appropriate access for emergency vehicles. Training and simulation/ testing of emergency systems. Isolation of pipework and / or equipment. Gas alarms and low-pressure switch.	

Appendix E. Air Quality Assessment

Air Quality Assessment

IQE Silicon Compounds Ltd

December 2023

IQE Silicon Compounds Ltd

IQE 80 GAN PERMITTING

Notice

This document and its contents have been prepared and are intended solely as information for IQE Silicon Compounds Ltd and use in relation to Environmental Permit Variation Application.

AtkinsRéalis UK Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 55 pages including the cover.

Document history

Document title: Air Quality Assessment

Document reference: IQE Silicon Compounds Ltd

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Draft for Client	MDL	ZT	SH	SH	19/12/23

Client signoff

Client	IQE Silicon Compounds Ltd	**Client signature/date**
Project	IQE 80 GAN PERMITTING	
Job number	5223588	

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INTRODUCTION

This report presents the findings of an air quality assessment required as supporting information to be submitted with the Environmental Permit variation application for the next phase of development of the IQE (Europe) Plc semiconductor facility at Celtic Way, Marshfield, Duffryn, Newport, NP10 8BE.

IQE have an existing permit for 20 reactors, covering emission points A1 and A4. To date 10 G4 reactors (1-10), which use gallium arsenide (GaAs) and indium phosphine-based (InP) technologies, have been installed. The associated emissions of phosphine and arsine are released from emission point A1, as modelled for the previous permit variation application (Atkins, 2018)[1]. The assessment undertaken in support of this environmental permit variation includes an additional arsine emissions source associated with the permanent operation of a small oxidation furnace, which will also discharge through emission point A1.

A subsequent Research and Development (R&D) exclusion (Atkins, 2023)[2] considered a change in the reactor type and abatement technology from G4 to gallium nitride (GaN) for reactors 11 to 20 (emission point A4). Instead of the thermal abatement proposed in that application, plasma abatement is now proposed.

The main proposals that are the subject of this environmental permit variation are an increase in the total number of reactor tools for the production of epitaxial wafer materials to 92, including 72 new GaN reactors. These will apply plasma abatement with residual emissions of ammonia and chlorine, plus oxides of nitrogen and carbon monoxide.

An air quality assessment has been carried out in line with Environment Agency online guidance on Air Emissions Risk Assessment for your Environmental Permit[3] and associated modelling guidance (supported by Natural Resource Wales (NRW)), and in accordance with accepted good practice for atmospheric dispersion modelling.

The assessment has addressed the following scenarios:

- Scenario 1a (most likely scenario):
  - Reactors 1-10 (existing) operate using GaAs and InP technologies and emit arsine and phosphine following chemisorption abatement, through emission point A1,
    - Arsine emissions from the oxidation furnace that will be used to ‘clean’ the semiconductor wafers are also released through this emission point.
  - Reactors 11-20 (considered within the recent R&D exclusion), operate using GaN technology and emit traces of ammonia, oxides of nitrogen and carbon monoxide emissions due to the application of plasma abatement, through emission point A4;
    - Emissions from chlorine abatement from the tool cleaning cycle gases will be released through an adjacent stack, A4a;
  - Reactors 21 to 92 (new) operate using GaN technology and emit traces of plasma abated ammonia, oxides of nitrogen and carbon monoxide emissions through new emission points A5 to A8.
- Scenario 1b (alternative scenario):

[1] Atkins, Newport Semiconductor Facility Air Quality Assessment for IQE (Europe) Limited, 31 October 2018

[2] Atkins, Research and Development Submission, 12 June 2023

[3] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

- The existing 10 reactors (1-10) as well as the 10 reactors addressed under the R&D permit (11-20) operate using GaAs and InP technologies, using chemisorption abatement.
- Reactors 21 to 92 operate using GaN technology with plasma abatement, as described for Scenario 1a.

There are slight variances in the reactor types installed within units 11-20 compared with the original permit application (as varied), as new generation reactors have been selected by IQE as technology has developed over time. A very conservative mass balance was applied to determine maximum flow rate and emission rates therefore there is limited impact of these variances.

This assessment also considers emissions from auxiliary boilers, both existing and new:

- Four existing 0.533 MW_{th} boilers discharging through a combined flue (two continuously operating, two in standby mode) to provide heat to support the reactors 1-20;
- Four new 0.8 MW_{th} boilers discharging through individual flues, (two continuously operating, two in standby mode but assumed to operate continuously for the purposes of modelling) which provide temperature control of the new GaN reactors (21-92).

In addition, the following standby plant are required to support the operation of the expanded facility:

- Two 0.5 MW_{th} Kohler KD2500-E emission optimised emergency standby diesel generators, anticipated to operate concurrently for fewer than 50 hours per year for emergency operation and maintenance testing.

Two scenarios have been assessed: Scenario 1 normal operation (i.e. the reactors and boilers continuously running, under Scenarios 1a and 1b), and Scenario 2, emergency operation (the reactors, boilers and emergency standby diesel generators running concurrently).

This report provides:

- a review of background concentrations and 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 a five-year period,
- an assessment of pollutant concentrations for human health receptors and designated ecological sites,
- a summary of results in tables detailing the field-wide maximum results and results for discrete receptors,
- a graphical presentation of the results as concentration isopleths on a base map,
- a comparison of total estimated concentrations against air quality criteria, and
- conclusions regarding the significance of emissions, in terms of effects on local air quality.

1. Baseline Condition

1.1 Site setting

The IQE Semiconductor Facility is located within the Imperial Park commercial and business park, approximately three kilometres to the south west of Newport. It is accessed via Celtic Way from the junction with the A48 trunk road to the north west. It is an existing building positioned to the south of and adjacent to the NGD Data Centre building. To the north, west and east it is surrounded by industrial and commercial buildings.

The nearest residential properties are on Pencarn Avenue, over 375 metres to the north east of the ventilation stacks. The Celtic Springs Guest House is a similar distance to the north north west, and a children's nursery is over 550 metres to the north west near the Holiday Inn, between the A48 and the M4 motorway.

There are nearby local wildlife sites at Celtic Springs to the north west, the LG Duffryn sites 1 and 2 on South Lake Drive to the south of the IQE building and the Duffryn Pond to the east, close to the superstore and residential areas of Duffryn.

The IQE site lies wholly within the Newport local authority administrative area. The local authority has not declared any air quality management areas (AQMA) in proximity to the site, the nearest being on the M4 at Junction 27 around 2.5 km to the north. The site location is shown in Figure 1-1.

1.2 Monitoring Data

The UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) network[4] measures air pollutants at several rural sites across the UK including ammonia and hydrogen chloride. The UK Automatic Urban and Rural Network (AURN) monitors pollutants such as nitrogen dioxide and particulate matter at urban and roadside locations. Information from relevant sites for the pollutants of interest to the study is summarised below.

1.2.1 Ammonia

The closest site to the facility which measures ammonia is Penallt, a rural background site (grid reference 352307, 209357) 35 kilometres to the north east of the IQE site. The average concentration from the latest available measurements in 2013 was 0.4 µg/m^3 and in 2014 was 0.3 µg/m^3. The Air Pollution Information System (APIS) website[5] also publishes maps of background values for ammonia for use in ecological assessments. The average background concentration for the 5 kilometre grid square containing the facility is 1.52 µg/m^3 (for the average period 2019 to 2021). On this basis, background concentrations of ammonia may be above the non-statutory criterion for the protection of vegetation where lichen are present (1.0 µg/m^3) but below the non-statutory criterion for higher plants (3.0 µg/m^3).

[4] https://uk-air.defra.gov.uk/networks/network-info?view=nh3

[5] http://www.apis.ac.uk/

1.2.2 Chlorine

Ambient measurements of chlorine gas are not available from any publicly accessible monitoring network. Limited measurements of hydrogen chloride are made across the UK as part of the UKEAP, including at Rosemaund, a rural background site (grid reference 356535, 247200) 70 kilometres to the north east. The average concentration measured at this site in 2016 was 0.19 µg/m^3. There is no long-term EAL against which to compare this value.

1.2.3 Arsine and phosphine

No monitoring data for arsine or phosphine are available from publicly accessible information sources. Arsenic (from which arsine, AsH_3, is formed through reaction with acid) is measured at Cardiff Rumney, an urban background site[6] (grid reference 322177, 179470) 8.5 km to the south west. The average concentration from measurements made in 2013 (the most recent year for which data are available) was 0.72 ng/m^3 or 0.00072 µg/m^3 compared to an environmental assessment level (EAL) for arsine of 1.6 µg/m^3.

1.2.4 Oxides of nitrogen and particulates

The urban background air quality monitoring station in Newport (UKA00380) forms part of the UK monitoring network[7]. The site description is as follows:

> *"The monitoring station is located in a self contained, air conditioned housing in the north-west corner of St Julian's School. The nearest road is the M4, with the station approximately 60 metres south of lane 1 protected by a barrier of trees. Further residential access roads surround the site. The surrounding area is urban residential."*

The Newport continuous monitoring station (CMS) is located 6.6 km to the north east of the IQE facility. The annual average nitrogen dioxide and particulate matter concentrations measured at the urban background location are shown in Table 1-1 to for the last nine years with complete ratified data.

Table 1-1 - Newport AURN site annual average concentrations, µg/m^3

Year	2018	2019	2020	2021	2022
NO_2	19^	20	15*	15*	15#
PM_{10}	14#	15	13*	12*	13
$PM_{2.5}$	8#	10	8*	7*	7

* concentrations may have been affected by Covid-19 lockdowns

^ low data capture <50%

data capture <85%

6 https://uk-air.defra.gov.uk/networks/network-info?view=metals

7 https://uk-air.defra.gov.uk/networks/site-info?site_id=NPT3

The annual mean nitrogen dioxide concentrations in Table 1-1 showed little variance between 2018 and 2019, ranging between 19 and 20 µg/m^3. A reduction was observed in 2020, which follows UK wide trends during the COVID-19 pandemic, however concentrations have remained at this level since. The 2019 urban background NO_2 concentration of 20 µg/m^3 is used in the interpretation of the results of the atmospheric dispersion modelling study, which is likely to be a slightly conservative estimate for the area adjacent to the IQE facility, given the proximity of the CMS to the heavily trafficked M4 (approximately 60 metres to the south).

The Defra background mapped concentrations[8] are lower (i.e. ranging between 9 µg/m^3 and 17 µg/m^3 in 2023, 11 µg/m^3 and 15 µg/m^3, and 7 µg/m^3 and 9 µg/m^3, in the study area, for NO_2, PM_{10} and $PM_{2.5}$ respectively). The higher, measured concentrations of NO_2, PM_{10} and $PM_{2.5}$ are used in the assessment.

NOx is not monitored at the Newport CMS, therefore 2023 Defra map estimates (ranging between 11.6 µg/m^3 and 22.7 µg/m^3 across the study area) have been used as background concentrations.

1.2.5 Carbon monoxide

Carbon monoxide is not measured at the Newport CMS and estimates are not provided in the 2023 Defra background maps; the 2001 mapped estimates (ranging between 288 µg/m^3 and 313 µg/m^3 across the study area) have been used as background concentrations.

1.2.6 VOCs

Benzene is used in permitting assessments as a surrogate to represent VOC emissions.

Benzene is measured as part of the Defra hydrocarbon network of CMS, which the Newport CMS is part of, however, as a conservative approach the maximum annual average recorded in 2017 at a roadside CMS in London Marylebone was used (i.e. 1 µg/m^3).

1.2.7 Summary

The background concentration values used in the assessment are summarised in Table 1-2.

Table 1-2 - Summary of background concentrations used in the assessment, µg/m^3

Pollutant	Value	Source	Comment
Ammonia	1.52	APIS Website (average period 2019-2021)	More conservative than the latest available measurements (0.4 µg/m^3 (2013) -0.3 µg/m^3 (2014)
Chlorine	0.19	Rosemaund UKEAP 2016	Latest available measured concentration
Arsine	0.00072	Cardiff Rumney 2013	Latest available measured concentration (as arsenic)

[8] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

Pollutant	Value	Source	Comment
Phosphine	N/A	N/A	No available measurements of phosphine
NO_2	20	NCC CMS 2019	More conservative than 2023 Defra maps (9-17 µg/m^3)
NOx	11.6-22.7	Defra 2023 Maps	No NOx measurements available
PM_{10}	15	NCC CMS 2019	More conservative or equivalent to 2023 Defra map estimate (11-15 µg/m^3)
$PM_{2.5}$	10	NCC CMS 2019	More conservative than 2023 Defra maps (7-9 µg/m^3)
CO	288-313	Defra map 2001	No longer included in latest maps
Benzene	1	London Marylebone CMS 2017	UK roadside concentration

1.3 Sensitive receptors

1.3.1 Human health receptors

Defra technical guidance (LAQM.TG(22))[9] states that the air quality standards and objectives in the Air Quality Strategy[10] (AQS) apply to locations where members of the public are likely to be regularly present for the duration of the exposure period.

The Environment Agency's Specified Generator modelling guidance[11] similarly states that "*Relevant exposure for an air quality assessment includes locations where members of the public have access, are regularly present and can be exposed for a significant portion of the averaging time of the standard*." It also goes on to state that air quality standards "*do not apply where health and safety at work provisions exist and where members of the public do not have access*".

The nearest residential properties are approximately 300 metres to the north east of the IQE building on Pencarn Avenue, and to the north along the A48. A children's nursery is 500 metres to the north west, between the A48 and the M4 motorway. Some 470 metres to the east and south east there are residential properties on Edmundsbury Road and Powis Close.

Nearby receptors that represent locations that are potentially sensitive to emissions in terms of human health effects are listed in Table 1-3. These locations were included as discrete receptors in the

[9] https://laqm.defra.gov.uk/air-quality/featured/uk-regions-exc-london-technical-guidance// (version August 2022)
[10] https://www.gov.uk/government/publications/the-air-quality-strategy-for-england
[11] https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

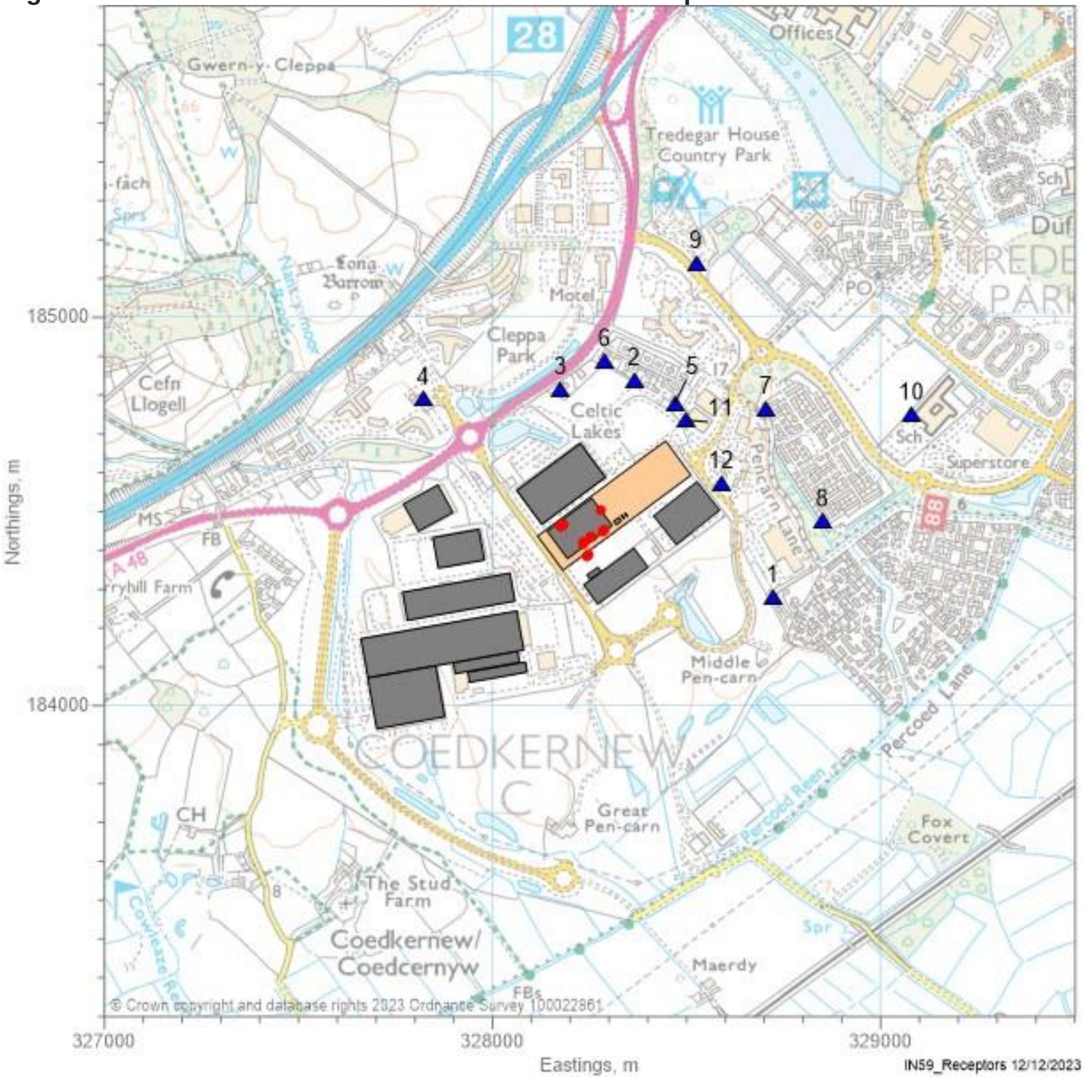
model, and are shown in Figure 1-1 as numbered blue triangles. The IQE facility is highlighted in sand colour and the building itself is grey with the stacks denoted by red dots.

Members of the public do not have access to the grounds of IQE or of the surrounding commercial and industrial facilities therefore such locations are not included in the assessment. IQE and Vantage 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, IQE and Vantage 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.

Table 1-3 - Selected local human health receptors

ID	Address	Eastings, m	Northings, m
1	47 Powis Close	328723	184280
2	18 Pencarn Avenue	328366	184839
3	Celtic Springs Guest House	328176	184816
4	Teddies Nursery	327822	184790
5	11 Pencarn Avenue	328470	184780
6	24 Pencarn Avenue	328290	184888
7	2 Sir Briggs Avenue	328705	184766
8	127 Edmundsbury Road	328850	184475
9	Tredegar House Caravan Site	328525	185140
10	St Joseph’s High School	329080	184750
11	Imperial Way, Commercial Property	328498	184736
12	Imperial Courtyard, Commercial Property	328590	184574

Figure 1-1 – Site location and local human health receptors



1.3.2 Ecological Sites

The IQE facility is located approximately 0.5 km north of the Gwent Levels-St Brides Site of Special Scientific Interest (SSSI), and 3.5 km north west of designated areas in the Severn Estuary. In addition, there are numerous sites with local designations.

