



Permit Application - Viridis 178 Swansea Power Plant

Technical Supporting Information Document (EPR-CP3630AJ)



November 2015

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& Infrastructure UK Limited



Report for

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Document revisions

No.	Details	Date
1	Draft Report 15362i1	June 2015
2	Final Report 15467i1	November 2015
3	Final Report 15467i2	November 2015

Non-Technical Summary

Purpose of this report

This report has been produced for the purpose of supporting Viridis 178 Ltd with the development of a power plant at Westfield Industrial Park, Timet, near Swansea, South Wales. Viridis 178 Ltd has a contract to supply electrical power via the recent capacity mechanism auction. These plants will operate on a short-term basis meeting peak demand within the electrical distribution network. They are expected to operate for some 1000-1500 hours per year with the typical average being 1250 hours per year, but when called by the National Grid, they have to reach maximum power output within 2 minutes and supply electricity for the duration of the call period. The expected duration of a call will be a maximum of 5 hours but frequently less than an hour, typically between 7am and 9 pm, Monday to Friday.

Viridis 178 Ltd proposes to install twenty seven gas fired spark ignition engines each with approximately 1.286MW export electrical output resulting in a total thermal input of 80.73MW based on the manufacturers quoted efficiency. Engines offer a number of advantages over other combustion techniques for this type of application including short duration to full power output, high levels of availability, reliability, high generation efficiency and the possibility to match the electrical requirements with the number of operational engines.

Type of Permit

The proposed activities will comply with the requirements of the Environmental Permitting Regulations (EPR), including the obligation to demonstrate Best Available Techniques (BAT) for combustion activities with a net rated thermal input of greater than 50MW.

Viridis 178 Ltd is applying to Natural Resources Wales (NRW) for an Environmental Permit (EPR-CP3630AJ) under the Environmental Permitting (England and Wales) Regulations 2010, as amended, the latest Amendment is 2015. The installation will require a permit under Part 2 of Schedule 1, Section 1.1 that relates to Combustion Activities (i.e. those combustion activities that require permitting under the EPR). Section 1.1 Part A(1)(a) states:

- ▶ “Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.”

Further guidance on the definition of 50MW is provided in the regulations, as follows:

- ▶ “For the purpose of Part A(1)(a) of this Section, where 2 or more appliances with an aggregate rated thermal input of 50 megawatts or more are operated on the same site by the same operator those appliances must be treated as a single appliance with a rated thermal input of 50 megawatts or more.”

