

Natural Resources Wales permitting decisions

IQE Silicon Compounds Limited – Newport Semiconductor Facility

Decision Document

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Glossary of acronyms used in this document

(Please note that this glossary is standard for our decision documents and therefore not all these acronyms are necessarily used in this document.)

BAT	Best Available Technique(s)
BAT-AEL	BAT Associated Emission Level
BREF	BAT Reference Note
CEM	Continuous emissions monitor
CHP	Combined heat and power
CROW	Countryside and rights of way Act 2000
DAA	Directly associated activity – Additional activities necessary to be carried out to allow the principal activity to be carried out
DD	Decision document
EAL	Environmental assessment level
ELV	Emission limit value
EMAS	EU Eco Management and Audit Scheme
EMS	Environmental Management System
EPR	Environmental Permitting (England and Wales) Regulations 2016
EQS	Environmental quality standard
EU-EQS	European Union Environmental Quality Standard
GWP	Global Warming Potential
IED	Industrial Emissions Directive (2010/75/EU)
LHB	Local Health Board
NO _x	Oxides of nitrogen (NO plus NO ₂ expressed as NO ₂)
OPRA	Operator Performance Risk Appraisal
PC	Process Contribution
PEC	Predicted Environmental Concentration
PHW	Public Health Wales
PPS	Public participation statement
PR	Public register
RGS	Regulatory Guidance Series
SAC	Special Area of Conservation
SCR	Selective catalytic reduction
SGN	Sector guidance note

SPA(s)	Special Protection Area(s)
SSSI(s)	Site(s) of Special Scientific Interest
TGN	Technical guidance note
WHO	World Health Organisation

1. Our decision

We have decided to grant the Permit for the Newport Semiconductor Facility, operated by IQE Silicon Compounds Limited.

The Permit number is EPR/AB3893FZ.

We consider that, in reaching this decision, we have taken into account all relevant considerations and legal requirements and that the Permit will ensure that the appropriate level of environmental protection is provided.

2. Purpose of this document

This decision document:

- explains how the application has been determined
- provides a record of the decision-making process
- shows how all relevant factors have been taken into account
- justifies the specific conditions in the Permit other than those in our generic Permit template.

This document should be read in conjunction with the application & supporting information and the Permit.

Unless the decision document specifies otherwise we have accepted the Applicant's proposals.

3. Key issues of the decision

3.1 What the Installation does

The Newport Semiconductor Facility is located within the Installation Boundary. It comprises the main building and service yard and will be centred at NGR ST 28227 84462.

The Newport Semiconductor Facility is located in an existing building located on a largely industrialised area in the eastern part of Imperial Park, approximately three miles south east of Newport City Centre. Imperial Park houses a number of industrial, distribution and administration facilities which are located to the north and west of the proposed development. The proposed Installation is bordered by Next Generation Data (NGD) to the north and Celtic Way to the west. There is an area of unmade land to the south of the site, whilst South Lake Drive, including the roundabout with Imperial Way, borders the site to the east.

The site itself is not subject to any environmentally sensitive designations. It is located approximately 0.6km north of the Gwent Levels-St Brides Site of Special Scientific Interest (SSSI). There are nearby local wildlife sites at Celtic Springs approximately 1km to the north west, the LG Duffryn sites 1 and 2 on South Lake Drive approximately 0.3km to the south of the main building and the Duffryn Pond approximately 1km to the east. The Severn Estuary Special Area of Conservation (SAC) is further afield at approximately 3km to the South East. The entirety of the site is within Flood Zone 1 (low probability of flooding).

The Installation manufactures advanced electronic and opto-electronic Group III – Group V semiconductor structures using a process called Metal-Organic Chemical Vapour Deposition (MOCVD). The Installation currently produces around 400kg of wafers, following this variation the Installation will produce around 14000kg of wafers.

