

Natural Resources Wales permitting decisions

IQE (Europe) Limited – St Mellons Semiconductor Plant Decision Document

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Substantial Variation

The application number is: PAN-001213

The operator is: IQE (Europe) Limited

The Installation is located at: IQE (Europe) Limited, Cypress Drive, St Mellons, Cardiff, South Wales, CF3 0EG

We have decided to issue the permit variation for the St Mellons Semiconductor Plant operated by IQE (Europe) Limited and consolidate the permit.

We consider in reaching that 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.

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.

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

Structure of this document

- Key issues of the decision

Key issues of the decision

Receipt of Application

An application was received on the 13th January 2016. The application was 'Not Duly Made' on the 1st February 2017 due to missing ecological receptors in the air quality assessment, missing human health assessment information and a number of errors in the application forms. This information was submitted and the application was accepted as duly made on the 22nd February 2017. This means we considered it was in the correct form and contained sufficient information for us to begin our determination, but not that it necessarily contained all the information we would need to complete the determination.

Consultation

The consultation requirements were identified and implemented. The decision was taken in accordance with our Public Participation Statement and our Working Together Agreements.

A copy of the Application and all other documents relevant to our determination (see below) are available for the public to view. Anyone wishing to see these documents could arrange for copies to be made. We sent copies of the Application to the following bodies, which includes those with whom we have "Working Together Agreements":

- Newport City Council (Environmental Protection Department)
- Cardiff City Council (Planning Department)
- Dwr Cymru Welsh Water
- Health and Safety Executive
- Aneurin Bevan Health Board
- Public Health Wales

These are bodies whose expertise, democratic accountability and/or local knowledge make it appropriate for us to seek their views directly.

The consultation started on the 6th April 2017 and ended on the 4th May 2017. An advert was also placed on our website during this time period.

No responses were received for this application from the statutory consultees.

The facility

The regulated facility is an installation which comprises the following activities listed in Part 2 of Schedule 1 to the Environmental Permitting Regulations and the following directly associated activities.

S4.2 A(1)(b) - Unless falling within any other section, any manufacturing activity which is likely to result in the release into air of any hydrogen halide (other than the manufacture of glass or the coating, plating or surface treatment of metal) or which is likely to result in the release into the air or water of any halogen or any of the compounds mentioned in paragraph (a) (vi) (other than the treatment of water)

S4.2 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 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

European Directives

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

The site

IQE (Europe) Limited hold an environmental permit for the St. Mellons Semiconductor Plant in Cardiff. The operator has applied for a substantial variation to their existing environmental permit, for the plant to remain competitive.

The plant is split into 2 areas; FAB 1 and FAB 2, several units were decommissioned in FAB1 and the area is not used for operational purposes. The operator has proposed to redevelop the recently decommissioned areas. This redevelopment will include the installation of three new G4 machines and one new G5a machine. In pre-application discussions with NRW and the operator, it was decided that the installation of the three new G4 did not require assessment as they are replacing identical machines and as the permit was not varied for decommissioning, no variation is needed to add them back in. Therefore this variation only concentrates on the new G5a machine and associated emissions.

The new G5a machine is being used as a trial piece of equipment to test a new type of semiconductor where Ammonia is used to achieve the finished product and Chlorine is used within the cleaning phase. The focus of this variation is the emissions from this machine, it is not possible to reduce the emissions as the concentrations are dictated by the process. Therefore, the only solution is the use of additional abatement; the operator has proposed the use of a thermal oxidiser. The operator has selected an Edwards Spectra G-800 natural gas fired thermal oxidiser, the use of this piece of abatement equipment is considered to be BAT.

The machine uses Chlorine in the cleaning phase, this is a new gas to the installation, and the Chlorine is a 5% mix with Nitrogen for 10% of the operating period of the machine. During product development, the amount of Chlorine required in the cleaning phase was optimised and therefore cannot be reduced any further. The operator considered the use of additional abatement to reduce the emissions of Chlorine to air, but this was discounted as the reduction in environmental impact due to emissions to air is offset by the additional energy use, production of additional aqueous waste and the additional use of Sodium Hypochlorite. However the impact of emissions of both Chlorine and Ammonia to air have been assessed and detailed dispersion modelling was submitted with the application. Other environmental impacts associated with the redevelopment of FAB1 have been assessed by the operator including noise, accidents and waste, these will be discussed in further detail later in this document.