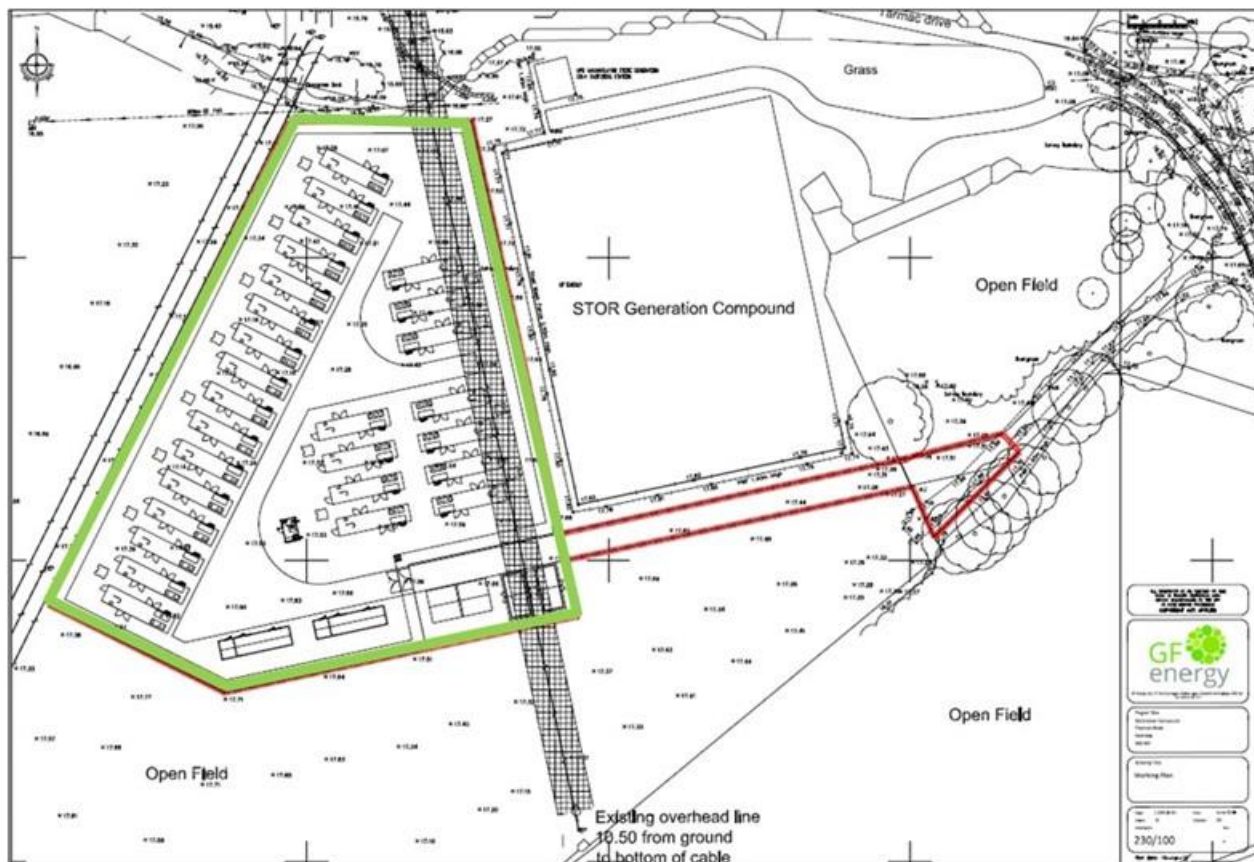
Appliances operated on the same site by the same operator must be aggregated. Current EPR Combustion Sector Guidance¹ and the Regulatory Guidance Notes² states that there is no de minimis threshold for excluding smaller combustion units, and units rated <5 MW_{th} and standby plant should be included in the aggregation. The sector guidance states that the thermal input threshold relates to gross rather than net calorific value of the fuels used.

It is important to note that the regulations make no distinction between standby plant and full time operating plant, the permitting requirement is linked to the rating only.

¹ EPR 1.01 How to comply with your environmental permit. Additional guidance for Combustion Activities. Environment Agency, March 2009.

² Regulatory Guidance Note 2 – Understanding the meaning of regulated facility, Environment Agency, March 2013

Figure i.2 Site Layout



The proposed installation boundary is shown in green.

Proposed Process Activities

The proposed Viridis power plant at the Westfield Industrial Estate, Timet, will be operated and managed by Viridis 178 Ltd. The proposal will be to install and operate up to 27 engines each with an electrical generation capacity of approximately 1.3MW. The engines will operate on natural (mains) gas burning an estimated 317 m³/h of gas per engine. The total thermal input will be 80.73MW, equivalent to 8,560 m³/h of gas consumed, with an electrical export of 34.7MW. The engines will provide a high level of availability and reliability, with a rapid response from cold to full power, as required by the electrical supply contract. Any maintenance will be carried out during periods outside of the call-off contract.

The power plant is planned to be commissioned during 2016 and will consist of two phases of development, the first using 14 engines and the second using 13 engines each with a thermal input of 2.99MW_{th} resulting in a total installed capacity of approximately 80.73MW_{th} thermal input. The engines will burn mains gas, which will be transported to site via underground HDPE pipes from the local gas distribution system with the resultant electricity being exported via transformers to the main electrical distribution grid.

The engines will operate using the principle of lean-burn combustion as it offers a combination of high power, high efficiency and reduced exhaust emissions. This will be achieved through the controlled combustion of a homogenous and lean mixture of gas and air in a compact combustion chamber. The gas feed pressure can be varied to keep the energy supply to the engines constant. To improve the performance of the engines a turbo charger and associated items of equipment will be used to boost the air pressure, hence allowing more fuel to be used and increasing power outputs.

Each engine will be connected to an electrical generator with a designed electrical gross output of approximately 1.286MW. Each unit will also have an air blast cooler, silencer and stack mounted on top of the engine container. The containers will be designed to minimise the noise levels emitted by the engines.