The Installation initially comprised 5 Aixtron G4 reactors, however following this variation this has been increased to 20 reactors, the rise from 5 to 20 reactors will take place over a period of time, the appropriate measures such as abatement and storage arrangements will be increased as the reactor number increase. As part of the expansion, an additional stack has been constructed and now 2 stacks (A1 & A4) remove the exhaust gases from 10 Aixtron units each. There will be an increase in emissions to air, new raw materials, storage of raw materials, waste generated, and energy used, this is discussed in greater detail later in the document.

3.2 Key Issues in the Determination

The key issues arising during this determination were;

- Emissions to air
- Storage of raw materials

We therefore describe how we determined these issues in more detail in this document.

4. Operator

We are satisfied that the Operator is the person who will have control over the operation of the facility after the grant of the Permit. The decision was taken in accordance with EPR RGN 1 “Understanding the meaning of Operator”.

5. The Legal Framework

5.1 European Directives

All applicable European directives have been considered in the determination of the application.

The applicability of the following European directives has particular relevance to this type of Installation. We have therefore assessed their relevance to this particular Permit as follows:

- [Industrial Emissions Directive](#)
- [Seveso III Directive](#)

NRW is satisfied that this decision is consistent with its general purpose of pursuing the sustainable management of natural resources in relation to Wales and applying the principles of sustainable management of natural resources.

6.The Regulated Facility

This Application is to operate an Installation which is subject principally to the Environmental Permitting Regulations 2016 ('EPR') and is subject to the requirements of the Industrial Emissions Directive ('IED').

The Installation is subject to the EPR because it carries out an activity listed in Part 2 of Schedule 1 to the EPR:

- Section 4.2 A1(c) - Manufacturing (other than the application of a glaze or vitreous enamel) involving the use of 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.

Schedule 1 EPR defines 'Installation' to include 'directly associated activities' ('DAA'). At this Installation, the DAAs include water treatment, foul sewer discharge, receipt of raw materials, waste handling and storage.

6.1 The site

The Operator submitted a site plan which we consider satisfactory, showing the site of the Installation, its extent, and emission points.

The site plan is included in Schedule 7 of the Permit, and the Operator is required to carry out the permitted activities within the site boundary.

6.2 Site Condition Report

This variation does not add any additional land to the existing Permit boundary, therefore no amendments to the current Site Condition Report (SCR) is required, however there are changes to the quantities of substances stored on-site including those with potentially hazardous substances, as such 'Table B1 – Determining relevant hazardous substances/substances which may present a pollution risk' in the SCR has been updated to reflect these changes.

6.3 Proposed site design: potentially polluting substances and prevention measures

Gases that are used in the process are stored in the external yard area in dedicated gas storage bays, this includes hydrogen gas stored in a cylinder mounted on a trailer, liquid nitrogen is stored in a dedicated tank and forming gas in cylinders.

Smaller volumes of process gases are stored in gas cabinets, gases such as arsine, phosphine, disilane, hydrogen sulphide and Helium.

As part of this variation there are no changes to the storage arrangements or gas quantities for hydrogen, Inert gases (nitrogen and helium), liquid nitrogen and forming gases. The storage arrangements for dopant gases remain the same, however, the quantity stored on-site has increased as a result of this variation to 200kg stored in individual cylinders.

There are changes to the storage arrangements of;

- Arsine – this will be stored in the service yard adjacent to the main buildings, it will be stored in a gas cabinet within a bunker to prevent loss of gas. There will be a duty and a standby cylinder stored in the cabinet. Total storage capacity will increase from 0.144 tonnes to 0.764 tonnes. There will be no change to the way this gas is used at the Installation. The gas cabinets will vent to atmosphere in the event of a leak, the emissions will pass through a dedicated chemisorption abatement unit prior to final discharge.
- Phosphine – prior to this variation there was no phosphine storage on-site, as a result of this variation cylinders of phosphine will be stored in the service yard in gas cabinets within a bunker to prevent losses to atmosphere. A total of 0.161 tonnes will be stored on-site. Phosphine gas will be used much in the same way as the arsine gas with the same high-level controls. The gas cabinets will vent to atmosphere in the event of a leak, the emissions will pass through a dedicated chemisorption abatement unit prior to final discharge.