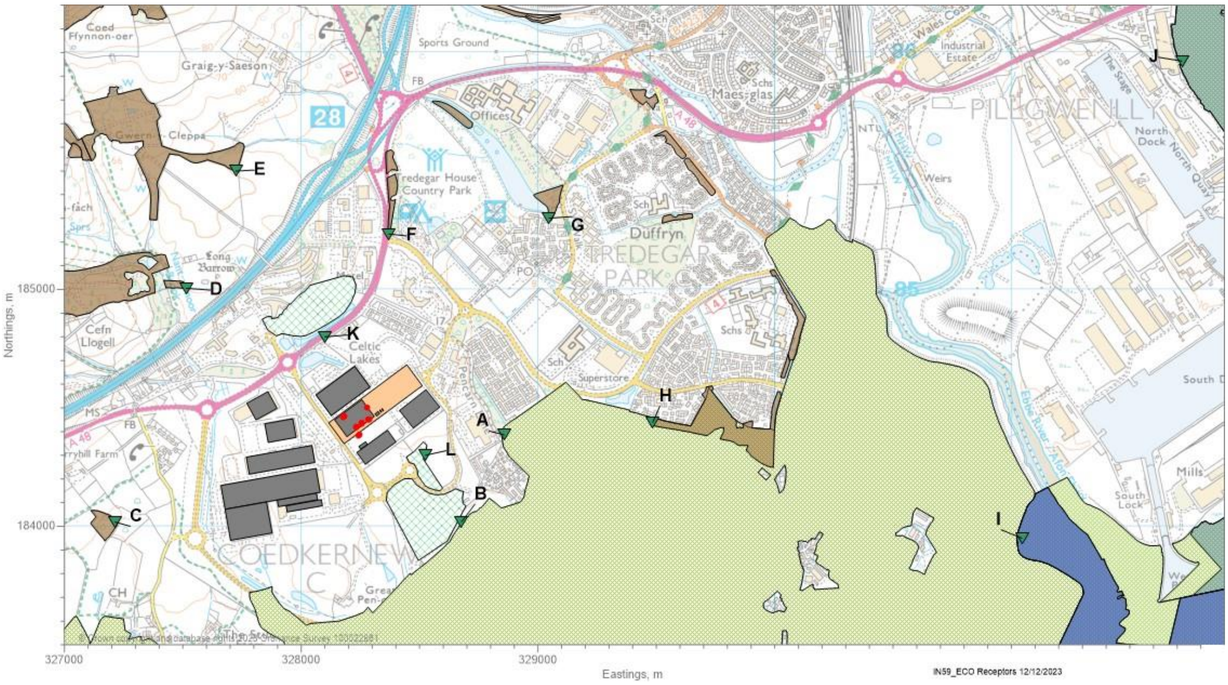
The closest ecological receptors are shown in Figure 1-2, denoted with green inverted triangles. These include two points (Receptors A and B) representing the Gwent Levels and St Brides SSSI to the south east. In addition, there are areas of semi-natural and restored ancient woodland (those within 1 km of the site have been considered as specific receptors in the modelling study as Receptors C to H) and local wildlife sites or Sites of Importance for Nature Conservation (SINC) in the vicinity (represented by Receptors K and L).

Further afield is the Severn Estuary Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar site, approximately 3.5 km to the south east where it is coincident with the River Usk SAC (the latter is also present approximately 4 km to the north east of the Vantage facility) (represented by Receptors I and J respectively).

Table 1-4 - Selected ecological receptors

ID	Site Designation	Eastings, m	Northings, m
A	Gwent Levels St Brides SSSI	328857	184386
B	Gwent Levels St Brides SSSI	328677	184019
C	Ancient woodland	327214	184018
D	Ancient woodland	327514	185005
E	Ancient woodland	327723	185500
F	Ancient woodland	328370	185234
G	Ancient woodland	329047	185301
H	Ancient woodland	329485	184440
I	Severn Estuary SPA/SAC/Ramsar	331044	183950
J	River Usk SAC	331720	185964
K	Celtic Springs SINC	328100	184800
L	LG Duffryn Site 1/2 SINC	328525	184300

Figure 1-2 - Selected ecological receptors in the vicinity of the site



The core features of designated sites within one kilometre of the IQE facility (the distance within which effects are potentially significant) are shown in Table 1-5. The river environment is not sensitive to the potential effects of air quality on vegetation[12].

Table 1-5 - Features of designated sites within 1 km of the IQE site

Designated Site	Location of Designated Site[13]	Features of Interest[14]
Gwent Levels-St Brides SSSI	~ 500 m south east	The features of interest common to all of the SSSIs within the Gwent Levels are the reen (drainage ditch) habitats, which support a varied assemblage of aquatic flora and fauna. St Brides SSSI supports a number of interesting plant species and rich invertebrate communities.
Celtic Springs SINC (MF9)	~ 200 m north west	Post-industrial mosaic habitat, neutral grassland and calcareous grassland.
LG Duffryn Site 1 (South Lake Drive) SINC (MF6)	~ 300 m south	Open standing water, designated for its pond/Phragmites reedbed habitat which supports a Schedule 1 bird species, Cetti's warbler.
LG Duffryn Site 2 SINC (MF7)	~ 450 m south	Large area of neutral grassland adjacent to the Gwent Levels.
Duffryn Pond SINC (TP1)	~ 700 m east	Pond with emergent swamp vegetation, which supports a range of important invertebrates, plant, reptile, amphibian and mammal species.

[12] https://naturalresources.wales/media/662000/SSSI_1232_Citation_EN001606d.pdf

[13] The distance and direction are for the closest point of the designated site from the Application Site

[14] SSSI Citation: Natural Resources Wales https://naturalresources.wales/media/640899/SSSI_0341_Citation_EN0014d9a.pdf
SINC citations: Newport Local Development Plan 2011-2026 http://www.newport.gov.uk/documents/Planning-Documents/LDP-2011-2026/Sites-of-Importance-in-Nature-Conservation-(SINC)-January-2013.pdf

2. Methodology

2.1 Atmospheric dispersion modelling

2.1.1 Modelling software

The atmospheric dispersion modelling study was undertaken using the latest version of the US EPA model AERMOD (v22112), as incorporated by Trinity Consultants Inc. in the software BREEZE AERMOD (currently v11.0). 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 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.

2.1.2 Meteorological data

The most appropriate meteorological station with adequate records in the format required for the dispersion modelling study is Cardiff Airport. This station is located approximately 27 km to the south west of the facility. Hourly sequential meteorological data for the five-year period 2018 to 2022 were used in the dispersion model. The general topography of the area is such that Cardiff Airport records will be suitably representative of conditions further along the Bristol Channel at the IQE site; furthermore, the airport and the facility are at comparable distances from the coastline.

The 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[15]. 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[16] and albedo[17] were determined by the land use categories within the far-field, represented by a 10 km^2 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 39%, urban 38%, water 16%, coniferous forest 6% and deciduous forest 1%.

Land use categories and sectors were inserted in the AERMET software programme to generate site surface characteristics for use in the model. The model parameters (AERMOD recommended values) used to represent the area around the site are shown in Table 2-1.

Table 2-1 - Site surface characteristics

Sector	Degrees	Albedo	Bowen Ratio	Surface Roughness, m
Urban	0 - 115	0.22325	1.04025	1.00
Cultivated land	115 - 210	0.22325	1.04025	0.0725
Urban	210 - 360	0.22325	1.04025	1.00

The processed meteorological data were used to generate a single five-year meteorological data file for use in this assessment. Frequency distribution of wind speed and direction for five years combined is presented in Figure 2-1. It is evident from the figure that there is a primary prevailing wind from the west and adjoining sectors; there is a secondary prevailing wind from the east north east.

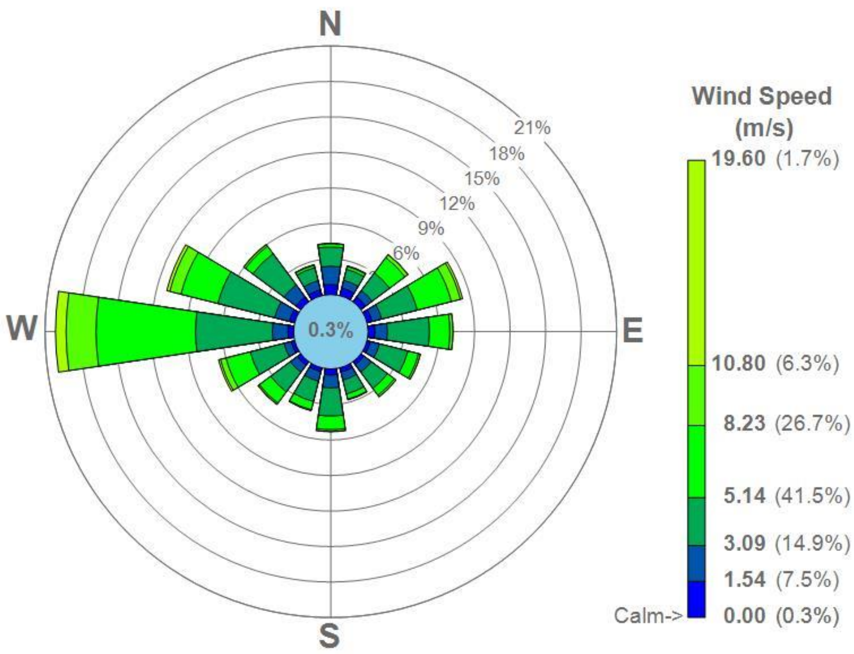
The modelling has been undertaken using a five year meteorological dataset. The annual average reported concentration is the five year period mean generated by the model rather than the maximum individual mean. This is considered proportionate for the scale of facility emissions and the results obtained.

[15] 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.

[16] 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.

[17] 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 2-1 - Cardiff Airport Windrose, 2018 to 2022



2.1.3 Modelled Receptors

Pollutant concentrations were modelled using nested Cartesian receptor grids covering wide and local areas. A 100 m resolution grid over an area 4 by 4 kilometres centred on the facility was used in combination with a smaller, local grid 800 m wide set at 25 m resolution. The higher resolution local grid improves the spatial resolution of the model results in those areas subject to the highest concentration gradients close to the site boundary. Boundary receptors were also used to delineate the IQE site boundary.

Receptors representing locations that are potentially sensitive to emissions in terms of human health and ecological effects were included as discrete receptors in the model. These are listed in Table 1-3 and Table 1-4.

All grid and discrete receptors were specified at a height of 1.5 metres above local ground elevation to represent breathing zone. The same height of 1.5 metres was also used for ecological receptors which suitably represents a range of vegetation types.

2.1.4 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.

Details of the structures included in the dispersion model are shown as a schematic in Figure 2-2, viewed from the south east; the existing IQE building, with a roof ridge height of 17.4 m is in the centre with the Vantage data centre CWL11 building to the north, slightly higher at 23.5 m, the KIA building to the south and the CWL13 building to the south east. Other nearby industrial units which may have potential downwash effects were also modelled. The dimensions for all modelled buildings are provided in Table 2-2.

Figure 2-2 - Schematic of modelled structures and stacks

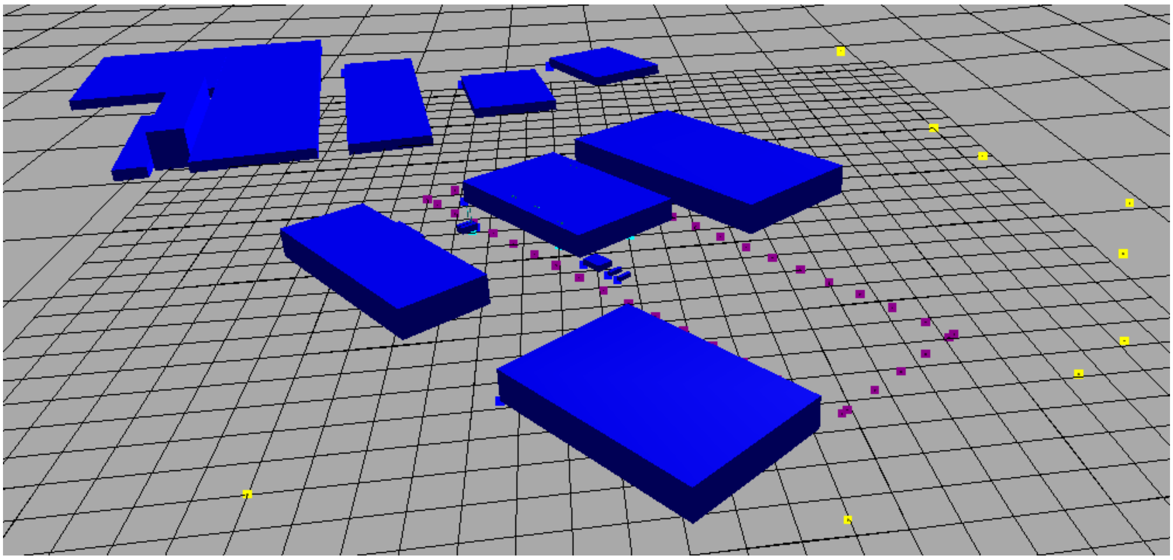


Table 2-2 -Building input data

Name	Height, m	X Length, m	Y Length, m
IQE main building	17.4	143.2	88.2
Vantage CWL11 building	23.5	203.0	108.0
Vantage CWL13 building	20.2	142.4	94.1
QRL Radiator - main	35.0	168.0	29.0
QRL Radiator - north low	10.0	408.0	102.0
QRL Radiator - south low	10.0	178.0	133.0
QRL Radiator - south east low	10.0	151.1	26.3
Imperial Park A	10.0	281.0	73.0
Imperial Park B	10.0	120.0	80.0
Imperial Park C	10.0	101.3	80.4
Gas Bunker 1	4.6	16.5	11.5
Gas Bunker 2	8.5	13.5	35.0
Ammonia Store A	3.1	3.0	10.0
Ammonia Store B	3.1	3.0	10.0
KLA building	21.0	61.0	160.0
Emergency Standby Generator Container 1	5.14	12.7	3.46
Emergency Standby Generator Container 2	5.14	12.7	3.46

2.1.5 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 digital terrain data files.

Terrain elevations for on-site model objects within IQE site boundary were set at +14.55 m aOD.

2.1.6 Model scenarios

Two normal operational scenarios have been considered in this modelling study:

- Scenario 1a:
  - 10 existing G4 reactors (1-10) emitting arsine and phosphine, and the oxidation furnace, emitting arsine only (emission point A1);
  - 82 new GaN reactors, comprising 10 reactors (11-20) considered within the existing R&D exclusion (emission point A4) plus residual chlorine emissions from the tool cleaning cycle gases from A4a, and 72 new reactors (21-92), emitting traces of plasma abated ammonia, oxides of nitrogen and carbon monoxide (emission points A5 to A8);
  - Auxiliary boilers, four existing (emission point A11) and four new (A12 to A15).
- Scenario 1b:
  - 10 existing G4 reactors (1-10) emitting arsine and phosphine and the oxidation furnace emitting arsine only (emission point A1);
  - 10 reactors (11-20) considered within the existing R&D exclusion emitting arsine and phosphine (emission point A4);
  - 72 new GaN reactors (21-92), emitting traces of plasma abated ammonia, oxides of nitrogen and carbon monoxide emissions as well as chlorine abatement emissions from the tool cleaning cycle gases (emission points A5 to A8);
  - auxiliary boilers, four existing (emission point A11) and four new (emission points A11 to A15).

The following operating regimes have been investigated:

- Normal operation: all above listed emission sources operating concurrently, 24 hours a day seven days a week.
  - This operating regime has been assessed in both Scenario 1a and Scenario 1b (through dispersion modelling and through a screening assessment, respectively); and
- Emergency operation: two emergency standby diesel generators operating concurrently with all of the above listed sources.
  - This operating scenario has been assessed for Scenario 1a only since the number of reactor tools emitting oxides of nitrogen is higher (82 versus 72) while the operation of the standby diesel generator is unchanged.

Although the semiconductor production methods are batch processes it is conservatively assumed for the purposes of the dispersion modelling study that each emission is continuous throughout the 24 hour cycle, as opposed to only operating at specific times of day; this is a robust approach as it ensures the least favourable hours of meteorological data are included in the study with reactors running simultaneously without downtime for maintenance.

The boilers will operate as two duty, two standby. Two existing boilers have been modelled while all four new boilers (individual flues) have been modelled for a conservative approach.

Furthermore, although the standby diesel generators are expected to be run for monthly maintenance testing for half an hour, or in an emergency power outage which may last up to two hours, the assessment of the emergency operation has considered a worst case scenario with all engines operating concurrently modelled maximum permitted run time of 50 hours per year.

It should also be noted that dispersion modelling for normal operation has been undertaken for Scenario 1a only, being the worst case scenario in terms of potential impacts due to the operational emissions of the site having higher emissions for all pollutants except for arsine and phosphine. A screening assessment of the impact on concentrations of arsine and phosphine at sensitive receptors has been undertaken to consider the impacts of the use of 20 reactor tools emitting arsine and phosphine from emission points A1 and A4 in Scenario 1b.

2.2 Emissions inventory

2.2.1 Reactors

The IQE Newport Semiconductor Facility operates under an environmental permit for 20 G4 reactors but to date only 10 of the permitted G4 reactors have been installed. Residual emissions of phosphine and arsine from these reactors, post chemisorption abatement, are released from the emission point A1, which was modelled for the permit variation application V002 (this increased the number of reactors from 5 to 20) (Atkins, 2018)[1].

The assessment undertaken in support of this latest permit variation additionally considers arsine emissions from the permanent operation of the oxidation furnace that will be used to 'clean' the semiconductor wafers. These will also be released through emission point A1 and so this point has been modelled as a combined discharge. Other than the additional arsine emissions from the oxidation furnace, there is no change to the process which removes process gases arsine and phosphine from that described in the assessment undertaken for the permit variation (Atkins, 2018)[1].

The subsequent R&D exclusion application (Atkins, 2023)[2] for emission source A4 concerned the use of GaN technology, instead of the original G4 technology, for reactors 11 to 20, with associated release of ammonia and chlorine from a thermal oxidation abatement system. The assessment undertaken for Scenario 1a, as described in section 2.1.6, considers emissions from the 10 GaN reactors post treatment by plasma abatement technology, therefore the emissions for this point differ to the R&D submission (Atkins, 2023) [2].

Chlorine abatement emissions from the tool cleaning cycle gases will be released through emission point A4a, which will be immediately adjacent to A4 on the roof of the main building facility. Due to their proximity and as the two stacks will both serve the 10 GaN reactors within the same bay, these emission points have been considered as a combined flue in the model in the detailed modelling for Scenario 1a.

An alternative approach for reactors 11 to 20 would be to use GaAs or InP technologies, which is discussed in section 2.1.6 (Scenario 1b). In this case, traces of arsine and phosphine would be emitted from A4 following abatement using chemisorption. The requirement for chlorine abatement and thus the emission point A4a is not applicable to this scenario.

The next phase of the development at the Newport Semiconductor Facility will increase the number of GaN reactor tools for the production of epitaxial wafer materials including 72 additional reactors in both scenarios 1a and 1b.

The process emissions from the new production areas will be discharged at height from four ventilation stacks (emission points A5 to and A8) on the southern façade of the facility building. Following the application of plasma abatement technology, trace emissions containing residual amounts of chlorine and ammonia will be released from these stacks. In addition, combustion gas emissions (including oxides of nitrogen and carbon monoxide) from the plasma abatement and process gas from clean-up of reactor exhaust emissions will be released through these stacks. The source characteristics for the reactor tools for both scenarios assessed are presented in Table 2-3.