Emissions to Air

As the generating plant burns its fuel it emits a number of pollutants, mainly oxides of nitrogen, carbon dioxide, carbon monoxide and unburnt methane. By using mains gas, there will be negligible emissions of sulphur compounds and particulate matter. Due to the nature of the fuel (mains gas), the engines will operate in a lean burn mode, this in effect reduces the quantities of nitrogen oxides emitted. The engines will be controlled by computerised engine management systems, these systems are set at the routine maintenance periods to control the emissions of nitrogen oxides by continuously adjusting the engine operating parameters. No other abatement systems are proposed to be installed as the primary emitted pollutant of potential concern is nitrogen oxide and this is minimised by the correct operation of the process. The use of qualified and trained staff, the routine maintenance programme and regular monitoring of process parameters are in place to ensure that plant emissions are minimised.

The combustion plant will be operated by a small team of experienced operators who will run the processes on a day-to-day basis. The company will institute comprehensive management systems to ensure that all operations are carried out efficiently.

Emissions to Ground Water

All maintenance and water treatment chemicals when stored on site are contained in impervious areas, on drip-trays and bunds to prevent accidental releases. Hence, there is little potential for the release of chemicals to contaminate ground water or surface water that might have significant impact. The quantities of chemicals stored on site are minimised and this will further reduce the impact of any accidental release of these chemicals.

There are no other discharges of process effluents from the installation. Domestic waste from the staff amenity block will be collected in a waste tank and periodically emptied by a licenced contractor.

Waste Handling, Recovery and Disposal

Viridis will operate a minimum waste policy and this will be adopted at the generating plant. The waste arising's will mainly be as a result of maintenance activities carried out by the engine manufacturers or trained technicians on behalf of the company. These wastes will include waste oil, oil filters, contaminated oily rags, and empty chemical drums used in normal operation, for example antifreeze chemicals, although these will not normally be kept on site and only brought onto site with the site maintenance technician during servicing.

These wastes will in most cases be returned to the suppliers for recycling or will be disposed of in compliance with current regulations and best practice via licensed waste contractors.

Where items such as used oil filters cannot be recycled and are proposed to be sent for disposal, (where there is no alternative disposal route), these will be periodically audited as part of the obligations under "Duty of Care". These quantities will be minimised and disposal is infrequent as recycling and reuse is the preferred option for wastes generated by Viridis' operations.

Energy

The net efficiency of the generating plant is expected to be not less than 41%, this will be limited due to the combustion system, but the engines will produce maximum output rapidly from start, a key requirement for the supply contract at this site. The main component in energy (fuel) consumption at the generating plant is predicted to be some 93,369 megawatt hours (MWh) of mains gas annually, based on typical projected operating hours of 1,250 hours per years, exporting some 40 149 MWh electricity per year. During start up, when no engines are operating, electricity can be imported from the local distribution grid to power the first engine. This is minimised and is expected to be less than 1,510 MWh per year based on typical number of starts per year. Once one of the engines has started, no more electricity is imported for normal operation.

Accidents

The plant is designed to operate automatically, with the remote monitoring of key parameters which along with the management systems in place will minimise the effects of any accidents on the environment. No accident scenarios which are considered 'Unacceptable' have been identified.

Noise and Vibration

The plant has been designed to minimise the potential for noise and vibration impact on the local sensitive receptors, including the local residential properties closest to the site. Measures adopted to minimise noise include initial plant specification, careful siting of noise sources, use of acoustic enclosures, etc. The results of noise control measures have shown that the impact of noise at the sensitive receptors will be at an acceptable level.

Monitoring

Viridis appreciate the importance of monitoring the process emissions and as part of the operation of the process the releases to atmosphere will be routinely monitored, for a proportion of the engines each year (15% of the engines), for a range of pollutants expected in the emissions including oxides of nitrogen, carbon monoxide and total volatile organic compounds (as carbon) mainly methane. As all the engines are the same type, will have the same maintenance and operate with the same fuel it is expected that the emissions will be similar and testing four engines will give an average for the remaining engines. The proposed emissions monitoring programme, uses approved sampling methodologies and these will be agreed with the NRW prior to the measurements being taken on the engines. The sampling will be carried out by a MCertS approved test equipment by a trained technician or an MCertS approved test team. Viridis has the management systems in place to ensure that the monitoring results are reported to the NRW in a timely manner and in an appropriate format.