Sodium Hypochlorite is currently produced at the installation as a result of the wet scrubbers on-site, which are in place to abate arsine and phosphine emissions from existing machines in FAB 2 and also the new machines to be installed in FAB 1. The operator proposes to discharge the waste to sewer directly as opposed to removing it from site, a full justification was submitted with the application and is discussed in further detail later on in this document.

The FAB 1 process stack will be reinstated as Emission point A1 due to the new releases from the G5a machine.

Operation of the Installation – General Issues

Management

The operator currently operates an ISO14001 accredited management system and the new machines and operations will be in line with this management system.

Abatement

Following assessment of the dispersion modelling, emissions of Chlorine from the facility have been deemed insignificant and therefore will be discharged to the environment unabated.

Emissions of Ammonia from the installation however will be abated by a thermal oxidiser. The current abatement system at the installation does not have the correct chemistry to abate the Ammonia emissions from the new G5a machine that is being installed. Thus, a new Edwards Spectra G-800 natural gas fired thermal oxidiser is being installed to abate the emissions. Thermal oxidisers are catalytic oxidisers that are commonly used to abate Ammonia emissions and can reduce the emissions by up to 99.8% (taken from operational tests at another plant). The thermal oxidiser will operate for the total time that the process is operational; 83%, meaning that all ammonia gas generated by the process will be abated.

The Chlorine gas used for the other 17% of the time (cleaning cycle) cannot be abated by this piece of equipment as it will damage the thermal oxidiser by etching. The operator used H1 to assess the emissions of Ammonia and unabated the discharge exceeded the emission limit value of 10mg/m³ and the long and short term EAL's; due to the very low background concentrations of Ammonia, the PEC's were still below 70% and deemed insignificant. Once the emissions are abated by the thermal oxidiser, the emission concentration was well below the 10mg/m³ emission benchmark. The use of a thermal oxidiser is also considered BAT for the installation.

Site Security

Having considered the information submitted in the application, we are satisfied that appropriate infrastructure and procedures will be in place to ensure that the site remains secure.

Accident Management

The installation is a lower tier COMAH site and has a detailed accident management plan. The addition of the G4 machines do not increase the risks of an accident at the site as they are replacing previously installed machines which were originally risk assessed. The operator provided their Major Accident Prevention Policy (MAPP) with the application which is a detailed document providing information relating to policies on-site and highlighting other management documents that are relevant. The operator has recently replaced all the fire systems on-site to a modern, automatic, centrally controlled fire alarm with zoned gaseous fire suppression & sprinkler system, meaning the risk of fire at the installation is low.

Due to the addition of a few gases and new machines, a new toxic monitoring system has been installed at the installation which is based on continuous monitoring. The alarm system for Arsine, Phosphine and Ammonia will give an alarm at low level and high level concentrations of the gases. The Hydrogen alarm will be extended to cover the new machines. There is also leak detection on the cooling water systems to prevent a major water leak to the environment.

The accident management plan will be updated by the operator to include the new G5a machine.

Off-site conditions

We do not consider that any off-site conditions are necessary.

Operating Techniques

We have specified that the installation must be operated in accordance with the techniques set out in Table S1.2 of the permit. The details referred to in that table describe the techniques that will be used for the operation of the Installation that have been assessed by Natural Resources Wales as BAT; they form part of the permit though permit condition 2.3.1 and Table S1.2 in the permit schedules.