2.2.2 Auxiliary boilers

In addition to the reactor tools, the following combustion plant are needed to support the operation of the facility:

- Four existing 0.533 MW_{th} boilers (two duty, two standby[18]) discharging through a combined flue (emission point A11), which provide heat to allow the existing reactor processes to occur;
- Four new 0.8 MW_{th} boilers, each discharging through an individual flue stack, all continuously operating for temperature control of the new reactor tools (emission points A12 to A15).

Information on the boiler plant was provided by the project process engineers and are shown in Table 2-4. The boilers will operate using natural gas. For a conservative approach the new emission sources, A12 to A15, have all been modelled as operating continuously although it is anticipated they would also operate on a duty/standby basis.

2.2.3 Standby plant

In the event of a loss of offsite power (LOOP) event, standby power generation is required and will be provided by:

- Two 0.5 MWth Kohler KD2500-E emission optimised emergency standby diesel generators (emission points A9 and A10):
  - anticipated to operate in parallel in an emergency;
  - expected to be run up to half an hour each for maintenance testing (on a monthly basis);
  - expected to run for up to a two hours in an emergency.

Each engine will be individually housed within a container and with an associated vertical stack which will discharge at a height of 18.4 metres above ground level.

Information on the standby plant was provided by the process engineers and taken from the manufacturer's specification (see Appendix B). The generators have been modelled as operating at maximum load (100% Prime Power (PRP).

The engine emission characteristics used in the dispersion modelling study for the Kohler KD62V12A engines are presented in Table 2-5. The pollutant emission rates for the standby diesel generators were derived from calculated normalised flow rates and the manufacturer's stated pollutant emission concentrations (or other given performance standard). Of note, although the emissions optimised engine should emit NOx at concentrations around 1,500 mg/Nm^3, the TA Luft value of 2,000 mg/Nm^3 has been applied for a conservative approach to modelling. Normalised flow rates and concentrations in Table 2-5 are expressed as at 273.1K, 101.3 kPa, 5% oxygen, (dry basis). This is consistent with the Environment Agency's BAT benchmark of 2,000 mg/Nm^3 (TA Luft) at those reference conditions.

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[18] As advised by the process engineering team, only two boilers will run continuously.

2.3 Source characteristics

2.3.1 Reactors

Data relating to the stack discharge characteristics for the reactor flues are summarised in Table 2-3.

Table 2-3 - Reactor stack discharge characteristics

Parameter	A1 (10 x G4)	A4 + A4a (10 x GaN)	A4 (10 x GaAs/InP)	A5-A8 (72 x GaN)	Source
Stack location, national grid reference	328287, 184453	328284, 184451	328283, 184454	328257, 184437 328254, 184435 328234, 184420 328232, 184418	Site drawings
Stack height, m (above ground level)	18.4	18.4	18.4	18.4	Site drawings
Actual discharge flow rate, Am^3/s	12.4	10.2	12.4	20	Process engineering calculations
Stack diameter, m	1.0	0.92^	1.0	1.3	Assumed for A4, A4a, A5-A8 to achieve efflux velocity of 15 m/s
Discharge velocity, m/s	15	15.2	15	15	
Flue gas discharge temperature, K	298.15	298.15	298.15	298.15	Assume close to ambient temperature
Arsine emission conc, ppb	50*	-	50	-	Process engineering calculations
Phosphine emission conc, ppb	100	-	100	-	
Chlorine emission conc, mg/Nm^3	-	$3.56x10^{-5}$	-	$3.08x10^{-5}$	
Ammonia emission conc, mg/Nm^3	-	$2.71x10^{-4}$	-	$2.34x10^{-4}$	

Parameter	A1 (10 x G4)	A4 + A4a (10 x GaN)	A4 (10 x GaAs/InP)	A5-A8 (72 x GaN)	Source
NOx emission rate, mg/Nm^3	-	9.4x10^{-03}	-	8.1x10^{-03}	
CO emission rate, mg/Nm^3	-	4.7x10^{-4}	-	4.06x10^{-4}	
Arsine emission rate, g/s	1.04x10^{-6}	-	4.35x10^{-7}	-	Process engineering calculations
Phosphine emission g/s	3.79x10^{-7}	-	3.79x10^{-7}	-	
Chlorine emission rate g/s	-	3.42x10^{-7}	-	6.15x10^{-7}	Calculated using normalised flow rate for A1, Process engineering calculations for other stacks
Ammonia emission rate g/s	-	2.6x10^{-6}	-	4.67x10^{-6}	
NOx emission rate, g/s	-	9.02x10^{-5}	-	1.62x10^{-4}	
CO emission rate, g/s	-	4.51x10^{-6}	-	8.12x10^{-6}	

* Plus 0.0028 (oxidation furnace)

^ Equivalent diameter for A4 and A4a

2.3.2 Boilers

Data relating to the stack discharge characteristics for each boiler flue are summarised in Table 2-4.

Table 2-4 - Boiler plant stack discharge characteristics

Parameter	A11 (combined)*	A12 to A15 (each)	Source
Stack location, national grid reference	328278, 184502	328175, 184463 328178, 184465 328180, 184466 328182, 184467	Site drawings
Stack height, m (above ground level)	18.4	18.4	Site drawings
Actual discharge flow rate, Am^3/s	0.44	0.3	
Oxygen content, % dry	5.9	5.8	Manufacturer's technical specifications
Water content, %	10	10	Assumed
Normalised flow rate, Nm^3/s	0.28	0.20	Calculated from actual flow rates and

Parameter	A11 (combined)*	A12 to A15 (each)	Source
			manufacturer's technical specification information
Stack diameter, m	0.4	0.35	Provided
Discharge velocity, m/s	3.5	3	Calculated
Flue gas discharge temperature, K	318	317	Manufacturer's technical specifications
NOx emission conc, mg/Nm^3	34.3	41.0	Calculated from mass emission rates and normalised flow rates
CO emission conc, mg/Nm^3	20	23	Manufacturer's technical specifications
NOx emission rate, g/s	0.010	0.008	Calculated using emissions per kWh and nominal heat output at 50/30°C
CO emission rate, g/s	0.006	0.005	Calculated

* Represents emissions from two boilers operating concurrently

2.3.3 Diesel generators

Data relating to the stack discharge characteristics for each standby diesel generator flue (100% load PRP) are summarised in Table 2-5.

Table 2-5 - Standby generator plant stack discharge characteristics

Parameter	A9	A10	Source
Stack location, national grid reference	328241, 184385	328245, 184388	Scheme drawings
Stack height, m (above ground level)	18	18	Provided
Actual discharge flow rate, Am^3/s	7.76	7.76	Manufacturer's technical specifications
Oxygen content, % dry	10.1	10.1	
Water content, %	10	10	Assumed
Normalised flow rate at 5% O_2, Nm^3/s	1.68	1.68	Calculated from actual flow rates and manufacturer's specification
Stack diameter, m	0.55	0.55	Provided
Discharge velocity, m/s	32.6	32.6	Calculated

Parameter	A9	A10	Source
Flue gas discharge temperature, K	769	769	Manufacturer's specification
NOx emission conc, mg/Nm³	2,000	2,000	TA Luft benchmark
CO emission conc, mg/Nm³	362	362	Emission datasheet
PM emission conc, mg/Nm³	23	23	
VOC emission rate, mg/Nm³	59	59	
NOx emission rate, g/s	3.37	3.37	Calculated
CO emission rate, g/s	0.61	0.61	
PM emission rate, g/s	0.04	0.04	
VOC emission rate, g/s	0.10	0.10	

2.4 Assessment criteria

The model results have been compared to relevant air quality criteria, including EU Directive limit values, national AQS[10] objectives and other environmental assessment levels (EALs) used in permitting as set out in the Environment Agency's online guidance for air emissions risk assessment[3]. The air quality criteria for the protection of human health and ecology that are relevant to this assessment are presented in Table 2-6.

Table 2-6 - Air quality assessment criteria (μg/m³)

Pollutant	Short term	Long term
Arsine	48 (1h)	1.6
Phosphine	42 (1h)	-
Chlorine	290 (1h)	-
Ammonia (human health)	2,500 (1h)	180
Ammonia (vegetation)	-	1 or 3
Carbon monoxide	30,000 (1h) 10,000 (8h)	
Particulate matter (PM_{10})	50 (24h)	40
Particulate matter ($PM_{2.5}$)	-	10^,
Nitrogen dioxide (human health)	200 (1h)	40
Oxides of nitrogen (vegetation)	75 (24h)	30

Pollutant	Short term	Long term
Benzene	30 (24h)	5

^ to be met by 2040, with annual target of 12 µg/m3 to be met by 2028

2.5 Post processing

The Environment Agency's online air emissions risk assessment guidance states that modelled long-term increments to concentrations "Process Contributions" (PC) may be added to the background annual mean concentration to derive a "Predicted Environmental Concentration" (PEC), for comparison with criteria. For short-term concentrations the PEC may be obtained by adding the process contribution to twice the background annual mean concentration. This is required if the PC exceeds 1% of the long-term criterion, or 10% for short-term criteria, the PEC (calculated from the PC plus the background concentration for long term PCs or twice the background concentration for short term PCs).

The Environment Agency's Specified Generators modelling guidance recommended conversion ratios for NO_X to NO_2 of 35% for short-term and 70% for long-term average concentrations have been applied.

In addition, the Environment Agency's online risk assessment guidance states that where a source does not operate all year round, a time weighted conversion should be applied to estimate the process contribution. To maintain the conservative nature of this assessment, no factoring has been applied to reflect batch processing during normal operation of the reactors.

The annual mean has been estimated by factoring the total number of hours in a year by the maximum permitted number of hours (50/8760).

For the estimation of daily concentrations for the emergency generators, which are expected to run for a maximum of two consecutive hours, the maximum hourly mean was factored by 2/24. This approach has previously been agreed with NRW for the adjacent Vantage facility permit application.

For the CO 8 hour mean, no factoring was applied as the results were negligible.

3. Impact assessment

3.1 Scenario 1a

The following sections of this chapter describe the results for human health and ecological receptors under normal operation for Scenario 1a, as described in section 2.1.6.

3.1.1 Human health

3.1.1.1 Arsine

The maximum hourly and annual average process contributions for arsine at sensitive receptors are presented in Table A-1. The highest hourly value at a receptor is found at Receptor 5, 11 Pencarn Avenue. Here, the concentration is 0.11 ng/m^3, several orders of magnitude less than the short term EAL of 48,000 ng/m^3 (48 µg/m^3). Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the hourly PEC.

Receptor 1, a residential property in 47 Powis Close, had the highest annual value of 0.002 ng/m^3, again several orders of magnitude less than the long term EAL of 1,600 ng/m^3 (1.6 µg/m^3). Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the annual mean PEC.

3.1.1.2 Phosphine

The maximum hourly average process contributions for phosphine at sensitive receptors are presented in Table A-2. The highest hourly value at a receptor is found at Receptor 5, 11 Pencarn Avenue. Here, the concentration is 0.04 ng/m^3, several orders of magnitude less than the short term EAL of 42,000 ng/m^3 (42 µg/m^3). Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

3.1.1.3 Chlorine

The maximum hourly average process contributions for chlorine at sensitive receptors are presented in Table A-3 The highest hourly value at a receptor is found at Receptor 12, representative of a commercial property in Imperial Courtyard. Here, the concentration is 0.27 ng/m^3, several orders of magnitude less than the short term EAL of 290,000 ng/m^3 (290 µg/m^3). Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

3.1.1.4 Ammonia

The maximum hourly average process contributions for ammonia at sensitive receptors are presented in Table A-4. The highest hourly value at a receptor is found at Receptor 12, a commercial property in Imperial Courtyard. Here, the concentration is 2.1 ng/m^3, several orders of magnitude less than the short term EAL of 2,500,000 ng/m^3 (2,500 µg/m^3). Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

The annual average process contribution for ammonia at sensitive receptors are presented in Table A-4. Receptor 12 had the highest annual value of 0.04 ng/m^3, several orders of magnitude less than the long term EAL of 180,000 ng/m^3 (180 µg/m^3). On this basis there is no requirement to estimate the PEC.

3.1.1.5 Nitrogen dioxide

The maximum hourly average process contributions for nitrogen dioxide at sensitive receptors are presented in Table A-5 (results in µg/m^3) and presented in form of concentration isopleths overlaid on a base map in Figure A-1. The highest hourly value at a receptor is found at Receptor 11, a commercial property in Imperial Way to the east of IQE. Here, the concentration is 2.7 µg/m^3, equivalent to 1.3% of the short term EAL of 200 µg/m^3. Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

The annual average process contribution for nitrogen dioxide at sensitive receptors are presented in Table A-5. The maximum annual average process contributions as oxides of nitrogen are presented in form of concentration isopleths overlaid on a base map in Figure A-3. The highest annual mean NO_2 concentration of 0.07 µg/m^3 is found at Receptor 12, a commercial property; this is 0.2% of the long term EAL 40 µg/m^3. On this basis there is no requirement to estimate the PEC.

3.1.1.6 Carbon monoxide

The maximum hourly average process contributions for carbon monoxide at sensitive receptors are presented in Table A-6 (results are in µg/m^3). The highest hourly value at a receptor is found at Receptor 11, a commercial property in Imperial Way. Here, the concentration is 4.3 µg/m^3, equivalent to 0.01% of the hourly EAL of 30,000 µg/m^3. Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

The eight hour average process contribution for nitrogen dioxide at sensitive receptors are presented in Table A-6. The highest eight hourly average of 1 µg/m^3 is found at Receptor 3 Celtic Springs Guest House, or 0.01% of the eight hour EAL of 10,000 µg/m^3. On this basis there is no requirement to estimate the PEC.

3.1.2 Ecology

Ammonia and oxides of nitrogen concentrations at designated ecological sites have been modelled (Receptors A to L in Table 1-4 and Figure 1-2).

3.1.3 Ammonia

The annual average process contributions for ammonia at sensitive receptors are presented in Table A-7 (results are in ng/m^3). The annual average ammonia concentration at all receptors is 0.06 ng/m^3. The highest value at a receptor is found at Receptor L, LG Duffryn SINC. This is less than 0.01% of the non-statutory EAL for the protection of vegetation of 1,000 ng/m^3 (1 µg/m^3) for lichen. Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

3.1.4 Oxides of nitrogen

The maximum daily average and the annual average process contributions for oxides of nitrogen at sensitive receptors are presented in Table A-8 (results are in µg/m^3) and are presented in form of concentration isopleths overlaid on a base map in Figure A-2 and Figure A-3 respectively.

The maximum daily average oxides of nitrogen concentration at a receptor is 1.2 µg/m^3. The highest modelled result is found at Receptor L, LG Duffryn SINC. This is just 1.6% of the non-statutory EAL for the protection of vegetation of 75 µg/m³. Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

The maximum annual average oxides of nitrogen concentration at a receptor is 0.14 µg/m³. The highest value at a receptor is found at Receptor L, LG Duffryn SINC. This is just 0.5% of the critical level for the protection of vegetation of 30 µg/m³. Concentrations at all other modelled receptors are lower. On this basis there is no requirement to estimate the PEC.

3.1.5 Nitrogen deposition

The feature of interest at the nearest statutory designated site, the Gwent Levels SSSI, is "standing open waters"; no critical loads for nitrogen and acid deposition are available from APIS. Given the extremely low process contributions to the critical levels for oxides of nitrogen and ammonia at even the closest non-statutory sites in the study area, it is not necessary to consider in further detail the effects of deposition on vegetation at this site. The contribution to critical loads – noting that none appear to apply to the SSSI – would be just a fraction of a percent.

3.2 Scenario 1b

The following sections of this chapter describe the findings of the screening assessment of the impact on concentrations of arsine and phosphine at sensitive receptors undertaken under normal operation for Scenario 1b, as described in section 2.1.6. Concentrations of all other pollutants will be either lower than or unchanged from Scenario 1a, and therefore have not been investigated further.

3.2.1 Human health

3.2.1.1 Arsine

With 10 new reactors emitting arsine and phosphine in place of 10 GaN reactors, the total arsine emission rate from the facility would increase by 142%. The emission rate for the 10 new reactors discharging through A4 is 4.35×10^{-7} g/s, in addition to the 1.04×10^{-6} g/s emitted from the 10 existing G4 reactors and the oxidation furnace discharging through A1. It is assumed that, with the exception of the additional mass emissions of arsine from the oxidation furnace through A1 in Scenario 1a, the exhaust characteristics of A4 will be the same as those for A1 as presented in Table 2-3.

The increase in emission rate will result in a roughly equivalent increase in ground level concentrations modelled at receptors, as the stacks A1 and A4 are of similar heights and at similar locations. The highest hourly PC of arsine for Scenario 1a was 0.11 ng/m³, at Receptor 5; this would increase to approximately 0.27 ng/m³ in Scenario 1b, which is still several orders of magnitude less than the short-term EAL of 48,000 ng/m³ (48 µg/m³).

The highest annual average process contribution of arsine modelled in Scenario 1a was 0.002 ng/m³, which would increase to 0.005 ng/m³ in Scenario 1b, again several orders of magnitude less than the long term EAL of 1,600 ng/m³ (1.6 µg/m³).

These results are of the same order of magnitude of the results presented in the air quality assessment for the environmental permit variation application (Atkins, 2018)[1] submitted in support of the second phase of the development at the IQE facility, which considered the installation of 20 G4 reactors (but excluded the operation of the oxidation furnace).

The concentrations of arsine at sensitive receptor locations are not expected to materially change for Scenario 1b compared to Scenario 1b, nor do the results represent an environmental concern.

3.2.1.2 Phosphine

The phosphine emission rate for the operation of the 10 10 new reactors emitting arsine and phosphine discharging through A4 is equal to the phosphine emission rate for A1. In other words, the phosphine emissions in Scenario 1b would be double that for Scenario 1a, giving a total of 7.6 x 10^{-7} g/s of phosphine.

The doubling of the emission rate would result in an equivalent increase in the concentrations modelled at receptors. The highest hourly process contribution of phosphine modelled in Scenario 1a was 0.04 ng/m^3 at Receptor 5, which would increase to 0.08 ng/m^3 in Scenario 1b, still several orders of magnitude less than the short-term EAL of 42,000 ng/m^3 (42 µg/m^3).

These results are of the same order of magnitude of the results presented in the air quality assessment for the environmental permit variation application (Atkins, 2018)[1] submitted in support of the second phase of the development at the IQE facility, which considered the installation of 20 G4 reactors.

The concentrations of phosphine at sensitive receptor locations are not expected to materially change with Scenario 1b, nor do the results represent an environmental concern.

3.3 Scenario 2

The following sections of this chapter describe the results at human health and ecological receptors for the short-term and long-term impacts from standby diesel generator operation. A conservative scenario, with both engines concurrently operational at full load in all hours of the year, in combination with the continuously operating sources in Scenario 1a, was used to determine the impacts from operation. This approach ensures that the least favourable hours of meteorological data are included.

For the long-term impacts, a factor was applied to account for the maximum permitted standby generator run time in a year for maintenance testing and emergency operation (i.e. 50 hours). This factor is conservative, as in reality the emergency standby generators are not expected to run more than two hours per year in an emergency, plus half an hour per month for maintenance; nonetheless it provides for a robust assessment. The results tables are provided in Appendix A, section A.2. The process contributions represent the impact from both standby generators in combination with other continuously operating plant described in Scenario 1a.