Due to the increased inventories on-site, the site will fall within the scope of the COMAH regulations 2015 and as such the Operator prepared an accident management plan that accompanied the application. There are a number of solid and liquid materials that are used on-site, due to the expansion and as a result of this variation, the storage quantities for a number of these will increase. The storage arrangements and loss prevention measures remain the same; all stored with secondary containment of at least 110% of the volume of the container, reinforced concrete hard standing with sealed construction joints and a separate sealed drainage system.

Incompatible materials are not stored together, and the Operator has spill kits and procedures in place to deal with any spillages. There are no areas where potentially contaminated process water can pass into the surface water drainage system. The site surface water drainage is routed to the main business parks surface water drainage system, where it passes an interceptor prior to release to the environment.

6.4 Closure and decommissioning

Having considered the information submitted in the Permit application, we are satisfied that the appropriate measures will be in place for the closure and decommissioning of the Installation. There is currently a site closure plan in place for the Installation and this will be updated to include the increased storage of substances plus the introduction of new substances on site.

Permit condition 1.1.1a requires the Operator to have a written management system in place which identifies and minimises risks of pollution including those arising from closure.

At the definitive cessation of activities, the Operator must satisfy us that the necessary measures have been taken so that the entire Installation ceases to pose a risk to soil or groundwater, considering both the baseline conditions and the site's current or approved future use. To do this, the Operator must apply to us for surrender, which we will not grant unless and until we are satisfied that these requirements have been met.

7. Biodiversity, Heritage, Landscape and Nature Conservation

The Installation emits gaseous hydrides; arsine and phosphine, the air quality assessment has considered these pollutants. There are EALs for these substances for human health, however, these pollutants are not associated with hazards to ecological receptors. Further, there are no assessment criteria for ecological receptors for these pollutants and as such no further assessment is required.

8. Environmental Risk

8.1 Assessment of Impact on Air Quality

The Applicant's assessment of the impact on air quality is set out in the Air Quality Assessment sections of the application. The assessment comprises:

- Dispersion modelling of emissions to air from the operation of the G4 reactors.
- A study of the impact of emissions on nearby sensitive receptors, including human receptors.

This section of the decision document deals primarily with the dispersion modelling of emissions to air from the Installation's stacks and its impact on local air quality. The impact on conservation sites is considered in the Biodiversity, Heritage, Landscape and Nature Conservation section above.

The Applicant has assessed the Installation's predicted emissions to air against the relevant air quality standards, and human health.

The Applicant used dispersion modelling software AERMOD, version 18081. Within the modelling they used 5 years (2011-2015) of meteorological data from the meteorological station at Cardiff airport.

Land use categories and sectors were defined to generate appropriate site surface characteristics for the area. Building downwash effects were included in the modelling assessment and included the main Installation building and surrounding buildings.

The Air Quality Assessment considered the following substances; arsine, phosphine, tributyl phosphine, trimethylgallium, trimethylindium, triethylaluminium, carbon tetrabromide, dimethylzinc, diethyl telluride, bis-cyclopentadienyl magnesium, hydrogen sulphide, disilane, nitrogen, helium and hydrogen.

Predicted emissions of all of these substances, except the inert gases and hydrogen are predicted to be released well below detectable levels even against the manufacturers conservative guarantees.

There is no publicly available background data for arsine or phosphine, however arsenic is measured in 2 locations in Cardiff (Llandaff and Rumney), giving annual average background levels in 2013 of 0.77 and 0.72ng/m³ respectively. Arsenic is also measured in Port Talbot where the annual average for 2017 was 0.75ng/m³ which is in-line with the measurements obtained in Cardiff.

Modelling was carried out for emission points A1 and A4 as these are served by the 20 G4 reactors emitting the substances outlined above, it was assumed in the modelling that each of the G4 reactors was discharging each pollutant continuously and concurrently, this is a conservative approach to the operation.

No modelling was carried out for emission point A2 as there will be no routine discharges from this point, the only emissions would arise from accidental releases from the gas storage area. No modelling was carried out for emission point A3 as this serves laboratory fume hoods with very small discharges.