Energy Efficiency

The 2 different types of machines present at the installation (G4 and G5a) are both run using an electrical supply. The installation is powered by the national grid. The operator used H1 to assess the energy usage, a usage figure of 5.7GWh per year was provided by the operator. The machines that are being added by this variation and the existing ones present on-site are used for a specific process (MOVPE process), this involves heating the machines and then cooling, this uses a lot of energy but due to the complexity of the process no lower energy options are available. A batch process is operated on-site whereby if the machines run for several hours, the machines will not run continuously. Due to the installation of the new machines and thermal oxidiser, the operator has calculated that the global warming potential will increase by up to 72%. However, the operator states that the energy use of the machines are conservative and this number is likely to be lower than stated. There are a number of environmental benefits when using a thermal oxidiser. The operator has also committed to installing a meter which will allow better analysis of the site's energy usage.

The operator has also explored the possibility of recovering heat from the waste heat produced by the machines, but this has been discounted due to the batch nature of the process meaning that energy generation would be very intermittent. A heat recovery system has been proposed by the operator, whereby grade heat low will be run around coils to recover heat from the general extract and thermal abatement units. This generated heat will then be circulated around the installation to assist the air handling units. This is expected to significantly reduce the thermal load of the air handling units.

Environmental Risk Assessment

Minimising the Installations environmental impact

Regulated activities can present different types of risk to the environment, including odour, noise and vibration, accidents, fugitive emissions to air and water; as well as point source releases to air, discharges to ground or groundwater, global warming potential and generation of waste. Consideration may also have to be given to the effect of emissions being subsequently deposited onto land (where there are ecological receptors). All of these factors are discussed in this document. For an installation such as this, the principal emissions are those to air, although we also consider those to water. The new G5a machine is to be installed and emission point A1 will be reinstated. The applicant has assessed the emissions from this point and Chlorine and Ammonia are the 2 substances that have been assessed. The G5a machine also includes integral cold traps on the exhaust pipe work; these will remove any suspended solids from the machine and remove Gallium Oxide produced from the process.

Air Quality Assessment

This section of the decision document deals primarily with the dispersion modelling of emissions to air from the stack and its impact on local air quality, human health and ecological sites.

The applicant has assessed the Installation's potential emissions to air against the relevant air quality standards, and the potential impact upon human health. These assessments predict the potential effects on local air quality from the Installation's stack emission. The air impact assessments, and the dispersion modelling has been based on the Installation operating continuously at the relevant long-term or short-term emission limit values, i.e. the maximum permitted emission rate. We are in agreement with this approach. The assumptions underpinning the model have been checked and are reasonably precautionary. The way in which the applicant used dispersion models, its selection of input data, use of background data and the assumptions made have been reviewed by Natural Resources Wales modelling specialists (AQMRAT) to establish the robustness of the applicant's air impact assessment. The output from the model has then been used to inform further assessment of health impacts.

The modelling was undertaken using ADMS Version 5.1. The pollutant emissions rates calculated for these conditions represent a worst case scenario under normal operating conditions with emissions throughout the year.

The applicant identified a number of human and ecological receptors to input into the modelling for consideration. There are no Air Quality Management Areas within the area, and the ambient background concentration is typical for the location.

Human Receptors

The operator identified 15 human receptors that were within the screening distance from the installation. The operator assessed the impacts of Nitrogen Dioxide (NO₂) and Carbon Monoxide (CO) against the relevant standards in relation to the protection of human health.

Emissions to air of Nitrogen Dioxide - NO₂

For comparison with human health Environmental Assessment Levels (EALs), the operator converted Nitrogen Oxide (NO_x) to NO₂ using a very conservative conversion of 100% conversion to NO₂ for the annual mean and 50% conversion to NO₂ for the hourly mean. The results show no significant effect to human health.

The operator submitted modelling showing this and there was a contour plot as part of this assessment. The contour plot showed that there were no sensitive human receptors with the $0.4\mu\text{g}/\text{m}^3$ contour ($0.4\mu\text{g}/\text{m}^3$ is equivalent to 1% of the Air Quality Strategy [AQS] Objective for NO_2). The highest annual mean for NO_2 is actually only $0.2\mu\text{g}/\text{m}^3$. The maximum increase to hourly mean ground level concentrations is $7\mu\text{g}/\text{m}^3$, this is the equivalent of 4% of the AQS standard for NO_2 . The results show that all short-term PC's are below the 1% screening threshold and all long-term Process Contributions (PCs) are below the 10% screening threshold. Based on these facts, emissions of NO_2 on sensitive human receptors can be concluded as 'not significant'.