3.3.1 Human health

3.3.1.1 Nitrogen dioxide

3.3.1.1.1 Short term impact

The maximum modelled hourly mean nitrogen dioxide process contribution (PC) is 127.1 µg/m^3 at Receptor 2, or 63.5 % of the 200 µg/m^3 air quality standard. The operation of standby generators, in combination with other continuous sources and including a baseline concentration of 40 µg/m^3 (twice the measured annual mean concentration) would not result in any exceedances of the air quality standard for nitrogen dioxide hourly mean at any of the discrete sensitive receptors. This represents the highest hourly result in a five-year meteorological data set, so is a very robust finding. Statistical analysis is not required to determine compliance with the hourly mean objective, as the highest PEC is 167 µg/m^3.

3.3.1.1.2 Long term impact

The annual mean NO_2 process contribution (as a five year average) resulting from both engines operating concurrently for up to 50 hours in a year plus the contribution from continuous plant is 0.11 µg/m^3. This is a significant overestimate as the generators are not typically expected to run for 50 hours per year[19].

3.3.1.2 Carbon monoxide

The maximum modelled hourly and eight hourly mean carbon monoxide process contributions for the standby generators operating concurrently with continuous sources are negligible. The results are several orders of magnitude below the respective criteria.

3.3.1.2.1 Short term impact

The highest maximum hourly carbon monoxide concentration at any of the sensitive receptors for the concurrent operation of engines is 13.2 µg/m^3 at Receptor 2, less than one percent of the 30,000 µg/m^3 criterion. The highest maximum eight hourly carbon monoxide concentration, is 4.2 µg/m^3 at Receptor 5, again just a fraction of a percent of the 10,000 µg/m^3 criterion.

3.3.1.3 Particulate matter

The maximum daily and annual mean PM_{10} concentrations were modelled for the standby generators. These results are orders of magnitude below the respective criteria and relate to the operation of both engines.

3.3.1.3.1 Short term impact

The highest maximum daily concentration at any of the sensitive receptors for the concurrent testing of engines is 0.3 µg/m^3 at Receptor 2, less than one percent of the 50 µg/m^3 criterion.

3.3.1.3.2 Long term impact

The annual mean PM_{10} PC resulting from both engines operating concurrently up to 50 hours in a year is just 0.001 µg/m^3. Assuming all PM_{10} is $PM_{2.5}$, this PC is a negligible fraction of the annual mean target of 12 µg/m^3.

3.3.1.4 Volatile organic compounds

The maximum daily and annual mean VOC concentrations were modelled for the standby generators.

3.3.1.4.1 Short term impact

The highest maximum daily concentration at any of the sensitive receptors for the concurrent operation of engines for two hours is 5.4 µg/m^3 at Receptor 2, i.e. 18% of the 30 µg/m^3 criterion

[19] The IQE facility is provided of two electricity supplies and they both of to fail in order for the standby generators to run. IQE Silicon Compounds ltd has advised that there has been a two hour outage in three years, therefore, considering an allowance of 50 hour run time per year provides an additional level of conservatism to the assessment.

assuming all VOC is benzene (a highly conservative assumption). Given the baseline concentration of 1 µg/m³, the PEC would remain well below the daily EAL.

3.3.1.4.2 Long term impact

The annual mean VOC PC resulting from both engines operating concurrently up to 50 hours in a year is just 0.01 µg/m³, just 0.3% of the AAD limit value of 5 µg/m³ even assuming all VOC is benzene.

3.3.2 Ecology

3.3.2.1 Oxides of nitrogen

3.3.2.1.1 Short term impact

An assessment has been undertaken for comparison to the non-statutory daily average guideline value for the protection of vegetation of 75 µg/m³ oxides of nitrogen. This scenario considers an outage coinciding with the least favourable hour of meteorological data in a five year modelled period, over 43,000 hours, assuming continuous operation of engines at full load.

The contribution to daily mean NOx at closest ecological sites was considered using a very conservative approach, taking the maximum hourly mean and dividing by 24.

The results are shown in

Table A-13. The maximum modelled hourly concentration of NOx is 352 µgm³ at LG Duffryn LWS. The maximum estimated 24 hour mean at any designated ecological site is therefore 29.3 µg/m³. This result occurs at the LG Duffryn LWS is well below the 75 µg/m³ non-statutory daily mean criterion.

There is a very small probability of these results occurring during an emergency event, given the very low likelihood of an outage occurring on the hour of least favourable meteorological data in five years.

The daily average oxides of nitrogen concentrations are even lower at the closest designated SSSI and areas of the Severn Estuary, which are considerably further away, approximately 3.5 km north west of the IQE facility.

In accordance with Environment Agency online guidance[3], calculation of the PEC for this short-term non-statutory guideline has not been undertaken.

3.3.2.1.2 Long term impact

An assessment has been undertaken for comparison to the annual mean air quality guideline for the protection of vegetation of 30 µg/m³ oxides of nitrogen.

The annual mean at any designated ecological site for engine testing is 0.3 µg/m³. This maximum result occurs at the LG Duffryn LWS and is approximately one percent of the 30 µg/m³ criterion. At the closest designated SSSI and areas of the Severn Estuary the PC is considerably less than one percent.

4. Conclusions

A detailed dispersion modelling study has been undertaken to determine the potential for the expansion of the IQE Newport Semiconductor Facility to impact on sensitive human health and ecological receptors, during normal and emergency operation.

In addition to the existing 10 G4 reactors, the upgrade will include either:

- a) 82 new GaN reactors with plasma abatement technology; or
- b) 10 new (GaAs or InP) reactors with chemisorption abatement and 72 GaN reactors with plasma abatement technology.

In addition, four new auxiliary boilers and two standby diesel generators, are proposed.

4.1 Normal operation

The maximum modelled hourly increments to ground level concentrations were found to be well below 10% (in most cases below 1%) of the human health criteria in Environment Agency risk assessment guidance during normal operation. This is the case for both Scenario 1a and Scenario 1b. On this basis, the emissions are considered not to have a significant adverse effect on human health.

The maximum modelled daily mean increments to ground level concentrations of oxides of nitrogen were found to be well below 10% of the non statutory criterion in Environment Agency risk assessment guidance. On this basis, the emissions are considered not to have a significant adverse effect on the environment.

The long term modelled increments to ground level concentrations do not exceed 1% of the human health and ecological criteria in the Environment Agency risk assessment guidance during normal operation. On this basis, the emissions can be considered not to have a significant adverse effect on human health or the environment.

4.2 Emergency operation

The impact on local air quality of the standby diesel generator emissions (either during maintenance testing and emergency running) was assessed using a conservative model scenario. The maximum concentrations resulting from the operation of the two engines concurrently with other continuously operating plant found that there would be no exceedences of the nitrogen dioxide hourly standard (including an allowance for baseline) at sensitive human health receptors.

The maximum short-term concentrations of carbon monoxide, and PM_{10}/$PM_{2.5}$ contributed a negligible proportion to the relevant health-based air quality standards at residential receptors. A conservative assessment of VOCs (as benzene) found that while the process contribution exceeded 10% of the daily mean EAL the achievement of the criterion would not be at risk.

No exceedences of the oxides of nitrogen daily mean or annual mean criteria for vegetation were identified at the closest designated ecological sites. This is an extremely robust finding, given the infrequent operation of the engines each year.

4.3 Overall conclusion

In conclusion, the findings of this study of the emissions to atmosphere from the proposed installation of 82 new reactors, with associated abatement technology and combustion plant, show that there would not be a significant impact on human health and the environment during normal and emergency operation.

APPENDICES

Appendix A. Model results

A.1 Scenario 1a - Normal operation

A.1.1 Human health receptors

Table A-1 - Maximum hourly and annual average arsine concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly		Annual	
		PC, ng/m³	PC/EAL, %	PC, ng/m³	PC/EAL, %
1	47 Powis Close	0.08	1.6×10^{-4}	0.002	1.3×10^{-4}
2	18 Pencarn Avenue	0.09	1.9×10^{-4}	0.001	8.2×10^{-5}
3	Celtic Springs Guest House	0.10	2.1×10^{-4}	0.001	7.9×10^{-5}
4	Teddies Nursery	0.09	1.9×10^{-4}	0.001	5.1×10^{-5}
5	11 Pencarn Avenue	0.11	2.2×10^{-4}	0.001	7.7×10^{-5}
6	24 Pencarn Avenue	0.08	1.7×10^{-4}	0.001	5.8×10^{-5}
7	2 Sir Briggs Avenue	0.07	1.5×10^{-4}	0.001	5.4×10^{-5}
8	127 Edmundsbury Road	0.06	1.2×10^{-4}	0.001	8.6×10^{-5}
9	Tredegar House Caravan site	0.06	1.2×10^{-4}	0.001	3.7×10^{-5}
10	St Joseph's High School	0.04	9.0×10^{-5}	0.000	3.1×10^{-5}
11	Imperial Way, Commercial Property	0.10	2.0×10^{-4}	0.001	7.9×10^{-5}
12	Imperial Courtyard, Commercial Property	0.10	2.1×10^{-4}	0.002	1.3×10^{-4}

Table A-2 - Maximum hourly average phosphine concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly	
		PC, ng/m^3	PC/EAL, %
1	47 Powis Close	0.03	6.7×10^{-5}
2	18 Pencarn Avenue	0.03	8.0×10^{-5}
3	Celtic Springs Guest House	0.04	9.0×10^{-5}
4	Teddies Nursery	0.03	8.0×10^{-5}
5	11 Pencarn Avenue	0.04	9.2×10^{-5}
6	24 Pencarn Avenue	0.03	7.3×10^{-5}
7	2 Sir Briggs Avenue	0.03	6.2×10^{-5}
8	127 Edmundsbury Road	0.02	5.0×10^{-5}
9	Tredegar House Caravan site	0.02	4.9×10^{-5}
10	St Joseph’s High School	0.02	3.8×10^{-5}
11	Imperial Way, Commercial Property	0.04	8.5×10^{-5}
12	Imperial Courtyard, Commercial Property	0.04	8.7×10^{-5}

Table A-3 - Maximum hourly average chlorine concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly	
		PC, ng/m^3	PC/EAL, %
1	47 Powis Close	0.17	5.7×10^{-5}
2	18 Pencarn Avenue	0.22	7.6×10^{-5}
3	Celtic Springs Guest House	0.23	7.8×10^{-5}
4	Teddies Nursery	0.21	7.2×10^{-5}
5	11 Pencarn Avenue	0.25	8.7×10^{-5}
6	24 Pencarn Avenue	0.21	7.4×10^{-5}
7	2 Sir Briggs Avenue	0.19	6.4×10^{-5}
8	127 Edmundsbury Road	0.16	5.4×10^{-5}
9	Tredegar House Caravan site	0.16	5.7×10^{-5}
10	St Joseph's High School	0.13	4.4×10^{-5}
11	Imperial Way, Commercial Property	0.26	8.8×10^{-5}
12	Imperial Courtyard, Commercial Property,	0.27	9.3×10^{-5}

Table A-4 - Maximum hourly and annual average ammonia concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly		Annual	
		PC, ng/m^3	PC/EAL, %	PC, ng/m^3	PC/EAL, %
1	47 Powis Close	1.27	5.1×10^{-5}	0.03	1.9×10^{-5}
2	18 Pencarn Avenue	1.67	6.7×10^{-5}	0.02	1.2×10^{-5}
3	Celtic Springs Guest House	1.71	6.8×10^{-5}	0.02	1.3×10^{-5}
4	Teddies Nursery	1.58	6.3×10^{-5}	0.02	8.9×10^{-6}
5	11 Pencarn Avenue	1.91	7.6×10^{-5}	0.02	1.3×10^{-5}
6	24 Pencarn Avenue	1.62	6.5×10^{-5}	0.02	1.0×10^{-5}
7	2 Sir Briggs Avenue	1.42	5.7×10^{-5}	0.02	8.9×10^{-6}
8	127 Edmundsbury Road	1.19	4.8×10^{-5}	0.02	1.4×10^{-5}
9	Tredegar House Caravan site	1.24	5.0×10^{-5}	0.01	5.8×10^{-6}
10	St Joseph’s High School	0.97	3.9×10^{-5}	0.01	5.1×10^{-6}
11	Imperial Way, Commercial Property	1.94	7.8×10^{-5}	0.02	1.4×10^{-5}
12	Imperial Courtyard, Commercial Property	2.05	8.2×10^{-5}	0.04	2.1×10^{-5}

Table A-5 - Maximum hourly and annual average NO_2 concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly		Annual	
		PC, µg/m³	PC/EAL, %	PC, µg/m³	PC/EAL, %
1	47 Powis Close	1.62	0.8	0.06	0.1
2	18 Pencarn Avenue	2.18	1.1	0.05	0.1
3	Celtic Springs Guest House	2.60	1.3	0.05	0.1
4	Teddies Nursery	2.21	1.1	0.03	0.1
5	11 Pencarn Avenue	2.02	1.0	0.04	0.1
6	24 Pencarn Avenue	2.30	1.2	0.04	0.1
7	2 Sir Briggs Avenue	1.61	0.8	0.03	0.1
8	127 Edmundsbury Road	1.20	0.6	0.04	0.1
9	Tredegar House Caravan site	1.36	0.7	0.02	<0.1
10	St Joseph's High School	1.67	0.8	0.02	<0.1
11	Imperial Way, Commercial Property	2.69	1.3	0.04	0.1
12	Imperial Courtyard, Commercial Property	2.57	1.3	0.07	0.2

Figure A-1 - Maximum hourly NO_2 concentrations (µg/m^3), Scenario 1a, normal operation

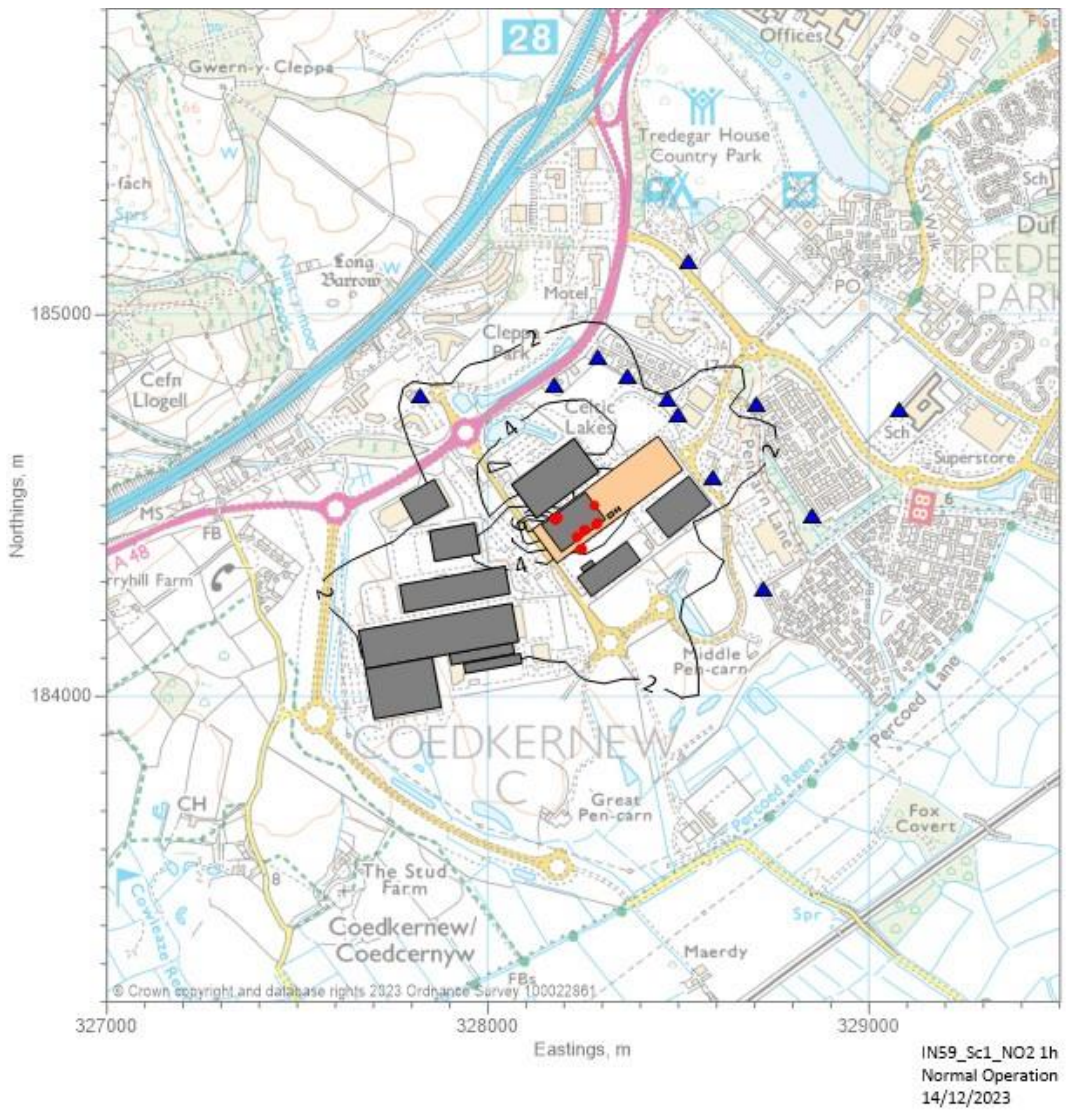


Table A-6 - Maximum hourly and eight hour CO concentrations at human health receptors, Scenario 1a

ID	Receptor Name	Hourly		8-hour	
		PC, µg/m³	PC/EAL, %	PC, µg/m³	PC/EAL, %
1	47 Powis Close	2.6	0.01	0.53	5.3×10^{-3}
2	18 Pencarn Avenue	3.5	0.01	0.83	8.3×10^{-3}
3	Celtic Springs Guest House	4.2	0.01	0.98	9.8×10^{-3}
4	Teddies Nursery	3.5	0.01	0.59	5.9×10^{-3}
5	11 Pencarn Avenue	3.2	0.01	0.68	6.8×10^{-3}
6	24 Pencarn Avenue	3.7	0.01	0.83	8.3×10^{-3}
7	2 Sir Briggs Avenue	2.6	0.01	0.73	7.3×10^{-3}
8	127 Edmundsbury Road	1.9	0.01	0.39	3.9×10^{-3}
9	Tredegar House Caravan site	2.2	0.01	0.52	5.2×10^{-3}
10	St Joseph's High School	2.7	0.01	0.42	4.2×10^{-3}
11	Imperial Way, Commercial Property	4.3	0.01	0.95	9.5×10^{-3}
12	Imperial Courtyard, Commercial Property	4.1	0.01	0.81	8.1×10^{-3}

A.1.2 Ecological receptors

Table A-7 - Annual average ammonia concentrations at ecological receptors, Scenario 1a

ID	Receptor Name	Annual	
		PC, ng/m^3	PC/EAL, %
A	Gwent Levels St Brides SSSI	0.025	2.5×10^{-3}
B	Gwent Levels St Brides SSSI	0.023	2.3×10^{-3}
C	Ancient woodland	0.007	7.0×10^{-4}
D	Ancient woodland	0.007	7.0×10^{-4}
E	Ancient woodland	0.004	4.1×10^{-4}
F	Ancient woodland	0.009	9.0×10^{-4}
G	Ancient woodland	0.004	3.8×10^{-4}
H	Ancient woodland	0.006	6.5×10^{-4}
I	Severn Estuary SPA/SAC/Ramsar	0.002	1.7×10^{-4}
J	River Usk SAC	0.001	5.9×10^{-5}
K	Celtic Springs SINC	0.057	2.0×10^{-3}
L	LG Duffryn Site 1/2 SINC	0.020	5.7×10^{-3}