The Applicant's modelling predictions with regard to human health are summarised in the following sections.

8.1.1 Consideration of Key Air Pollutants

The emission values used in the modelling were based on guarantees provided by the manufacturer. These are highly conservative values and are based on workplace exposure levels rather than what the equipment will actually be able to achieve. Based on this, actual emitted values are likely to be non-detectable.

There are no ELV's set for metal organics, however the emissions will be orders of magnitude lower than the benchmark values in the Additional guidance for the Inorganic Chemical Sector (EPR 4.03), therefore are not considered further in this assessment. The annual usage of disilane and hydrogen sulphide are extremely low and intermittent, based on this these substances have not been considered further.

Arsine and phosphine EALs were obtained from the Environment Agency's online risk assessment guidance.

Pollutant	Annual EAL ($\mu\text{g}/\text{m}^3$)	Hourly EAL ($\mu\text{g}/\text{m}^3$)
Arsine (AsH_3)	1.6	48
Phosphine (PH_3)	-	42

A 100m resolution grid was used over a wide area, approximately 2.5km x 2.5km centred on the Installation, with a smaller local 25m resolution grid, this identified 4 sensitive receptors were identified within the grids and were modelled as discrete receptors. The model reported the maximum hourly and five-year period average concentrations at each receptor. This gives a worst-case scenario at each modelled receptor.

Arsine

Long Term (Annual Mean)

The long-term Process Contributions (PCs) for receptors 1 – 4 are 9.88×10^{-5} , 5.75×10^{-5} , 6.56×10^{-5} and 3.81×10^{-5} of the annual mean EAL of $1,600\text{ng}/\text{m}^3$ respectively, all PC's are below the 1% threshold and therefore all long-term emissions of Arsine are insignificant, and no further assessment is required.

Short Term (Hourly Mean)

The short-term PCs for receptors 1 – 4 are 1.13×10^{-4} , 1.98×10^{-4} , 2.04×10^{-4} and 1.59×10^{-4} of the hourly mean EAL of 48,000ng/m³ respectively, all PC's are below the 10% threshold and therefore all long-term emissions of Arsine are insignificant, and no further assessment is required.

Phosphine

Long Term (Annual Mean)

There are no long-term EALs for phosphine, therefore no further assessment has been carried out.

Short Term (Hourly Mean)

The short-term PCs for receptors 1 – 4 are 1.13×10^{-4} , 1.97×10^{-4} , 2.03×10^{-4} and 1.58×10^{-4} of the hourly mean EAL of 42,000ng/m³ respectively, all PC's are below the 10% threshold and therefore all long-term emissions of Arsine are insignificant, and no further assessment is required.

In summary, we are satisfied that there are unlikely to be any exceedances of long and short-term air quality standards for arsine and short-term for phosphine, for protection of human health at sensitive receptors due to the proposal.

8.2 Emissions to surface water

Based upon the information in the application we are satisfied that the appropriate measures will be in place to prevent and/or minimise emissions to water.

There will be no process emissions to surface water from the Installation. Only clean, un-contaminated surface water run-off from the yard area will be discharge via emission point W1. No liquid chemicals or oils are stored in this area and only gas is stored in the yard area. All surface water drains are routed to the sites drainage system and pass through an interceptor prior to discharge to the environment.

We are satisfied that the pollution risk associated with the Installation is low based on the use of appropriate surfacing, satisfactory containment, inspection measures and the operating procedures which will be put in place as part of the ISO 14001 environmental management system.

8.3 Emissions to sewer

The Installation discharges effluent to sewer, the effluent arises from the water softener and reverse osmosis plant which provides purified water to the cooling loops and humidifiers. No process cooling water is released to sewer, if this is required separate arrangements will be made with an authorised waste contractor or the sewerage undertake to take the effluent. There will be a small increase in effluent discharged to the sewer as part of this variation. The discharge point is listed in Schedule 3 of the environmental Permit as S1. The discharge is authorised by a separate discharge consent with Dŵr Cymru Welsh Water. No emission limits are therefore set in this Permit.