Emissions to air of Carbon Monoxide – CO

All emissions of CO are well below the AQS objectives for CO, as a worst case, highly conservative prediction, the emissions are only around 2% of the AQS (screening level is 10%). Based on these facts, the emissions to air of CO can be concluded as 'not significant'.

Emissions to air of Chlorine and Ammonia – Cl & NH_3

All emissions to air of NH_3 are well below the screening threshold and can therefore be screened as insignificant and do not require any further assessment.

Low concentrations of Chlorine are used in the process, however the dispersion modelling concluded that the maximum hourly increments to ground level chlorine concentrations slightly exceeded the 10% screening threshold and the concentration of the emission exceed the emission benchmark of $10\text{mg}/\text{Nm}^3$.

There are however no background measurements available for Chlorine, once the emission of Chlorine encounters moisture in the atmosphere chlorine will quickly form hydrogen chloride.

The operator converted the chlorine emission concentration into hydrogen chloride and added twice the annual average background, based on this the Predicted Environmental Concentration (PEC) calculated to 40.1µg/m³ which is equivalent of 5.3% of the short-term EAL and therefore the emission can be deemed insignificant.

The operator explored the options to install a scrubber to abate the Chlorine emissions, however the installation of a scrubber would have significant financial cost and would result in additional energy usage and increased volumes of aqueous waste. As the emissions of Chlorine have been deemed insignificant, installation of an additional scrubber is disproportionate.

Biodiversity, Heritage, Landscape and Nature Conservation

The original air quality assessment submitted with the application had a number of ecological receptors missing. The application was not duly made due to this issue on the 1st February 2017. The operator re-submitted the air quality modelling on the 22nd February 2017 where the additional ecological receptors were considered and had been assessed. The application was then Duly Made as of the 22nd February 2017. The operator identified several ecological receptors that were within the screening distance from the Installation. The following ecological receptors were assessed for impact:

- River Severn SAC/SPA/Ramsar/SSSI
- Gwent Levels Rumney & Peterstone SSSI
- Gwent Levels at St. Brides SSSI
- Ancient Woodland at golf club
- Tyla Farm Local Wildlife Site
- Cath Cobb Local Wildlife Site
- Druidstone Road Local Wildlife Site
- Hendre Lake Local Wildlife Site
- Marshfield Local Wildlife Site

Emissions of NO_x, NH₃ and CO were assessed in line with Air Quality Regulations and assessed against Specific Pollutant Environmental Assessment Limits detailed in NRW guidance. Acid and nutrient deposition was also assessed.

Emissions to air of Oxides of Nitrogen - NO_x

The operator carried out detailed modelling of the emissions of oxides of Nitrogen. The maximum incremental annual mean ground level concentration of NO_x at the closest point of the Gwent Levels Rumney & Peterstone SSSI is 1µg/m³, this makes the PC 1.3% of the critical level for vegetation and above the screening threshold. However, when the background is considered, the PEC is less than 70% and therefore screens out as insignificant and no further assessment is required. It should be noted that the Gwent Levels Rumney & Peterstone and the adjacent St Brides SSSI are classified on Air Pollution Information System (APIS) as standing water and open canals and are therefore not considered to be sensitive to NO_x and although there is vegetation on the site boundary, it is not a feature of interest for the SSSI.

The PC for NO_x is less than 1% at the River Severn and screens out as insignificant. At all non-statutory sites the PC is less than 1% and again screens out as insignificant.

Emissions to air of Ammonia - NH₃

NRW's conservation advisor confirmed that there are no lichens present at the Gwent Levels and the operator's assessment level of 3µg/m³ is the appropriate level to use. The original air quality report that was submitted with the application predicted that the abated Ammonia results at the Gwent Levels Rumney & Peterstone SSSI would be 1.3µg/m³ as an annual mean concentration. This value is above the 1% significance threshold; when the background of 1.3µg/m³ is considered, the PEC is greater than 70% of the critical level.