Table A-8 - Maximum daily and annual average NOx concentrations at ecological receptors, Scenario 1a

ID	Receptor Name	Daily		Annual	
		PC, µg/m^3	PC/EAL, %	PC, µg/m^3	PC/EAL, %
A	Gwent Levels St Brides SSSI	0.31	0.4	0.06	0.2
B	Gwent Levels St Brides SSSI	0.52	0.7	0.05	0.2
C	Ancient woodland	0.32	0.4	0.02	0.1
D	Ancient woodland	0.25	0.3	0.02	0.1
E	Ancient woodland	0.15	0.2	0.01	0.0
F	Ancient woodland	0.37	0.5	0.02	0.1
G	Ancient woodland	0.18	0.2	0.01	<0.1
H	Ancient woodland	0.13	0.2	0.02	0.1
I	Severn Estuary SPA/SAC/Ramsar	0.06	0.1	0.00	<0.1
J	River Usk SAC	0.05	0.1	0.00	<0.1
K	Celtic Springs SINC	0.78	1.0	0.07	0.2
L	LG Duffryn Site 1/2 SINC	1.16	1.6	0.14	0.5

Figure A-2 - Maximum daily NOx concentrations (µg/m³), Scenario 1a, normal operation

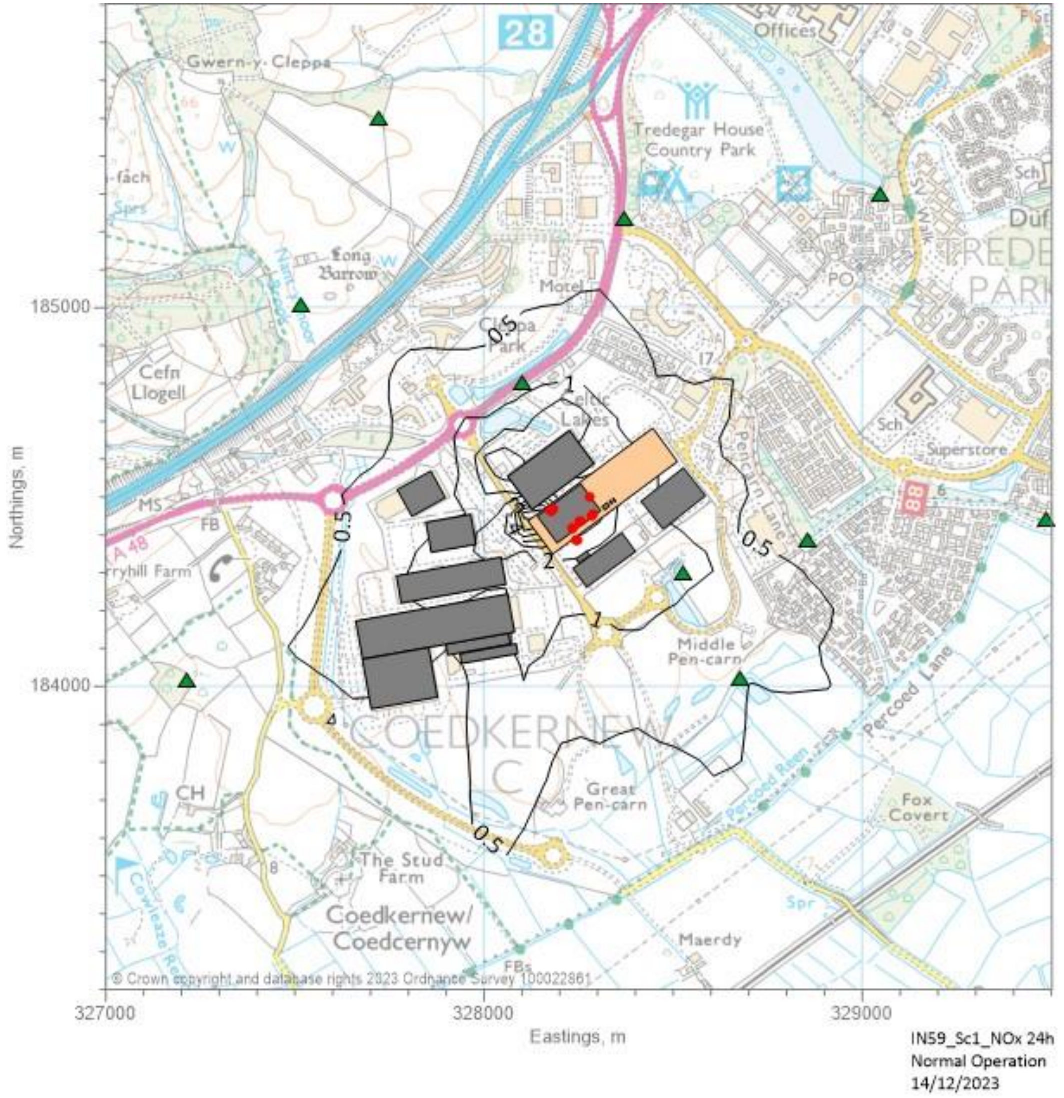
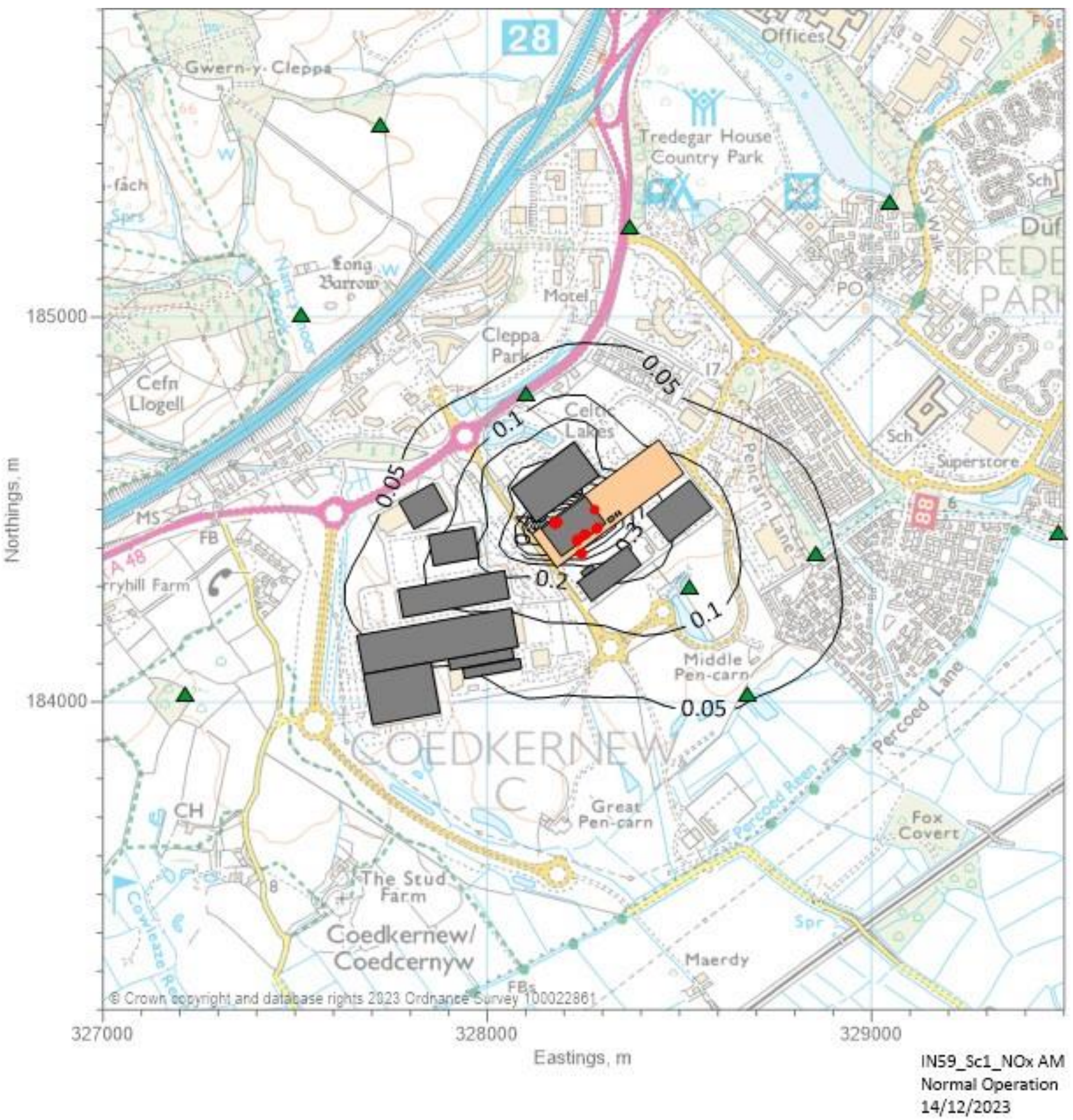


Figure A-3 - Annual average NOx concentrations (µg/m³), Scenario 1a, normal operation



A.2 Scenario 2 - Emergency operation

A.2.1 Human health receptors

Table A-9 - Maximum hourly and annual average NO_2 concentrations at human health receptors

ID	Receptor Name	Hourly				Annual	
		PC, µg/m³	PC/EAL, %	PEC^, µg/m³	PEC/EAL, %	PC, µg/m³	PC/EAL, %
1	47 Powis Close	106.4	53.2	146.5	73.3	0.11	0.3
2	18 Pencarn Avenue	127.1	63.5	167.2	83.6	0.06	0.2
3	Celtic Springs Guest House	64.6	32.3	104.7	52.4	0.07	0.2
4	Teddies Nursery	102.7	51.3	142.7	71.4	0.04	0.1
5	11 Pencarn Avenue	121.8	60.9	161.9	81.0	0.06	0.1
6	24 Pencarn Avenue	88.6	44.3	128.6	64.3	0.05	0.1
7	2 Sir Briggs Avenue	57.6	28.8	97.7	48.8	0.04	0.1
8	127 Edmundsbury Road	98.5	49.3	138.6	69.3	0.06	0.2
9	Tredegar House Caravan site	93.9	46.9	133.9	67.0	0.03	0.1
10	St Joseph's High School	19.9	9.9	59.9	29.9	0.02	0.1
11	Imperial Way, Commercial Property	106.1	53.1	146.2	73.1	0.06	0.2
12	Imperial Courtyard, Commercial Property	39.0	19.5	79.2	39.6	0.09	0.2

^PC includes the contribution of the emergency standby generators, the continuous sources normally operating; PEC includes the baseline contribution

Table A-10 - Maximum hourly and eight hour CO concentrations at human health receptors

ID	Receptor Name	Hourly		8-hour	
		PC, µg/m³	PC/EAL, %	PC, µg/m³	PC/EAL, %
1	47 Powis Close	11.0	0.04	4.0	0.04
2	18 Pencarn Avenue	13.2	0.04	3.8	0.04
3	Celtic Springs Guest House	7.7	0.03	3.3	0.03
4	Teddies Nursery	9.7	0.03	3.2	0.03
5	11 Pencarn Avenue	11.9	0.04	4.2	0.04
6	24 Pencarn Ave	10.1	0.03	3.6	0.04
7	2 Sir Briggs Avenue	4.9	0.02	1.2	0.01
8	127 Edmundsbury Road	8.9	0.03	2.5	0.03
9	Tredegar House Caravan site	9.8	0.03	3.5	0.03
10	St Joseph's High School	3.3	0.01	0.7	0.01
11	Imperial Way, Commercial Property	9.6	0.03	3.5	0.03
12	Imperial Courtyard, Commercial Property,	6.8	0.02	2.0	0.02

Table A-11 – Maximum daily and annual average PM_{10} concentrations at human health receptors

ID	Receptor Name	Daily		Annual	
		PC, µg/m^3	PC/EAL, %	PC, µg/m^3	PC/EAL, %
1	47 Powis Close	0.29	0.6	<0.01	<0.01
2	18 Pencarn Avenue	0.35	0.7	<0.01	<0.01
3	Celtic Springs Guest House	0.18	0.4	<0.01	<0.01
4	Teddies Nursery	0.28	0.6	<0.01	<0.01
5	11 Pencarn Avenue	0.33	0.7	<0.01	<0.01
6	24 Pencarn Ave	0.24	0.5	<0.01	<0.01
7	2 Sir Briggs Avenue	0.16	0.3	<0.01	<0.01
8	127 Edmundsbury Road	0.27	0.5	<0.01	<0.01
9	Tredegar House Caravan site	0.26	0.5	<0.01	<0.01
10	St Joseph’s High School	0.05	0.1	<0.01	<0.01
11	Imperial Way, Commercial Property	0.29	0.6	<0.01	<0.01
12	Imperial Courtyard, Commercial Property	0.10	0.2	<0.01	<0.01

Table A-12 - Maximum daily and annual average VOC concentrations (as benzene) at human health receptors

ID	Receptor Name	Daily				Annual	
		PC, µg/m³	PC/EAL, %	PEC, µg/m³	PEC/EAL, %	PC, µg/m³	PC/EAL, %
1	47 Powis Close	4.6	15.2	6.6	21.9	0.01	0.25
2	18 Pencarn Avenue	5.4	18.1	7.4	24.7	<0.01	0.10
3	Celtic Springs Guest House	2.8	9.2	4.8	15.8	<0.01	0.07
4	Teddies Nursery	4.4	14.6	6.4	21.3	<0.01	0.06
5	11 Pencarn Avenue	5.2	17.3	7.2	24.0	0.01	0.11
6	24 Pencarn Ave	3.8	12.6	5.8	19.2	<0.01	0.07
7	2 Sir Briggs Avenue	2.5	8.3	4.5	14.9	<0.01	0.05
8	127 Edmundsbury Road	4.2	14.1	6.2	20.7	0.01	0.12
9	Tredegar House Caravan site	4.0	13.3	6.0	20.0	<0.01	0.05
10	St Joseph's High School	0.8	2.7	2.8	9.4	<0.01	0.03
11	Imperial Way, Commercial Property	4.5	15.2	6.5	21.8	0.01	0.10
12	Imperial Courtyard, Commercial Property	1.6	5.3	3.6	11.9	0.01	0.11

Table A-13 - Maximum daily and annual average NOx concentrations at ecological receptors

ID	Receptor Name	Daily		Annual	
		PC, µg/m³	PC/EAL, %	PC, µg/m³	PC/EAL, %
A	Gwent Levels St Brides SSSI	22.8	30.5	0.10	0.3
B	Gwent Levels St Brides SSSI	19.1	25.4	0.09	0.3
C	Ancient woodland	5.3	7.1	0.03	<0.1
D	Ancient woodland	19.8	26.4	0.02	<0.1
E	Ancient woodland	17.0	22.7	0.01	<0.1
F	Ancient woodland	15.0	20.0	0.03	0.1
G	Ancient woodland	16.1	21.5	0.02	<0.1
H	Ancient woodland	16.0	21.3	0.03	<0.1
I	Severn Estuary SPA/SAC/Ramsar	7.6	10.2	0.01	<0.1
J	River Usk SAC	1.1	1.5	0.00	<0.1
K	Celtic Springs SINC	29.3	39.1	0.09	0.3
L	LG Duffryn Site 1/2 SINC	22.7	30.3	0.28	0.9

Appendix B. Supporting information

B.1 Manufacturers datasheets

Figure B-1 - Kohler KD62V12A generator datasheet

ENGINEINFORMATION

Model:	KD62V12A	Bore:	175 mm
Type:	4-Cycle, 12-V Cylinder	Stroke:	215 mm
Aspiration:	Turbocharged, Intercooled	Displacement:	62.06 l
Compression ratio:	16 : 1		
Emission Control Device:	Direct Diesel Injection, Engine Control Module, Turbocharger, Charge Air Cooler		

EXHAUST EMISSION DATA		ISO 8178 Test Cycles TypeD2
NO_x	(Oxides of Nitrogen as NO2)	5.41 g/kWh
CO	(Carbon Monoxide)	0.89 g/kWh
HC		0.47 g/kWh
PM	(Particulate Matter)	0.09 g/kWh

NOMINAL EMISSIONS DATA

Cycle point	110%	100%	75%	50%	25%	10%
Engine Power [kW]	2148	1953	1465	977	488	195
Speed [rpm]	1500	1500	1500	1500	1500	1500
Exhaust Gas Flow [kg/h]	13010	12666	9655	6405	4079	3196
Exhaust Gas Temperature [°C]	514	496	485	500	450	320
O2 [%]	9.5	10.1	10.7	10.5	11.5	14.7
NOx [g/kWh]	5.91	5.24	5.02	5.36	5.71	7.92
CO [g/kWh]	0.72	0.74	0.50	1.43	1.37	2.14
HC [g/kWh]	0.15	0.20	0.34	0.47	1.00	2.51
PM [g/kWh]	0.050	0.061	0.052	0.052	0.052	0.052
CO2 [g/kWh]	704	716	694	708	801	1033
	@5%O2	@5%O2	@5%O2	@5%O2	@5%O2	@5%O2
NOx [mg/Nm3]	1766	1544	1531	1605	1519	1644
CO [mg/Nm3]	357	362	252	708	600	715
HC [mg/Nm3]	46	59	104	143	266	510
PM [mg/Nm3]	19	23	21	53	75	19

TEST METHODS AND CONDITIONS

Test Methods :

Steady-State emissions recorded per ISO8178-1 during operation at rated engine speed (+/-2%) and stated constant load (+/-2%) with engine temperatures pressures and emission rated stabilized.