8.4 Emissions to soil and groundwater

There will be no emissions to soil or groundwater as a result of the operation of the Installation.

8.5 Fugitive emissions

There will be no significant fugitive emissions associated with the Installation. The raw material gases are stored within robust storage systems with leak detection present. The gas storage bunkers have extraction equipment served by abatement technology that will remove any accidental releases of arsine, phosphine and other process material. Fugitive releases to water is not an issue as large inventories of liquids aren't stored on site, small quantities of process fluids are stored within the main building. The only items stored in large quantities are firefighting water and liquid nitrogen. Overall the risk of fugitive emissions to the environment are low.

8.6 Odour

We consider that the Applicant's proposals represent the appropriate measures to prevent/minimise odour from the permitted activities. The changes to the original Permit brought about by this variation are not likely to cause an off-site nuisance. Some of the gases present on-site have the ability to generate low levels of odour nuisance, however, the abatement units installed on-site will prevent routine and accidental emissions of the gases. The Operator used the conservative manufacturers guarantee levels, and even at this level, the emissions prior to dispersion of hydrogen sulphide at $<0.001\text{mg/m}^3$ will be well below the odour threshold of $0.05\text{-}2.25\text{mg/m}^3$, arsine emissions of $<50\text{ppb}$ will be well below the odour threshold of $500\text{-}10000\text{ppb}$ and phosphine emissions of $<100\text{ppb}$ will be well below the odour threshold of 150ppb . Disilane used at the installation is between $20\text{-}100\text{ppm}$ diluted in hydrogen and is therefore odourless.

In addition to this a stack height of 20.45m will aid in the dispersion further reducing the above emissions, therefore odour issues from the Installation are likely to be negligible.

As we are satisfied that appropriate measures will be in place to prevent or, where that is not practicable to minimise odour and prevent pollution from odour, we consider that no odour management plan is needed and Permit conditions 3.3.1 and 3.3.2 are sufficiently protective.

8.7 Noise

There are very few external noise sources associated with the Installation as most of work is carried out within a building, the main external noise sources are chillers and fans, due to the expansion there are now 4 roof mounted chillers instead of 3. The Installation employs good practice to minimise noise impact from the site, this includes having a planned maintenance programme and completing planned maintenance. The site has been designed to screen the activities carried out on site from sensitive receptors.

The equipment used on-site has been selected with minimisation of noise as a priority and guarantees from equipment manufacturers for noise levels have been agreed.

The Operator submitted an updated noise assessment in-line with the BS4142:2014 methodology. This assessment considered the addition of 1 roof mounted AHU chiller. In the initial assessment and permit, 3 chillers were considered, with 2 running at any one time, however as part of this variation there will be 4 chillers present, with 3 running at any one time, there are no changes to the other fans and noise sources modelled for the initial permit and as such the addition of the 1 roof chiller is the only change to the original assessment.

BS4142:2014 defines daytime periods and night time periods. Day time is defined as 7am-11pm and night time is defined as 11pm to 7am.

The assessment predicted impact from various situations using the assessment methodology BS 4142:2014. BS 4142:2014 assesses the likelihood of significant adverse impact by subtracting the measured background noise level from the rating level:

- 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.

Four noise sensitive receptors (NSRs) were identified in the assessment. NSR 1-3 are residential dwellings so daytime and night time periods are relevant, NSR4 is a nursery so only daytime period is applicable.

A baseline acoustic survey was carried out as part of the initial permit application, in September 2017, this baseline data is still applicable.

A +1dB acoustic penalty has been included in the modelling to account for the pumps associated with the chillers that weren't initially included in the manufacturers data. The chillers will operate intermittently so a +2dB tonality penalty and a +3dB intermittency penalty was added. Further, a +2dB tonal penalty has been included to the hydrogen dilution gas bunker fans.

Results show that daytime impacts at NSR 1-4 are -13dB, -13dB, -30dB and -27dB respectively and night time impacts at NSR 1-3 are (NSR 4 excluded as it is a nursery so only daytime considered) -3dB, -4dB and -20dB. The results show that the impact at all sensitive receptors is negligible and likely to be insignificant.