In relation to this emission, we concluded that as the operator has carried out detailed modelling to get the PC value of 1.3µg/m³ and calculated the PEC as 88%, Ammonia emissions are potentially significant.

Following the normal procedure for any other pollutant; detailed modelling shows that the PEC is <100%, the conclusion is the discharge is not likely to damage the SSSI features.

All the PC's at ancient woodlands and local wildlife sites are below 100% of the EAL for Ammonia and screen out as insignificant, therefore require no further assessment.

For the River Severn and Gwent Levels St Brides, APIS classifies the habitats as standing open water and canals. As a worst-case scenario, the operator has assumed that coastal and floodplain grazing marsh may be present and sensitive to Ammonia. However, the PC for Ammonia is very small (less than 1% of the EAL for Ammonia) and screens out as insignificant.

Impact of Acid deposition

The PC from the Installation is below 1% for all the receptors listed above and can be screened out as insignificant. APIS does note that the effects of acid deposition at coastal grazing marsh are likely to be small as these habitats are generally brackish and alkaline. Also the habitats are inter-tidal and naturally subject to large influxes of nutrients and for this main reason critical loads are not available for these habitats.

Impact of nutrient deposition.

The operator used the approach set out in AQTAG06 to calculate the nutrient deposition associated with the combined releases of NO_x and Ammonia. The total contribution to nitrogen deposition is dominated by the Ammonia.

The incremental nitrogen deposition rate within the Gwent Levels Rumney & Peterstone SSSI is 7kgN/ha/yr and 0.07kgN/ha/yr at the adjacent St Brides SSSI. There are no critical loads associated with the habitat type of *standing open water and canals* and therefore no further assessment is required. The PC for nitrogen deposition at the River Severn is below the 1% screening threshold and therefore screens out as insignificant.

APIS states that the overall nitrogen deposition is likely to be of low importance for saltmarsh systems as inputs are likely to be '*significantly below the large nutrient loadings from river and tidal inputs*'.

There is not likely to be any significant effect at any of the non-statutory sites (ancient woodlands & local wildlife sites) as the PC is below the 1% screening threshold for all sites.

Emission limits

We have decided that emission limits should be set for the parameters listed in the permit. The limits are based on Sector Guidance for the Chemical Industry. It is considered that the ELVs described in the permit will ensure that significant pollution of the environment is prevented and a high level of protection for the environment secured.

Emissions to Surface Water

Based upon the information in the application we are satisfied that the appropriate measures will be in place to prevent pollution of ground and surface water. There will be no emissions to surface water associated with this variation. As part of the variation the operator will install 3 new air cooled chillers to support the cooling water required for the new machines. The cooling water will include water treatment chemicals to ensure good quality of the water. The water circuit will be operated in-line with existing site procedures to ensure environmental protection.

Emissions to Sewer

Sodium Hypochlorite is produced at the IQE site because of the existing scrubber arrangement which is in place to abate arsine and phosphine emissions from the existing machines in FAB 2, and the proposed G4 machines to be installed in FAB 1. The scrubbing columns use sodium hypochlorite, sodium hydroxide and ortho-phosphoric acid, in which the exhaust process gases are reacted and any excess arsine and phosphine removed.

The spent liquor is currently collected in intermediate bulk containers (IBC's) and removed from site. As part of this application the operator has proposed to alter this disposal method and discharge the spent sodium hypochlorite to foul sewer. The operator provided samples of Sodium Hypochlorite to the sewerage undertaker (Dwr Cymru Welsh Water). Following analysis of these samples the operator received written authorisation to discharge to foul sewer and the discharge consent was provided with the application.

During pre-application discussions between the operator and NRW it was decided that H1 wasn't the best method to assess the discharge. This is because H1 is designed for large volumetric flow whereas the operator is only discharging around 3m³/day. Based on this it was agreed to base the assessment on calculations relating to total volume discharges and the concentration of each compound in the discharge.