Management Systems

Viridis will manage and operate the proposed power plant and will be the operator for the permit for the overall site.

Viridis does not currently operate a formally certified Environmental Management System (EMS) such as ISO 14001 but it does operate within a quality assurance management system to the internationally recognised standard (ISO9000) series. Viridis has written management systems in place that covers the design, construction and operational phases of the proposed power plant. It will also include training and record keeping for all staff who are employed on site. The procedures include the assessment of the potential risks to the environment and reasonable actions to minimise those risks.

The EMS system will be in place before the plant is commissioned will comply with the BAT requirements as set out in the Environment Agency/NRW Guidance "How to comply with your environmental permit" and additional sector specific guidance.

The management system will include the maintenance of the equipment, both preventative and unplanned to ensure that the impacts on the environment are minimised. Process critical spares will be kept on site with non-critical spares being available from the manufacturers.

Operational Control

The main operational plant at the site, spark ignition engines, will be controlled through automated process control systems with trained operatives supervising the process. The engines and associated systems have been designed to operate with minimal intervention with the automated process control system monitoring the process conditions and hence emission parameters continuously. The system will be set up to achieve:

- ▶ Optimum process conditions;
- ▶ Maximum generation of electricity; and

- ▶ Compliance with all statutory requirements and emission limits.

Process alarm and interlocks will be built into the control system so that abnormal operation will be detected and quickly rectified, if the system cannot bring the process to within normal parameters, the control system will instigate a shutdown of the engine and trigger an alarm for operator intervention. This will minimise any potential for emissions outside of permit values.

Impact Assessment

As the process will emit a number of pollutants that can have an impact on local receptors a number of detailed risk assessments have been carried out including:

- ▶ Detailed dispersion modelling of air emissions,
- ▶ Detailed noise impact assessment,
- ▶ Site condition report, and
- ▶ Impact Assessment using Environment Agency/NRW's H1 Methodology.

A number of the assessments have shown that the impact of the emissions from the plant, mainly emissions to air from the combustion of fuel in the engines, cannot be classed as insignificant, although no environmental assessment levels, (Air Quality Objectives) are breached even when the background concentrations are included. The H1 assessment concludes that the releases from the proposed power plant to be operated by Viridis will not pose an unacceptable risk to human health or the environment.

The detailed noise assessment based on the Environment Agency/NRW's Guidance H3, using worst case assumptions, at the nearest noise sensitive receptors has been undertaken. The impact has identified that there would be a small increase above background levels with the plant operational and as such the impacts are unlikely to give rise to complaints at any of the nearest identified receptors, particularly as the plant will only operate intermittently.

Site Condition Report

A preliminary site condition report, using Environment Agency/NRW's Guidance H5, has been undertaken for the site. This is a 'live' document that will be periodically updated and reviewed during the life of the permitted installation. The preliminary work has not identified any areas of concern. To minimise any future contamination the tanks containing material that may cause environmental harm to ground or surface water will be bunded and the infrastructure regularly inspected.

Site Closure

The site will have a design life of at least 25 years. Once the site is no longer operational, it will be decommissioned following the procedures in place at the time to minimise the environmental impact of the demolition and other decommissioning processes. These procedures will be included in the site condition report submitted to the Environment Agency at the time of permit surrender.



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1. Introduction

The report has been prepared to support Viridis 178 Ltd (Viridis) with an application for a new bespoke permit under the Environmental Permitting (England and Wales) Regulations (EPR) 2010, as amended. The proposed activities will comply with the requirements of the Environmental Permitting Regulations (EPR), including the obligation to demonstrate Best Available Techniques (BAT) for combustion activities with a rated thermal input of greater than 50MW.

This document should be read in conjunction with the Natural Resources Wales (NRW) Application forms EPR A, B2, B3 and F1, which are provided in the appendices of this supporting Technical report.