Fuel Specification :
EN590 DieselFuel

Reference Conditions :
25°C (77°F) Air Inlet Temperature, 40°C (104°F) Fuel Inlet Temperature, 100kPa (29.53 inHg) Barometric Pressure, 10.7g/kg (75 grains H2O/lb.) of dry air Humidity (required for NOx correction); Intake Restriction set to maximum allowable limit for clean filter;

Figure B-2 - Hoval UltraGas 2 (530-800) boiler datasheet

3No. EXISTING BOILER SPECIFICATION (DUTY/DUTY/STANDBY)

4No. PROPOSED BOILER SPECIFICATION (DUTY/DUTY/DUTY/STANDBY)

Hoval UltraGas® 2 (530-800)

Type			(530)	(620)	(700)	(800)
• Nominal heat output at 80/60 °C, natural gas 1)		kW	100-497	125-580	132-653	150-743
• Nominal heat output at 50/30 °C, natural gas 1)		kW	110-533	136-622	146-703	166-804
• Nominal heat output at 80/60 °C, propane 2)		kW	137-489	168-569	174-643	233-744
• Nominal heat output at 50/30 °C, propane 2)		kW	145-533	178-622	187-703	254-804
• Nominal heat input with natural gas 3)		kW	101-506	124-591	134-668	151-759
• Nominal heat input with propane 2)		kW	141-506	174-591	180-668	236-759
• Operating pressure heating min./max. (PMS)		bar	1/6	1/6	1/6	1/6
• Operating temperature max. (T_{max})		°C	95	95	95	95
• Boiler water content ($V_{(H2O)}$)		l	571	536	509	831
• Flow resistance boiler				see diagram		
• Minimum circulation water quantity		l/h	-	-	-	-
• Boiler weight (without water capacity, incl. cladding)		kg	978	1050	1100	1370
• Boiler efficiency at 80/60 °C in full-load operation (NCV/GCV) 4)		%	98.2/88.5	98.2/88.5	98.2/88.5	98.3/88.6
• Boiler efficiency at 30 % partial load (NCV/GCV) 4)		%	109.1/98.3	109.0/98.2	108.9/98.1	109.1/98.3
• Room heating energy efficiency						
- without control	ηs	%	-	-	-	-
- with control	ηs	%	-	-	-	-
- with control and room sensor	ηs	%	-	-	-	-
• NOx class (EN 15502)			6	6	6	6
• Nitrogen oxide emissions (EN 15502) (GCV)	NOx	mg/kWh	33	33	40	36
• Carbon monoxide emissions at 50/30 °C (related to 3 % of O_2)	CO	mg/Nm³	20	24	26	23
• O_2 content in flue gas min./max. output 6)		%	5.9/5.9	5.9/6.0	6.0/5.7	6.0/5.8
• Heat loss in standby mode		Watt	1000	1000	1000	1200
• Dimensions				see dimensional drawing		
• Gas flow pressure min./max.						
- Natural gas E/LL		mbar	17.4-80	17.4-80	17.4-80	17.4-300
- Liquid gas		mbar	37-57	37-57	37-57	37-57
• Gas inlet pressure max. (idle pressure)		mbar	80	80	80	300
• Gas connection values at 15 °C/1013 mbar:		mbar				
- Natural gas E (Wo = 15.0 kWh/m³) NCV = 9.97 kWh/m³		m³/h	10.1-50.8	12.4-59.3	13.4-67.0	15.1-76.1
- Natural gas LL (Wo = 12.4 kWh/m³) NCV = 8.57 kWh/m³		m³/h	11.8-59.0	14.5-69.0	15.6-77.9	17.6-88.6
- Propane (NCV = 25.9 kWh/m³) 2)		m³/h	5.5-19.5	6.7-22.8	7.0-25.8	9.1-29.3
• Operating voltage		V/Hz	1 x 230/50	1 x 230/50	1 x 230/50	1 x 230/50
• Electrical power consumption min./max.		Watt	57/806	63/831	67/1060	94/1012
• Standby		Watt	5	5	5	7
• Type of protection		IP	20	20	20	20
• Permitted ambient temperature during operation		°C	5-40	5-40	5-40	5-40
• Sound power level						
- Heating noise (EN 15036 part 1) (room air dependent)		dB(A)	77	75	76	78
- Flue gas noise radiated from the mouth (DIN 45635 part 47) (room air dependent/independent of room air)		dB(A)	70	72	71	-
- Sound pressure level heating noise (reference value depending on installation conditions)		dB(A)	67	65	66	68
• Condensate quantity (natural gas) at 50/30 °C		l/h	38	51	48	57
• pH value of the condensate (approx.)		pH	4.2	4.2	4.2	4.2
• Construction				B23, B23P, C53, C63		
• Flue gas system						
- Temperature class			T120	T120	T120	T120
- Flue gas mass flow at max. nominal heat input (dry)		kg/h	800	933	1055	1198
- Flue gas mass flow at min. nominal heat input (dry)		kg/h	159	196	211	238
- Flue gas temperature at max. nominal heat output and 80/60 °C		°C	67	68	69	66
- Flue gas temperature at max. nominal heat output and 50/30 °C		°C	45	47	49	44
- Flue gas temperature at min. nominal heat output and 50/30 °C		°C	28	28	29	28
- Max. permissible temperature of the combustion air		°C	48	48	48	48
- Volume flow of combustion air		Nm³/h	654	764	863	981
- Maximum supply pressure for combustion air supply and flue gas line		Pa	130	130	130	130
- Maximum draught/underpressure at flue gas outlet		Pa	-50	-50	-50	-50

1) In relation to natural gas G20 (100 % methane). With a hydrogen content (H_2) of up to 20 % in accordance with DVGW ZP3100, an output reduction of up to 7 % is possible.

2) Data related to NCV, conditional data

3) Data related to NCV. The boiler series is tested for EE/H setting. With a factory setting to a Wobbe value of 15.0 kWh/m³, operation in the Wobbe value range from 12.0 to 15.7 kWh/m³ is possible without resetting.

4) Conversion acc. to EN 15502-1, Appendix J

AtkinsRéalis

AtkinsRéalis UK Limited
Woodcote Grove
Ashley Road
Epsom
KT18 5BW

Appendix F. Noise Assessment

AtkinsRéalis

Noise Impact Assessment

IQE plc

19 December 2023

2023/NOV/15

IQE PERMIT APPLICATION

Notice

This document and its contents have been prepared and are intended solely as information for IQE plc and use in relation to the noise from IQE.

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This document has 36 pages including the cover.

Document history

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Document reference: 2023/NOV/15

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Issue	WW	LM	AL	AL	8/12/2023
2.0	Issue	WW	LM	AL	AL	19/12/2023

Client signoff

Client	IQE plc
Project	IQE PERMIT APPLICATION
Job number	5223588
Client signature/date	

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1. Introduction

New plant has been proposed for the IQE site at Imperial Park, Celtic Way, Marshfield, Newport, NP10 8BE. The plant is for the design and manufacture of semiconductors. The project, as part of support for the South Wales cluster of compound semiconductor companies, is one of the largest investments in this field in Europe to pursuing high-volume silicon technology in the UK.

The new proposed plant includes cooling units, extract fans and transformers, which are expected to operate 24 hours a day and 7 days a week. Two emergency generators are also proposed which would only operate in case of an emergency.

The proposed plant have the potential to cause noise impact on the nearby noise sensitive receptors. This report is prepared to assess the noise impact at noise sensitive receptors in support of a permit application.

The assessment includes:

- Review of relevant technical guidance, and establishment of noise assessment criteria,
- Identification of the noise sensitive receptors,
- Determination of the baseline noise conditions,
- Sound propagation modelling, and
- BS4142 noise impact assessment.

A glossary of technical terms is provided in Appendix A.

2. Regulations, Planning and Context

2.1 Natural Resources Wales

Based on consultation with Natural Resources Wales for similar projects at this area, it is understood that that assessments should principally focus on engine testing scenarios (i.e. not all engines operating at the same time as they may in an emergency scenario). Following this, assessments of the following scenarios have been undertaken:

- Normal operation
- Emergency operation

2.2 BS 4142:2014+A1:2019

British Standard 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound (BS 4142) describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard is used to determine the rating levels for sound sources of an industrial and/or commercial nature and the ambient, background and residual sound levels at outdoor locations. These levels could be used for the purposes of investigating complaints; assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and assessing sound at proposed new dwellings or premises used for residential purposes. However, the determination of sound amounting to a nuisance is beyond the scope of the standard.

The procedure contained in BS 4142 assesses the significance of sound which depends upon the margin by which the rating level of the specific sound sources exceeds the background sound level ($L_{A90,T}$) and the context in which the sound occurs.

The reference time interval for the specific sound source 'Tr' is 60 minutes during the daytime and 15 minutes during the night. The reduced reference time at night reflects the increased sensitivity to sound during this period. The relevant time periods for daytime and night-time are as follows:

- Daytime – 07:00 to 23:00 hours; and
- Night-time – 23:00 to 07:00 hours.

The assessment method considers the characteristics of the sound, such as tonality, impulsivity and intermittency. Corrections are applied to the specific sound source to account for these characteristics in order to obtain the rating level; the corrections account for acoustic features which have the potential to increase disturbance.

An initial estimate of the impact of the sound source is obtained by subtracting the measured background sound level from the rating level and considering the following:

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does

not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, the standard adds a character correction to the specific sound level to obtain the rating level. Character corrections can be included for tonality, impulsivity, other sound characteristics that make it “readily distinctive”, and intermittency.

During the night time, the background sound level may be low. Absolute levels can therefore be more relevant than the margin by which the rating level exceeds the background. It is considered that if the noise from the proposed plant does not cause sleep disturbance, adverse impact is avoided. To achieve this, the noise from the external units should not exceed 45 dB L_{Aeq} at the façade of the bedroom window. In this case, the indoor noise level from the plant would be 30 dB L_{Aeq} by assuming the noise reduction with partially open windows is 15 dBA. According to BS 8233, when the indoor noise level is below 30 dB L_{Aeq}, it is unlikely to cause sleep disturbance and adverse impacts are avoided.

For this assessment the following impact scale has been adopted:

Table 2-1 – Impact assessment scale

Rating level of industrial/commercial sound	Impact	Significance
Up to 1dB above the background sound level	Negligible	Not significant
1 to 5 dB greater than the background sound level	Minor adverse	Not significant
More than 5 dB greater than the background sound level	Moderate adverse	Significant depending on context
More than 10 dB greater than the background sound level	Major adverse	Significant depending on context

3. Noise Sensitive Receptors

The site is in a largely industrialised area in the western part of Imperial Park, approximately 750 m from the M4. Imperial Park houses several industrial, distribution and administration facilities which are located around the proposed development. The proposed installation is bordered by the existing Vantage Data Centres CWL11 and CWL12 to the north and CWL13 to the east, Imperial Way to the north-east and G24 Power to the south-east. The business units in proximity to the site are industrial or commercial in nature and therefore not considered to be sensitive to sound.

There is some residential land-use near to the site, and the closest noise sensitive receptors (NSRs) are as follows:

Table 3-1 – Residential Noise Sensitive Receptors

ID	Address	Receptor Type	Location (relative to the site)
1	14 Church Crescent	Residential	Approximately 850m to the west
2	1 Nant-Y-Moor Cottages, Blacksmiths Way	Residential	Approximately 750m to the west
3	Teddies Nursery	Non-residential	Approximately 550m to the northwest
4	1-4 Cardiff Road	Residential	Approximately 340m to the north
5	19 Pencarn Avenue	Residential	Approximately 400m to the northeast
6	11 Pencarn Avenue	Residential	Approximately 410m to the northeast
7	61-65 Edmundsbury Rd	Residential	Approximately 540m to the east
8	89-95 Edmundsbury Rd	Residential	Approximately 570m to the east
9	117-119 Edmundsbury Rd	Residential	Approximately 620m to the east
10	50-62 Edmundsbury Rd	Residential	Approximately 620m to the east
11	14-16 Powis Close	Residential	Approximately 540m to the southeast
12	49 Powis Close	Residential	Approximately 530m to the southeast

Residential dwellings are considered to be noise sensitive at all times of day and night. Non-residential receptors are considered to be noise sensitive in daytime hours only as they would not be occupied at night. The nearest NSR locations are shown in Figure 3-1 with IQE shown in red.

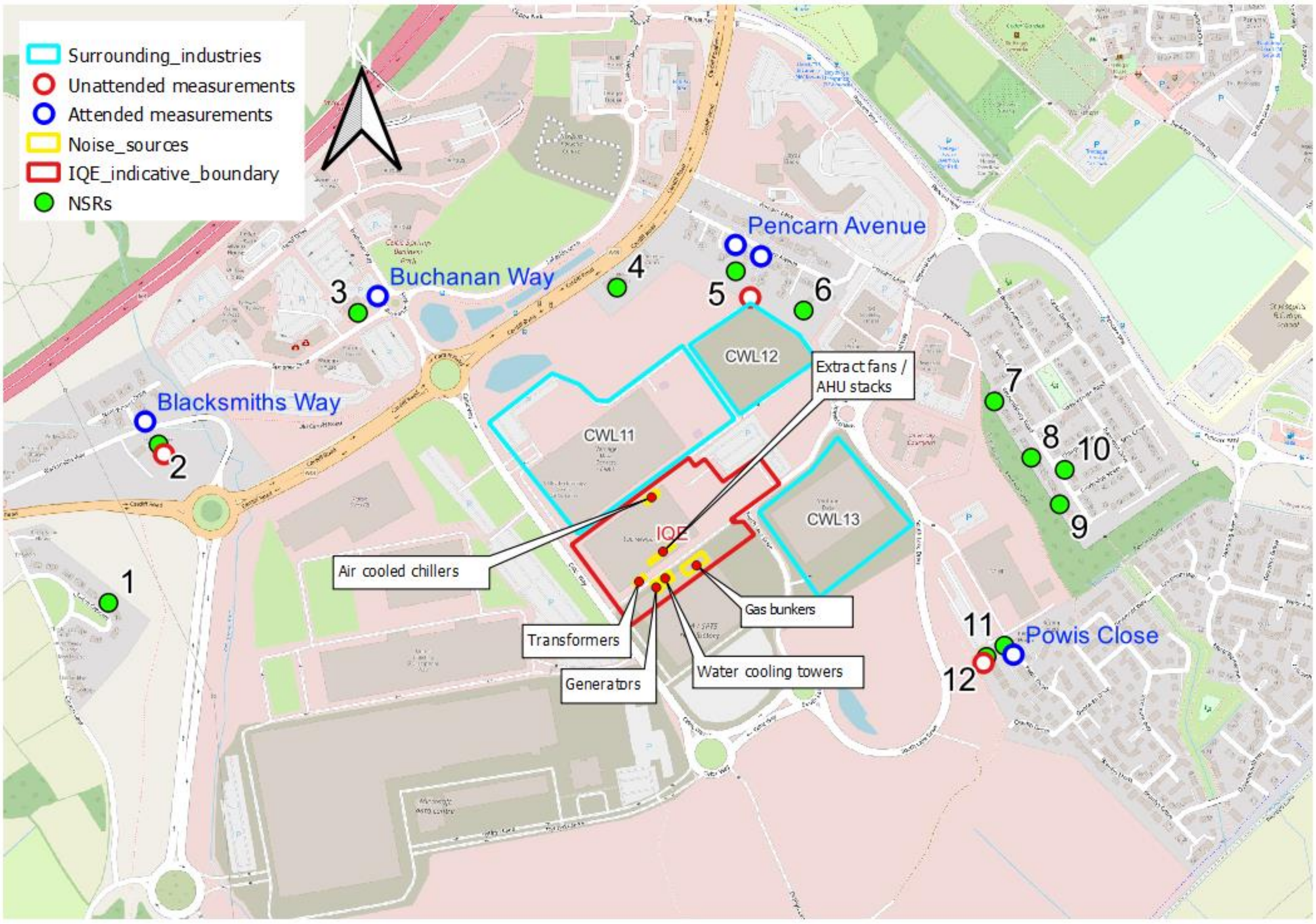

Figure 3-1 – Nearest noise sensitive properties (NSRs) to the site and measurement positions

4. Baseline Noise Survey

4.1 Locations

Acoustic surveys were carried out on Tuesday 15th May 2018 and between 27th June and 8th July 2019, and on 7th December 2020, to establish the existing conditions at the closest sensitive receptors to the adjacent data centre site, as identified in Figure 3-1. Measurements were taken under free-field conditions, unless otherwise stated, during the daytime and night-time periods and additional soundscape observations were made. Given the proximity of IQE to the data centre, these measurements are considered a valid baseline when assessing sound from IQE.

The four locations (as shown in Figure 3-1) visited were:

- Position 1 – 11 Pencarn Avenue (co-ordinates: 328421, 184808) in 2018. This location was moved to 19 Pencarn Avenue in 2019 due to the sound of a garden water feature close to number 11. Logging data was recorded on the boundary fence with Vantage at the rear of the properties, sample measurements were taken in front of the properties.
- Position 2 – 43 Powis Close (co-ordinates: 328726, 184268). Logging data was recorded in the rear garden of this property with façade reflections from the garden fence. Sample measurements were taken in front of the property in free-field conditions.
- Position 3 – 1 Nant-Y-Moor Cottages, Blacksmith Way near (co-ordinates: 327544, 184602). 2019 logging data was recorded in the rear garden of this property. Additional sample measurements were made in the layby on Blacksmith Way. The 2018 sample measurements were taken on the opposite side of the road at the junction of Blacksmith Way and Nant-Y-Moor Close.
- Position 4 – Buchanan Way (co-ordinates: 327847, 184808). Sample measurements taken on the pavement outside of Teddies Nursery.

4.2 Methodology

4.2.1 Noise Survey During 2018

The acoustic survey consisted of attended short-term measurements at each of the four survey positions. At least two measurements of 15-minute duration were recorded at each receptor position using an integrating sound level meter, that was tripod-mounted with a microphone height of approximately 1.4m above ground level.

A full range of acoustical parameters were recorded, including the ambient sound level ($L_{Aeq,T}$), background sound level ($L_{A90,T}$) and maximum sound level (L_{AFmax}). Details of the main sound sources affecting the measured sound levels and the weather conditions were recorded in site notes.

4.2.2 Noise Survey During 2019

A further acoustic survey was conducted in 2019. This survey consisted of unattended long-term logging over a period of several days at the three residential locations which are considered to be noise sensitive at night. Measurements were made using integrating sound level meters, that were tripod-mounted with a microphone height of approximately 1.3 to 1.4m above ground level. Additional attended night-time sample measurements were also made close to each logger location.

A full range of acoustical parameters were recorded, including the ambient sound level ($L_{Aeq,T}$), background sound level ($L_{A90,T}$) and maximum sound level (L_{AFmax}). Details of the main sound sources affecting the measured sound levels and the weather conditions were recorded in site notes.

4.2.3 Noise Survey During 2021

A noise survey was carried out by third party in 2021 for a planning application for a nearby site. The data are publicly accessible[1]. The measurement positions were close to NSR ID 6 (Pencarn Avenue) and NSR ID 12 (Powis Close) as shown in Figure 3-1. As the full measurement details (such as instrument, duration, weather conditions etc) are not available, this measurement is used to compare to Atkinsréalis' measurements and consider if the baseline sound environment has changed significantly since 2018/2019.

4.3 Instrumentation

4.3.1 Noise Survey During 2018

The acoustic monitoring equipment that was used for both surveys is compliant with precision class 1 or type 1 as defined in IEC 61672-1:2013 or BS EN IEC 60651/804. All equipment was calibrated on site before and after each measurement period with no noticeable drift in calibration. All equipment has been laboratory calibrated within the required period and calibration certificates are available upon request. A summary of the equipment details can be found below.

Table 4-1 - Instrumentation details – 2018 survey

Item	Model	Serial number	Date of most recent laboratory calibration before survey
Sound level meter	Norsonic 140	1403242	26/05/2017
Preamplifier	Norsonic 1209	12198	26/05/2017
Microphone	Norsonic 1225	79574	26/05/2017
Calibrator	Norsonic 1251	1859044	26/05/2017

4.3.2 Noise Survey During 2019

The acoustic monitoring equipment that was used for both surveys is compliant with precision class 1 or type 1 as defined in IEC 61672-1:2013 or BS EN IEC 60651/804. All equipment was calibrated on site before and after each measurement period with no noticeable drift in calibration. All equipment has been laboratory calibrated within the required period and calibration certificates are available upon request. A summary of the equipment details can be found below.

Initially all three logger locations were monitored simultaneously but two of the loggers suffered from power supply failures and lost the bulk of their data. Logging at these locations was therefore repeated later using different equipment.