8.8 Efficient use of raw materials, water and Energy

Having considered the information submitted in the Application, we are satisfied that the appropriate measures will be in place to ensure the efficient use of raw materials and water within the Installation.

Raw material use will increase as part of this variation, the increase will be proportional to the increase in throughput of the Installation. Additional water will be used which requires pre-treatment for use in the process, therefore, additional materials will be required for this treatment. Phosphine gas will be introduced as a new raw material as part of this variation.

There will be an increase in the amount of water used on-site, water is used on-site for cooling and within the humidifiers needed for the MOCVD process. The increase from 5 to 20 reactors will require additional water for cooling.

There will be an increase in energy use as part of this variation, as the number of G4 reactors has increased. Measures have been put in place such as variable speed fans and pumps, high efficiency cooling/heating plant and regular on-going preventative maintenance, this is aimed at reducing the overall energy use of the Installation.

8.9 Avoidance, recovery or disposal with minimal environmental impact of wastes produced by the activities

This requirement addresses wastes produced at the Installation. Due to the expansion of operations there will be an increase in waste produced at the Installation. There will be a new waste stream in addition to this, this will comprise small amounts of solids from the maintenance of the reactors. The waste produced on-site is minimal and the main waste streams are; solid wastes produced by the abatement equipment (this isn't discarded, instead this is sent back to the manufacturer for regeneration), packaging waste and oil. All waste is stored and disposed in-line with procedures to minimise the impact to the environment. All waste, both hazardous (small quantities of solids arising occasional maintenance of the reactors – gallium, arsenide and trace metal organics) and non-hazardous wastes will be removed from site by an authorised waste contractor.

Having considered the information submitted in the application, we are satisfied that the waste hierarchy referred to in Article 4 of the Waste Framework Directive will be applied to the generation of waste and that any waste generated will be treated in accordance with this Article.

We are satisfied that waste from the Installation that cannot be recovered will be disposed of using a method that minimises any impact on the environment. Permit condition 1.4.1 will ensure that this position is maintained.

8.10 Flood Risk

The Installation is located within Flood Risk Zone 1, which is a low probability of flooding. The Operator has stated the following measures will be in place to reduce any impact from the site during a flood event;

- Containment strategy implemented;
- Additional procedures and staff training in place;
- Emergency shutdown system;

- Emergency plan for flooding in place;
- Subscription to NRW's flood watch warning system;
- Containers of raw materials will be strapped to the ground to prevent release;
- Training & simulation/testing of emergency systems will take place;
- Isolation of equipment; and
- Spillage containment and clean-up measures will be in place.

9. Operating Techniques

The Operator demonstrated in the initial permit application that the Installation represented best available techniques. As part of this variation the Operator has used a number of reference documents as sector specific BAT conclusions for the Inorganic Chemical Sector have not been published. The Operator used; Additional guidance for the Inorganic Chemicals Sector (EPR 4.03), Defra Environmental Core Guidance, Environment Agency Regulatory Guidance Series, and How to Comply with your Environmental Permit, for both the initial Permit application and this variation.

The above documents haven't been updated since the initial Permit was issued and therefore the techniques explained previously remain valid.

9.1 Technology Choice

The Aixtron G4 reactor is used on-site to produce the finished product. Each reactor is contained within its own bay and receives all of the ancillary services to carry out the required reactions. The primary process; MOCVD is carried out at the molecular level so material balance is carefully controlled by automated process control software. The careful balance of materials also minimises releases to the atmosphere.

9.2 Abatement of emissions to air

The Operator assessed a number of options for abatement of emissions from the reactors, they looked at, carbon based chemical absorption, filtration, wet scrubbing, chemical absorption, oxidation by combustion and combined burner washer. Due to the complexity of the materials and gases used within the process, the Operator decided to use chemical absorption (chemisorb scrubbing).