The calculations were provided and showed the discharge quality and reduction factors once the discharge reached the treatment works. The solution will be diluted 1:1 with freshwater make-up, meaning the maximum discharge rate in any 24 hour period would be 1.5m³ of sodium hypochlorite diluted 1:1 will give a maximum of 3m³ of discharge in a 24 hour period. Dwr Cymru Welsh Water have not imposed any monitoring conditions on the operator. However the reports from Welsh Water state a pH range of 6-11 and therefore the operator will monitor the pH of the effluent to ensure that it remains within this range. In addition, the operator has stated that the flow rate will be monitored closely to ensure that the limit set by Welsh Water of 3m³ is complied with. The above method will be used for normal operation however during maintenance periods higher levels of contaminants may be present. In this instance the operator will transfer the effluent to IBC's and removed from site. There are a number of environmental benefits that accompany this change. By discharging directly to foul sewer it eliminates the risk of any accidental releases to surface water associated with the storage and handling of IBC's. This also eliminates the storage of large quantities of waste which in turn reduces the size of a fire or spillage on-site. There are also a number of benefits associated with removing this waste from site with a reduction in vehicle movements on-site and surrounding area. A reduction in noise from traffic movements will also be seen.

Noise

The only significant sources of noise associated with this variation is from:

1. The chiller plant fans and pumps – as the chiller plant is located externally to the installation the operator carried out an impact assessment of the noise. 8 sensitive receptors close to the installation were selected as being the most representative and background noise data for these sensitive receptors was obtained. The new chillers are designed to be quiet during operation and have a noise rating of 53dB (A) at 10m. This level was added to the background to obtain sound level data for the chiller plant. The results show that the sound levels created at each sensitive receptor are below the background concentration. Using BS4142:2014 which states that '*a difference of -10dB is a positive indication that complaints are unlikely*'. This -10dB threshold is met at all 8 sensitive receptors and therefore no further assessment is required.
2. G5a machine – the machine is located within the building itself which offers noise attenuation and therefore the noise will not be audible beyond the walls of the building and therefore requires no further assessment.
3. Air passing through the stack – the change in air passing through the stack is minimal and therefore will not cause any audible change, therefore no further assessment is required.

Monitoring

We have decided that monitoring should be carried out for the parameters listed in Schedule 3 of the permit using the methods and to the frequencies specified in those tables. These monitoring requirements have been imposed in order to demonstrate compliance with emission limit values. The original permit set limits for the A1 and A3 releases, whereas the most recent variation only set limits for A3, the other release points A2, A4 and A5 do not have any monitoring requirements. The existing permit does not set limits to air for other parameters (only arsenic and ammonia) or the other release points, as these were outside its scope.

On considering whether it is justified to set ELV's for these other releases, the H1 assessment supplied with the application identified that the typical release figures for Nitric acid, Carbon Monoxide, Nitrogen Dioxide, Hydrogen Chloride and Disilane were all <1% of the EAL by at least an order of magnitude and therefore required no monitoring.

The reinstated emission point A1 will be used to discharge ammonia via the thermal oxidiser and unabated chlorine. A value of 10mg/m³ has been applied to both substances. For emissions to air, the methods for continuous and periodic monitoring are in accordance with the Environment Agency Guidance M2 for the monitoring of stack emissions to air. Based on the information in the application and the requirement set in the conditions of the permit we are satisfied that the operator's techniques, personnel and equipment have either MCERTS certification or MCERTS accreditation as appropriate.

Reporting

We have specified the reporting requirements in Schedule 4 of the permit either to meet the reporting requirement set out in the IED, or to ensure data is reported to enable timely review by Natural Resources Wales to ensure compliance with permit conditions and to monitor the efficiency of material use and energy recovery at the installation.

BAT Assessment

The operator has carried out a BAT assessment in relation to the use of the thermal oxidiser and the discharge of sodium hypochlorite to foul sewer as part of their application. Having assessed the BAT assessment we agree with the operators conclusions.