Table 4-2 - Instrumentation details – 2019 survey

[1] Newport City Council, Planning Application File Link

Location	Item	Model	Serial number	Date of most recent laboratory calibration before survey
L1	Sound level meter	01dB Fusion	11200	31/10/2018
	Preamplifier	01dB Pre No22	1605098	31/10/2018
	Microphone	GRAS 40CE	226400	31/10/2018
	Calibrator	Brüel & Kjær 4231	2385276	30/10/2018
L2	Sound level meter	01dB Fusion	12076	13/05/2019
	Preamplifier	01dB Pre No22	1805399	13/05/2019
	Microphone	GRAS 40CD	331856	13/05/2019
	Calibrator	01dB Cal 21	35183004	16/04/2019
L3	Sound level meter	01dB Fusion	12078	13/05/2019
	Preamplifier	01dB Pre No22	1805324	13/05/2019
	Microphone	GRAS 40CD	331906	13/05/2019
	Calibrator	Rion NC-74	35125802	08/04/2019
Sample measurements	Sound level meter	Rion NL-52	00620854	13/09/2018
	Preamplifier	Rion NH-25	20914	13/09/2018
	Microphone	Rion UC-59	03690	13/09/2018
	Calibrator	Rion NC-74	35125802	08/04/2019

4.4 Measured Sound Levels

4.4.1 Noise Survey During 2018

The measured sound levels at each of the monitoring locations are summarised in Table 4-3. The $L_{Aeq,T}$ shown is the logarithmic average of the individual 15-minute readings. The L_{AFmax} is the maximum sound pressure level that was recorded during any of the measurement periods. The L_{A90} and L_{A10} levels shown in Table 4-3 have been approximated by the arithmetic means of the individual L_{A10} and L_{A90} during each sample measurement.

Table 4-3 - Summary of measured sound levels

Measurement ID	Address	Measured sound levels, dB				Main sound sources
		$L_{Aeq,T}$	$L_{A10,T}$	$L_{A90,T}$	$L_{AFmax,T}$	
1	11/19 Pencarn Avenue	52.0	54.7	44.7	76.4	Construction sounds from IQE, birds, local water feature
2	Powis Close	44.9	46.6	36.4	67.7	Birds, distant road traffic, distant construction works at IQE, plant

Measurement ID	Address	Measured sound levels, dB				Main sound sources
		$L_{Aeq,T}$	$L_{A10,T}$	$L_{A90,T}$	$L_{AFmax,T}$	
						operating at the adjacent IQE site
3	Blacksmith Way	59.1	57.3	51.3	82.0	Distant road traffic, birds, engine/generator (possibly from Vantage), possible construction
4	Buchanan Way	59.8	62.9	50.7	75.5	Local and distant road traffic, people (nursery), water, engines/ generator (possibly from Vantage)

Throughout the attended measurements, observations were made on the existing acoustic environment at each location. The main sound sources were identified as local and distant roads, including the A48 and M4, birdsong, water, construction works at IQE, and plant operating at IQE, with engine sound from the existing Vantage site only occasionally being audible.

The weather conditions during the acoustic survey were dry with an air temperature of approximately 20°C. The wind conditions were still. The weather conditions are considered appropriate for acoustic surveys.

4.4.2 Noise Survey During 2019

The measured sound levels at each of the monitoring locations are summarised Table 4-4, Table 4-5 and

Table 4-6. The $L_{Aeq,T}$ shown is the logarithmic average of the individual 15-minute readings. The L_{AFmax} is the maximum sound pressure level that was recorded during any of the measurement periods. The L_{A90} and L_{A10} levels shown in Table 4-4, Table 4-5 and

Table 4-6 have been approximated by the arithmetic means of the individual L_{A90} and L_{A10} during each sample measurement.

Table 4-4 - Summary of attended measured daytime sound levels

Measurement ID	Address	Measured sound levels, dB				Main sound sources
		$L_{Aeq,T}$	$L_{A10,T}$	$L_{A90,T}$	$L_{AFmax,T}$	
1	11/19 Pencarn Avenue	47.7	43.0	39.5	73.6	Distant road traffic noise, faint hum from plant
2	Powis Close	45.2	37.7	35.6	62.7	Plant noise (500Hz hum), some local road traffic noise, local residents in gardens
3	Blacksmith Way	54.1	51.8	49.6	68.7	Road Traffic Noise from M4, some local road traffic noise, pedestrians talking
4	Buchanan Way	57.1	54.7	48.6	84.4	Road Traffic Noise, some movement of cars in nursery car park

Table 4-5 - Summary of attended measured night-time sound levels

Measurement ID	Address	Measured sound levels, dB				Main sound sources
		$L_{Aeq,T}$	$L_{A10,T}$	$L_{A90,T}$	$L_{AFmax,T}$	
1	11/19 Pencarn Avenue	39.8	38.9	36.9	49.7	Distant Road Traffic Noise, faint hum from plant
2	Powis Close	40.3	38.0	36.2	58.5	Plant Noise (500Hz hum), Freight Train
3	Blacksmith Way	50.1	49.1	45.8	62.7	Road Traffic Noise from M4. Intermittent clicking from nearby animal deterrent, some local road traffic noise

Table 4-6 - Summary of unattended measured sound levels

Measurement ID	Address	Measured sound levels, dB							
		Daytime				Night-time			
		$L_{Aeq,16h,16h}$	$L_{AF10,16h}$	$L_{AF90,16h}$	L_{AFmax}	$L_{Aeq,8h}$	$L_{AF10,8h}$	$L_{AF90,8h}$	L_{AFmax}
1	Vantage site, near Pencarn Avenue	52.8	51.6	45.2	96.9	48.7	45.7	40.8	75.8
2	Powis Close*	62.3	60.9	49.8	89.6	58.2	52.6	44.0	96.4
3	1 Nant-Y-Moor	56.3	54.8	51.0	85.3	49.2	49.7	45.4	74.6

*It is noted that there were high noise levels in the evening and early morning at this location. These high noise level conditions were not observed during the attended measurements. It is therefore considered that the unattended measurements are not representative of typical conditions and the attended measurements have been used to define the background noise climate.

Throughout the attended measurements, observations were made on the existing acoustic environment at each location.

The weather conditions during the 2019 acoustic surveys were dry with an air temperature of between 18 and 27 °C. The wind conditions were still. The weather conditions are considered appropriate for acoustic surveys.

4.4.3 Noise Survey During 2021 by the Third Party

The measure sound levels at Percarn Avenue and Powis Close are shown in Table 4-7

Table 4-7 - Summary of measured sound levels by others

Address	Measured sound levels, dB							
	Daytime				Night-time			
	$L_{Aeq,T}$	$L_{AF10,T}$	$L_{AF90,T}$	L_{AFmax}	$L_{Aeq,T}$	$L_{AF10,T}$	$L_{AF90,T}$	L_{AFmax}
Pencarn Avenue	61-70	63-67	47-50	80-99	41	42	39	53
Powis Close	52-57	47-50	35-37	77-80	43	45	36	68

4.5 Representative Background Sound Levels

In 2018, the main sound sources were identified as local and distant roads, including the A48 and M4, birdsong, water, construction works at IQE, and plant operating at IQE, with plant sound from Vantage only occasionally being audible.

In 2019, the main sound sources were identified as local and distant roads, including the A48 and M4, birdsong, plant sound from various sites including Vantage and G24 Power (especially at Powis Close), occasional aircraft, and one night-time occurrence of a freight train approximately 800m to the south-east. Construction sound from IQE was no longer present in 2019 although some light construction works were present on the Vantage site. These were intermittent and are judged to have had no consequence on the measured background sound levels.

The measured background sound levels measured in 2021 are similar to that measured in 2018 and 2019. Daytime levels measured at Pencarn Avenue in 2021 are higher than the levels measured in 2018 and 2019, whilst night time levels are similar or slightly lower. The measurements at Powis Close are also similar to that measured in 2018 and 2019. Based on those measurements in different years, it is considered that the baseline sound conditions have not significantly changed.

The background sound levels used in the BS 4142 assessment are:

Table 4-8 - Background noise levels – Receptors with Noise Measurements

Receptor ID	Address	Background sound levels, dB		Basis
		Daytime L_{A90}	Night-time L_{A90}	
2	Blacksmith Way	51	45	Unattended measurements, 2019
3	Buchanan Way	50	-	Attended measurements, 2019
5 & 6	Pencarn Avenue	45	41	Unattended measurements, 2019
11 & 12	Powis Close	36	36	Attended measurements, 2019

In addition to those locations where sound measurements have been taken, there are three additional noise sensitive locations which are included in the assessment. The background sound levels at these receptors have been estimated from the results in Table 4-8, taking into consideration the main baseline sound sources is road traffic noise.

Table 4-9 - Background noise levels – Additional Receptors

Receptor ID	Address	Background sound levels, dB		Basis
		Daytime L_{A90}	Night-time L_{AF90}	
1	Church Crescent	49	43	2dB lower than Blacksmiths Way(note1).
4	Cardiff Road	47	43	2dB higher than Pencarn Avenue(note2)
7-10	Edmundsbury Road	40	38	Between Pencarn avenue and Powis Close

Note (1): 2dB lower than measurements on Blacksmiths Way to account for being further from main road sources.

Note (2): Measurements at Pencarn Avenue and Buchanan Way are both approximately 150m from A48, which will be the main noise source for the receptor at Cardiff Road. Therefore, a case could be made to use the average of the measurements on Pencarn Avenue and Buchanan Way. However, the noise levels at Buchanan Way are influenced to a greater level by traffic on M4. Therefore, it is our professional judgement that a baseline noise level 2dB greater than Pencarn Avenue is suitable as it accounts for greater contributions from A48 whilst also noting levels would be lower than Buchanan Way due to being further from M4.

5. Proposed Development

5.1 Noise Sources

The proposed plant includes cooling units, extract fans, transformers and emergency generators. These units are either at the ground level or roof level. The quantity, operating pattern, dimension, and noise data are provided by the process engineer and are shown in Table 5-1 and Table 5-2. The noise source locations of the plant are shown in Figure 5-1. The existing noise source from IQE and other nearby industrial sites are considered as residual sound sources and part of the existing sound environment. Therefore they are not included in the noise modelling.

Table 5-1 - Noise sources associated with the development

Plant	Quantity	Operating routine	Dimension LxWxH mm	Comment
Water cooling towers	9	8 in operation and 1 standby	7250x2360x3930	Located externally at ground floor level
Air cooled chillers	2	All in operation	10000x2860x3150	Discharge via stack to atmosphere
Exhaust fans	8 no. Ammonia fans and 8 no. Chlorine fans	8 in operation and 8 standby	1200x1200x1200	
Transformers	6	All in operation	2000x1500x2500	Located externally at ground floor level
Generators	2	All in operation in case of an emergency	15000x2800x3000	
Gas bunker exhaust fans	8	4 in operation and 4 standby	1200x1200x1200	Located externally at ground floor level
GaN reactor bay AHU[2]	8	All in operation		Discharge via stack to atmosphere
Abatement supply AHU	2	All in operation (supply only)		Discharge via façade louvre to atmosphere
Clean corridor AHU	2	All in operation (supply only)		Discharge via façade louvre to atmosphere
Dirt corridor AHU	2	All in operation		Discharge via façade louvre to atmosphere
Water cooled chillers	4	3 in operation and 1 standby		Located internally at ground level
Boilers	4			Located internally at ground level

[2] AHU: air handling unit

Table 5-2 - Noise levels of the proposed plant

Plant	Sound power level, dB L_{WA}	Sound power level, dB						
		125	250	500	1k	2k	4k	8k
Water cooling towers	100	90	94	95	93	91	89	84
Air cooled chillers	86	Spectrum data is not available						
Exhaust fans - Chlorine fans	95	76	81	88	89	88	88	80
Exhaust fans – Ammonia fans	78	65	71	67	71	72	71	67
Transformers	90	Spectrum data is not available						
Generators	99	Spectrum data is not available						
Water cooled chillers	102	Since these sources are located internally, the building façade is likely to provide at least 25 dB noise reduction therefore the contribution of these units is negligible compared to other external sources.						
Boilers	78	Since these sources are located internally, the building façade is likely to provide at least 25 dB noise reduction therefore the contribution of these units are negligible compared to other external sources.						
Gas bunker exhaust fan	Not available at the moment. Assumed sound power level are specified in the following sections							
AHU	Not available at the moment. Assumed sound power level are specified in the following sections							

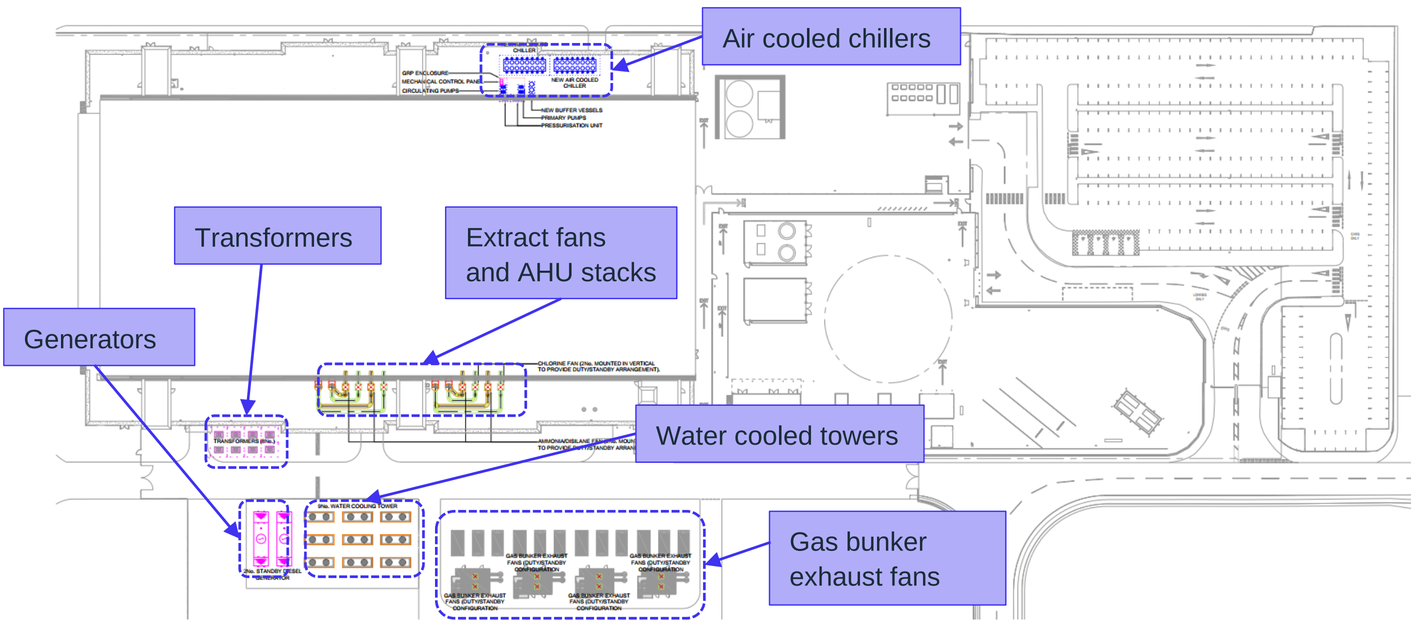

Figure 5-1 - Indicative noise source locations

5.2 Operation Pattern

All plant except the emergency generators operate 24 hours a day and 7 days a week. The generators will be used only for emergency situations and tested regularly as described below:

- one test per month;
- the two generators will be tested together with both generators active simultaneously, and the test will last around 1 hour in total; and
- the tests will be carried out during normal weekday working hours between 9:00 am and 5:00 pm.

During normal operation, the plant listed in Table 5-1 will operate simultaneously and continuously. The generators will not operate during normal operation.

In case of emergency, all the plant which are in normal operation mode and the generators will operate simultaneously. The worst-case non-emergency scenario is considered to be that the overall duration for testing is less than 50 hours per year.

6. Assessment

6.1 Methodology and Assessment Scenarios

A BS 4142 assessment has been undertaken for the operation of the IQE site. This requires the specific sound level to be predicted for a typical one-hour period when the plant is in operation during the daytime, or a 15-minute period at night-time.

The following operating scenarios have been considered:

1. Normal operation scenario.

   During normal operation, the plant listed in Table 5-1, i.e. 8 no. water cooling towers, 2 no. air cooled chillers, 8 no. exhaust fans, 6 no. transformers, 4 gas bunker exhaust fans, and 16 AHUs will operate simultaneously. For the gas bunker exhaust fans, and AHUs, total sound power level limits are assumed as the specific products have not yet been determined. The generators will not operate during normal operation.
2. Emergency scenario.

   In case of emergency, all the plant which are in normal operation mode and the generators will operate simultaneously.
3. Generator testing scenario

   The plant operating pattern of generator testing is the same as the emergency scenario. The generators will be tested once a month. Each test will last around 1 hour. The testing will be undertaken during normal weekday working hours between 9:00 am and 5:00 pm.

A 3D noise model has been constructed using SoundPlan Version 8.2 software to predict the specific sound levels at the identified sensitive receptors for the normal and emergency operational scenarios. The noise model calculates sound propagation in accordance with ISO 9613-2 and considers ground topography, the absorption of the intervening ground type, and dimensions of nearby buildings or structures that may provide screening. It is assumed that during the reference time period the plant will operate continuously as a worst case.

The specific sound levels outputted from the noise model have been used to undertake a BS 4142 assessment taking into account the measured background sound levels obtained from the acoustic survey. Acoustic penalties have been applied to calculate the rating level for the daytime and the night-time assessment periods in line with the BS 4142 methodology. These are required to consider acoustic features that may cause annoyance to sensitive receptors.

6.2 Noise Modelling Assumptions

6.2.1 Base Mapping

The ground topography was modelled using open-source LiDAR data accompanied with ground height information shown on relevant drawings. The ground type was modelled as mixed ground using an absorption coefficient ranging from 0 to 0.8 throughout the study area, with large areas of soft ground (e.g. fields) having an absorption coefficient of 1.

The locations of buildings in proximity to Vantage were modelled using OS Open Data and their heights were set to 6m above ground level. Site observations and online mapping resources such as Google Streetview were used to identify taller buildings and estimate appropriate heights, which included industrial buildings at Imperial Park. The CWL11 and CWL13 sites are already built and operational. At the time of writing, CWL12 has been granted planning permission but has not been built. The buildings of CWL11 and CWL13 were included in the acoustic model, but CWL12 was not included and that land was considered as open field in the model. Once CWL12 is built, the building itself will be like a noise barrier and it will further reduce the noise impact from IQE for the NSRs at Pencarn Avenue.

Receivers were modelled at heights of 1.5m and 4m above ground level at sensitive receptors of interest, with additional receivers added for taller buildings as required. The worst-case predictions are reported.

6.2.2 Site Features

Due to the distance between the plant and nearest sensitive receptors, the plant units were modelled as point sources radiating sound omnidirectionally. The point sources were positioned at the top of the plant (approximately 2.5m-4m above ground level or roof level) in order to predict the worst-case sound emissions. The plan positions of the plant were modelled in accordance with scheme drawings.

6.2.3 Sound Feature Corrections

A BS 4142:2014 + A1:2019 assessment has been undertaken based on the specific sound levels and the sound feature corrections. The plant is likely to generate broad band industrial noise and unlikely to have tonal components, and unlikely to have impulsive components. It is assumed that the plant will operate continuously during the reference 1 hour (daytime) and 15 minutes (night time) periods. Therefore, no intermittency correction is considered applicable. Considering the noise at the receptors from the proposed plant may be discernible, a +3 dB other feature correction is applied to the specific sound levels to calculate the rating levels.