Main Stack

The Operator has installed a PrimeLine chemisorb scrubber system to each of the reactors which will abate emissions produced as part of the reaction. The scrubbers will abate arsine, phosphine, tributylphosphine, trimethylgallium, trimethylindium, triethylaluminium, carbon tetrabromide, dimethylzinc, diethyltelluride, bis-cyclopentadienyl magnesium, hydrogen sulphide and disilane. The exhaust gases leave the reactor and interact with the scrubber, where a chemical reaction occurs; water is produced as part of this process and leaves the exhaust as moisture laden nitrogen, additional nitrogen is added to prevent overheating. This is controlled by a process logic controller, there are multiple redundancies in the scrubber to ensure continuous abatement in the event of failure. The scrubbers are equipped with alarms that detect when the scrubber becomes blocked or is not working to its optimal efficiency. There are detectors that monitor the life of the columns within the scrubber and alert the operators to when the columns are reaching the end of life and need replacing. Spare columns are kept on-site for quick replacement and used columns will be removed from site by the manufacturer. The Operators safety management systems covers the operation of the scrubbers and replacement of the columns.

The scrubber unit is designed to specifically handle the materials and gas flows from the reactors. The raw materials are highly reactive towards the hydrides of the arsine and phosphine gases, they are inert towards hydrogen over large temperature ranges, this therefore means that the final concentrations emitted from the stack are very low as the scrubber media breaks down these pollutants.

The Operator has confirmed that the scrubber manufacturer guarantees that the levels of emitted pollutants will be below workplace exposure limits. However, the scrubber achieves complete breakdown of the pollutants meaning that the actual emissions will be even lower and are predicted to be below detectable levels. The pollutants in the column are left in solid form, meaning they are sealed in the column and can be removed safely.

The gas exiting the stack will be rich in hydrogen and nitrogen which may form explosive mixtures, to reduce the risk, the exhaust gas is mixed with air drawn into the stack to 20% of the lower explosive limit, thereby reducing the risk.

Gas storage areas

The Operator has installed one chemisorption scrubber located in the gas storage area, this will capture and treat emissions from the accidental release of gas from the storage area. This scrubber is capable of treating one entire cylinder of gas. Following this variation and the increase of inventory the Operator will install up to 4 additional scrubbers that will serve the gas supplies for up to 20 additional G4 reactors. After the accidental release of gas, the entire scrubber column will be replaced.

Air Cabinets

Arsine and phosphine cylinders are stored in separate, dedicated gas cabinets ready to be used, as per the existing arrangements on-site. When the cylinders are changed over, the lines are purged via the scrubber to abate any residual gas that may be present. The scrubber is fitted with alarms that will alert operators to when the columns need changing or aren't performing at optimal efficiency. This technology is currently employed to the arsine stored on-site but has been extended to account for the addition of phosphine gas and the increased gas inventories on-site.

NRW agree that the chosen technology and the abatement technology employed on site represent BAT for the Installation.

10. The Permit Conditions

10.1 Raw Materials

As part of this variation there will be an increase in the storage of raw materials on-site plus the addition of phosphine gas to be used in the reactors. The primary raw materials used on-site are arsine, phosphine, tributyl phosphine, trimethylgallium, trimethylindium, triethylaluminium, carbon tetrabromide, hydrogen sulphide, disilane, dimethyl zinc, diethyl telluride, bis-cyclopentadienyl magnesium, inert gases, nitric and hydrochloric acid and hydrogen. Items like maintenance oils and water treatment chemicals are also used on-site and stored in small quantities. All materials are either stored inside a building or are provided with appropriate primary and secondary containment.

10.2 Incorporating the application

We have specified that the Applicant must operate the Installation in accordance with the descriptions in the application, including all additional information received as part of the determination process. These descriptions are specified in table S1.2 “Operating Techniques” in the Permit and are therefore directly enforceable.

10.3 Emission Limits

We have decided that emission limits shouldn't be set in the Permit. The Operator submitted detailed air quality modelling with the application and screened all emissions to air from the reactors as insignificant, therefore no limits have been set in the Permit. However, as phosphine is a new substance on site, an improvement condition has been included in the Permit (IC3), that requires the operator to carry out routine emissions testing during commissioning to ensure that the actual emissions agree with the predicted emissions in the air quality assessment and emissions are insignificant.