6.1 Assessment of Different Scenarios

6.1.1 Normal Operation Scenario

The highest calculated rating levels (at ground and first floor levels) are shown in Table B-1 and Table B-2 for daytime and night time respectively. The calculated specific sound level contours are shown in Appendix C.

When the site in normal operation, the calculated rating levels are below the background sound levels at most of the noise sensitive receptors. The rating levels at Pencarn Avenue and Powis Close exceed the background sound levels by 3 dB and 5 dB respectively. The BS 4142 assessment indicates that the noise impact from the proposed plant is likely to have negligible to minor adverse impact on the noise sensitive receptors during normal operation. The effect is not considered significant.

6.1.2 Emergency Scenario

The highest calculated rating levels (at ground and first floor levels) are shown in Table B-3 and Table B-4 for daytime and night time respectively.

In case of emergency, the rating levels are still below the background sound levels at most of the noise sensitive receptors. At the most affected noise sensitive receptor (Powis Close) the rating level is 6 dB above the background sound level. This is considered as an indication of a moderate adverse impact. The BS 4142 assessment indicate that the noise impact from the proposed plant is likely to have negligible to moderate adverse impact on the noise sensitive receptors during emergency operation. Considering that emergency situation is expected to be very rare, the effect is not considered to be significant.

6.1.3 Generator Testing Scenario

The noise sources and operating pattern in this scenario are the same as the emergency scenario (during daytime). The highest calculated rating levels are shown in Table B-3. The noise impact is the same as the emergency scenario. The noise during the testing is likely to have negligible to moderate adverse impact on the noise sensitive receptors. Considering that testing comprises one test a month for 1 hour during weekday daytime, the effect is not considered to be significant.

6.2 Context

To fully assess impacts, BS 4142 requires context to be considered. Contextual factors affecting the impact significance are discussed in the subsections below.

The IQE site is located in an already industrialised area, including a few existing data centres. The background sound levels at nearby receptors already contains some sound from the existing industrial and commercial units adjacent to the IQE site. Therefore, the proposed IQE is in character with the existing and planned noise sources in the area.

The total testing period for the IQE site would occur approximately 12 times per year, with each test lasting around one hour. No testing would take place during night-time hours or at weekends, which are more sensitive time in terms of sleep and rest.

BS 4142 notes that an increase of 5dB above background sound levels is an indication of an 'adverse' impact and an increase of 10dB is an indication of a 'significant adverse' impact. This assessment has taken the conservative approach of assessing a 5dB increase over background sound as potentially being significant.

BS 8233 '*Guidance on sound insulation and noise reduction for buildings*' provides recommendations for overall noise levels inside of buildings. For daytime, the recommended level for suitable resting inside living rooms and bedrooms is 35dB $L_{Aeq,16h}$. The standard also explains that sound insulations from a partially open window can be assumed to be 15dB. This would mean that noise levels at the façade of a building would need to be 50dB $L_{Aeq,16h}$ for internal levels to exceed the recommended 35dB $L_{Aeq,16h}$ limit. Rating sound levels at receptor facades do not exceed 45dB $L_{Ar,1h}$ during normal operation or the emergency scenario for IQE. Therefore, the specific sound levels from the site will not exceed the recommended internal noise levels during the day or night to achieve suitable resting conditions, and the resulting impacts are not significant.

6.3 Suggestion for Mitigation

The assessments assume that the sound power level limits shown in Table 6-1 below for the gas bunker exhaust fans and AHUs are met. The noise from these units should not exceed the overall sound power level limits stated. The sound power level limit for each unit is calculated based on the overall sound power level and the quantity in operation.

Table 6-1 - Sound power level limits for gas bunker exhaust fans and AHUs

Plant	Quantity in operation	Sound power level limit, all plant, dB L_{Aw}	Sound power level limit for each plant unit, dB L_{Aw}
Gas bunker exhaust fan	4	97	91
GaN reactor bay AHU	8	98	89

Plant	Quantity in operation	Sound power level limit, all plant, dB L_{Aw}	Sound power level limit for each plant unit, dB L_{Aw}
AHUs at south façade	3	90	85
AHUs at north façade	3	90	85

Provided that there are no changes to the selected plant for the development, the development is unlikely to cause significant effect, and no further mitigation measures would be required.

7. Uncertainty

In accordance with BS 4142, this section summarises sources of uncertainty that can influence the assessment. Uncertainty can arise from the use of measured sound levels in calculations, assumptions about the sound sources, the calculation method, and simplification of data or site conditions.

Sources of uncertainty have been minimised as far as possible by undertaking the baseline acoustic survey and predicting the specific sound levels from the site using validated calculation methods. Nevertheless, the following aspects for the assessment have introduced uncertainty:

- Baseline surveys from different years were compared and no significant changes have been identified. The baseline acoustic survey was relatively short term, based on measurements over a few days. Longer measurements would give a more reliable assessment of baseline conditions.
- Detailed LiDAR has been used to provide a more accurate ground model, and therefore better reflects the real-world situation and sound propagation between the proposed development and the nearest sensitive receptors assessed in this study.
- The specific sound levels were calculated based on the manufacturer source noise data. The predictions rely on the actual plant and equipment generating no more sound than shown by the manufacturer.
- The specific sound levels were calculated assuming that sound is propagating over mixed hard and soft ground to the receptors and that there is no other localised screening which may reduce sound levels at receptors.
- Rating corrections have been applied to the specific sound level for the total specific sound levels as a prudent approach.

8. Conclusion

New plant has been proposed to the IQE site at Imperial Park in Newport to expand the current operation. The baseline sound environment has been measured and the assessment methodology has been established. An acoustic model was built to predict the specific sound levels at the surrounding noise sensitive receptors.

A BS 4142 worst case assessment of the impact of sound from the proposed plant at the nearest noise sensitive receptors has been undertaken, with reference to the baseline conditions at the sensitive receptors and manufacturer sound data where available. Three scenarios, including normal operation, emergency, and generator testing, were assessed.

The assessment indicates that the proposed plant would have negligible to minor adverse impact at all noise sensitive receptors during normal operation. Considering the exceedance of the rating level over the background sound level is low and the proposal does not introduce new type of noise sources to the area, the plant would not cause significant effect at the noise sensitive receptors.

In case of an emergency, the noise may have up to moderate adverse impact on the closest noise sensitive receptors. Considering the emergency situations are rare, the plant is unlikely cause significant effect at the noise sensitive receptors.

The rating level during generator testing may also cause moderate adverse impact. However, the testing is only scheduled once a month for less than one hour. The impact is not considered significant during generator testing.

As the impacts are not significant, no further mitigation would be required.

APPENDICES

Appendix A. Glossary

Decibel (dB)

The unit of measurement used for sound pressure levels. The scale is logarithmic rather than linear. The threshold of hearing is 0 dB and the threshold of pain is 120 dB. In practical terms these limits are seldom experienced and typical levels lie within the range 30 dB (a quiet night-time level in a bedroom) to 90 dB (at the kerbside of a busy city street).

A-weighting

An electrical frequency weighting used to represent the response of the human hearing mechanism to sound. A-weighted sound level is indicated either by placing the capital letter A after the letters dB to get dB(A) or it may be added as a subscript to the sound level parameter as in $L_{Aeq,T}$.

Percentile Level (Statistical Sound Level Indices, L_{AN}, L_{A10}, L_{A90})

L_{AN} is the dB(A) level exceeded N% of the time measured on a sound level meter with Fast(F) time weighting, e.g. L_{A90} the dB(A) level exceeded for 90% of the time, is commonly used to estimate background sound level. LA10, the level exceeded for 10% of the time, is commonly used in the assessment of road traffic noise. Research has shown that the arithmetic average of the 18, 1-hour L_{A10} levels (depicted as $L_{A10,18h}$) between 0600 and 2400 hours shows a reasonably good correlation with community responses to traffic noise. This unit is used in the UK for the assessment of road traffic noise.

Equivalent Continuous A-Weighted Sound Pressure Level ($L_{Aeq,T}$)

Equivalent continuous A-weighted sound pressure level is the steady sound level that has the same sound energy as the fluctuating A-weighted sound pressure level occurring over the same time period and at the same location.

Ambient Sound Level ($L_{Aeq,T}$):

Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

Background Sound level ($L_{AF90,T}$)

The A-weighted sound pressure level of the existing ambient sound level that is exceed for 90% of a given time period, T, measured using time weighting ‘Fast’.

Free-Field (acoustical)

Free-field means a position far away from any reflecting surfaces other than the ground. Several standards and guidelines recommend that to achieve free-field conditions the microphone should be positioned at least 3.5 metres from any reflecting surfaces.

Facade position

A façade position is located one metre from a building façade or large vertical structure.

Appendix B. BS 4142 Assessment Tables

B.1 Normal Operation Scenario

When the rating levels indicate a moderate adverse impact or higher, it is coloured to red otherwise, it is coloured in green.

Table B-1 - BS 4142 assessment - daytime, normal operation

Receiver	Rating level $L_{Ar,1hr}$, dB	Day background, $L_{A90,T}$, dB	$L_{Ar,1hr}$-$L_{A90,T}$ exceedance, dB	BS 4242 level of impact
14 Church Crescent	38	49	-11	Negligible
1 Nantymor Cottages, Blacksmiths Way	38	51	-14	Negligible
Teddies Nursery	39	50	-11	Negligible
1-4 Cardiff Road	39	47	-8	Negligible
19 Pencarn Avenue	39	45	-7	Negligible
11 Pencarn	44	45	-1	Negligible
61-65 Edmundsbury Rd	36	47	-11	Negligible
89-95 Edmundsbury Rd	37	47	-10	Negligible
117-119 Edmundsbury Rd	38	47	-9	Negligible
50-62 Edmundsbury Rd	38	47	-9	Negligible
14-16 Powis Close	41	36	5	Minor adverse
49 Powis Close	41	36	5	Minor adverse

Table B-2 - BS 4142 assessment – night time, normal operation

Receiver	Rating level $L_{Ar,15min}$, dB	Night time background, $L_{A90,T}$	$L_{Ar,15min}$-$L_{A90,T}$ exceedance, dB	BS 4242 level of impact
14 Church Crescent	38	43	-5	Negligible
1 Nantymor Cottages, Blacksmiths Way	38	45	-8	Negligible
Teddies Nursery	39		N/A	Negligible
1-4 Cardiff Road	39	43	-4	Negligible
19 Pencarn Avenue	39	41	-3	Negligible
11 Pencarn	44	41	3	Minor adverse
61-65 Edmundsbury Rd	36	38	-2	Negligible
89-95 Edmundsbury Rd	37	38	-1	Negligible
117-119 Edmundsbury Rd	38	38	0	Negligible
50-62 Edmundsbury Rd	38	38	0	Negligible
14-16 Powis Close	41	36	5	Minor adverse
49 Powis Close	41	36	5	Minor adverse

B.2 Emergency Scenario

When the rating levels indicate a moderate adverse impact or higher, it is coloured to red otherwise, it is coloured in green.

Table B-3 - BS 4142 assessment - daytime, emergency and generator testing

Receiver	Rating level $L_{Ar,1hr}$, dB	Day background, $L_{A90,T}$, dB	$L_{Ar,1hr}$-$L_{A90,T}$ exceedance, dB	BS 4242 level of impact
14 Church Crescent	40	49	-9	Negligible
1 Nantymor Cottages, Blacksmiths Way	40	51	-11	Negligible
Teddies Nursery	40	50	-10	Negligible
1-4 Cardiff Road	41	47	-6	Negligible
19 Pencarn Avenue	41	45	-5	Negligible
11 Pencarn	45	45	0	Negligible
61-65 Edmundsbury Rd	38	47	-9	Negligible
117-119 Edmundsbury Rd	40	47	-7	Negligible
89-95 Edmundsbury Rd	39	47	-8	Negligible
50-62 Edmundsbury Rd	40	47	-7	Negligible
14-16 Powis Close	42	36	6	Moderate adverse
49 Powis Close	41	36	5	Minor adverse

Table B-4 - BS 4142 assessment – night time, emergency

Receiver	Rating level $L_{Ar,15min}$, dB	Night time background, $L_{A90,T}$	$L_{Ar,15min}$-$L_{A90,T}$ exceedance, dB	BS 4242 level of impact
14 Church Crescent	40	43	-3	Negligible
1 Nantymor Cottages, Blacksmiths Way	40	45	-5	Negligible
Teddies Nursery	40		N/A	N/A
1-4 Cardiff Road	41	43	-2	Negligible
19 Pencarn Avenue	41	41	-1	Negligible
11 Pencarn	45	41	4	Minor adverse
61-65 Edmundsbury Rd	38	38	0	Negligible
117-119 Edmundsbury Rd	40	38	2	Minor adverse
89-95 Edmundsbury Rd	39	38	1	Minor adverse
61-65 Edmundsbury Rd	40	38	0	Negligible
50-62 Edmundsbury Rd	40	38	2	Minor adverse
14-16 Powis Close	42	36	6	Moderate adverse
49 Powis Close	41	36	5	Minor adverse

Appendix C. Specific Sound Level Contour

The calculated specific level contour map at 1.5 m above the ground level is shown in Figure C-1 and Figure C-2 for normal operation scenario and emergency scenario respectively.

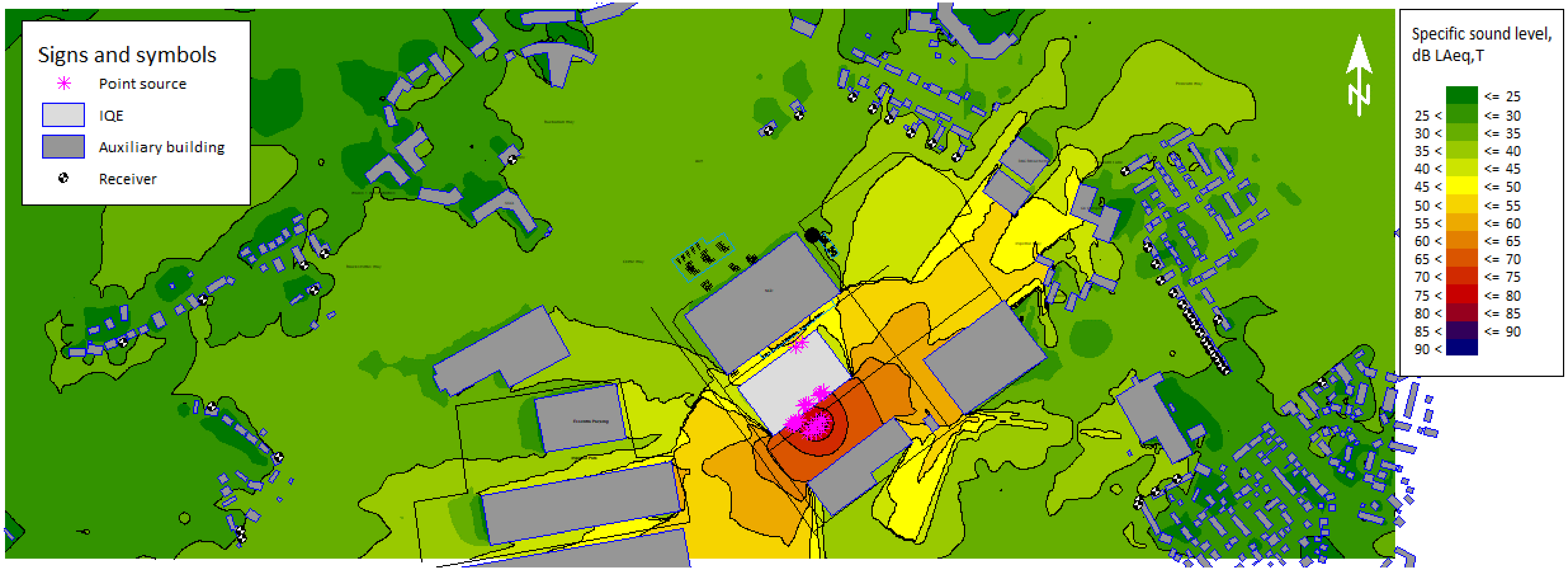

Figure C-1 - Specific sound level contour at 1.5m above the ground – normal operation

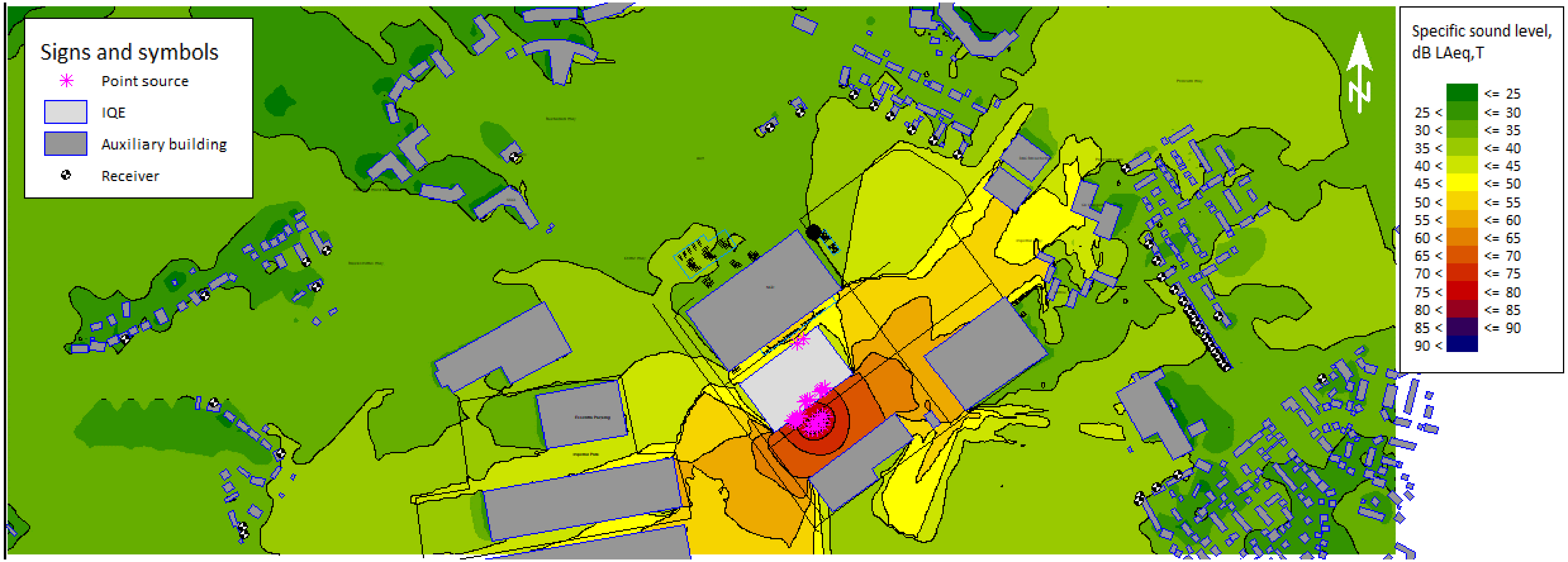

Figure C-2 - Specific sound level contour at 1.5m above the ground – emergency

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