10.4 Monitoring

The current Permit doesn't require routine monitoring and as the levels of pollutants being released are insignificant, as outlined above, the increase in emissions from the Installation are still insignificant and therefore, no routine monitoring of the emission points is required. However as mentioned above, testing of emissions of phosphine will be carried out during commission to confirm predictions made in the application.

There is no monitoring of emissions to water, as surface water discharge is clean, uncontaminated surface water run-off and the emissions to sewer are authorised under a separate discharge consent issued by Dŵr Cymru Welsh Water.

10.5 Reporting

We have specified the reporting requirements in Schedule 4 of the Permit. We are satisfied that this frequency is appropriate for an Installation of this type. These meet the reporting requirement set out in the IED and ensure data is reported to enable timely review by NRW.

11. Operator Competence

11.1 Environmental Management System

The Applicant operates an Environmental Management System (EMS) certified under ISO14001:2014. The EMS covers all activities carried out at the Installation and will be amended to incorporate the changes made as part of this variation. Handling of the new gas; phosphine, will be carried out with the same high-level controls as arsine.

To ensure that the management system proposed by the Applicant sufficiently manages the residual risk of accidents, Permit condition 1.1.1a requires the implementation of a written management system which addresses the pollution risks associated with, amongst other things, accidents.

11.2 Accident Management Plan

The site currently has an accident management plan, there are no changes to the management and control of the Installation as part of this variation. The Operator submitted an updated accident management plan that includes the additional storage capacity and new raw materials being brought on to site, in particular the handling and storage of phosphine gas.

Due to the increased inventories of certain raw materials and the inclusion of phosphine gas, the lower tier COMAH threshold will be exceeded and therefore the Installation is now classed as a lower tier COMAH site and fall within the scope of the COMAH regulations. As part of these regulations the Operator has listed a number of potential accident scenarios in preparation for a Major Accident Hazard (MAH) assessment process that is required under COMAH. This will be constantly reviewed and updated as necessary.

11.3 Site Security

Access to the site is restricted by a 3-meter black welded mesh fence. Entrance to the site is via an automatic entrance gate controlled by the site. All authorised access is via a fob system. The site is manned 24/7. The site is covered by CCTV which is monitored by on-site staff. All aspects of site security are covered in the management systems.

11.4 Relevant convictions

Our Enforcement Database has been checked to ensure that all relevant convictions have been declared. No relevant convictions were found. The Operator satisfies the criteria in EPR RGN 5 on Operator Competence.

11.5 Financial Provision

There is no known reason to consider that the Operator will not be financially able to comply with the Permit conditions. The decision was taken in accordance with EPR RGN 5 on Operator Competence.

11.6 OPRA

We are satisfied that the Applicant's submitted Operator Performance Risk Appraisal ('OPRA') profile is accurate. The OPRA score is 32 and will be used as the basis for subsistence and other charging, in accordance with our Charging Scheme. OPRA is Natural Resources Wales method of ensuring application and subsistence fees are appropriate and proportionate for the level of regulation required.

ANNEX 1. Improvement Conditions

Table S1.3 Improvement programme requirements

Ref.	Requirement	Date
IC1	The operator shall submit a site closure report to NRW within 6 months of operations commencing	22/11/18
IC2	Within 12 months of operating the Operator shall submit to Natural Resources Wales, details of its management systems certification to ISO:14001:2015	22/05/19
IC3	The operator shall carry out emissions testing of arsine during the commissioning of the plant from emission points A1 and A4, to ensure that the predictions made in the application are accurate and emissions are insignificant. The emissions will be compared to the emission benchmarks as quoted in the <i>'Additional guidance for Speciality Inorganic Chemicals Sector guidance EPR 4.03'</i>. The monitoring will be in-line with M1 – sampling requirements for stack emission monitoring, Version 7, March 2016 and monitoring will be carried out in accordance with MCERTS. A report shall be submitted to NRW within 3 months for approval, if the results show emissions are not insignificant then additional measures will be proposed.	01/06/19