2. About the Application

Viridis has a contract to supply electrical power via the recent capacity mechanism auction. These plants will operate on a short-term basis meeting peak capacity shortfalls within the electrical distribution network. They are expected to operate for 1000 – 1500 per year with an average of some 1250 hours, but when called by the National Grid, they have to reach maximum power output within 2 minutes and supply electricity for the duration of the call period. The expected maximum call period will be 5 hours in any 24 hour period or a number of shorter less than an hour call, typically during peak times of 7am to 9pm, Monday to Friday.

Viridis proposes to install twenty seven (27) gas fired spark ignition engines each with approximately 1.3MW export electrical output. Engines offer a number of advantages over other combustion techniques for this type of application including short duration to full power output, high levels of availability, reliability, high generation efficiency and the possibility to match the electrical requirements with the number of operational engines.

2.1 The Site and Operator

The combustion plant is located at the Westfield Industrial Estate, near Swansea.

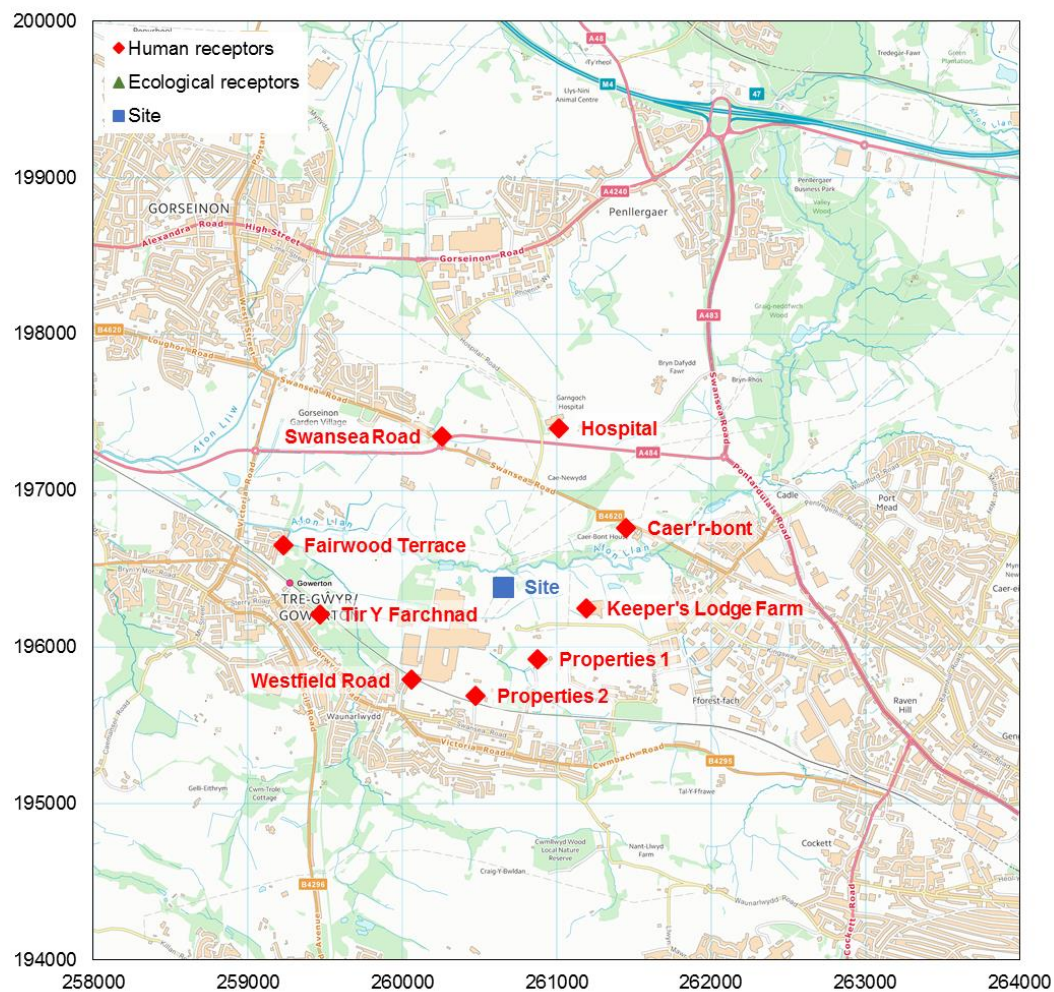
The site address is:

**Westfield Industrial Park
Titanium Road,
Waunarlwydd
Swansea
SA5 4SF**

National Grid Reference: SS 60798 96429

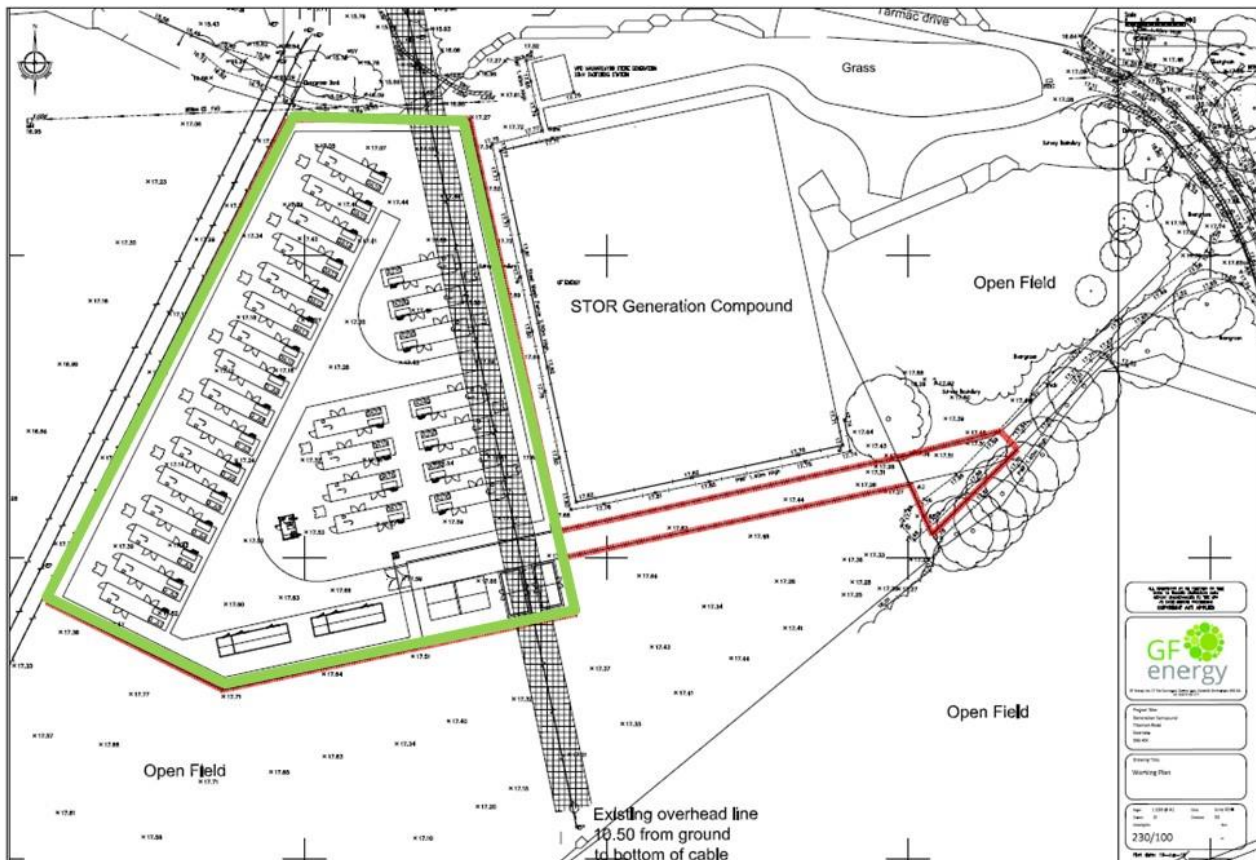
A location map showing the installation and its surroundings is displayed as Figure 2.1.

Figure 2.1 Location and Receptor Maps



The expected site layout is shown in Figure 2.2 and is also given in Appendix B

Figure 2.2 Site Layout



The proposed installation boundary is shown in green.

2.2 Permit Type

This document supports the application for a bespoke permit under EPR for a Part A(1) Energy Activity as described below.

Viridis proposes to install 27 gas fired spark ignition engines each with approximately 1.3MW export electrical output and a corresponding thermal input of 2.99MW_{th}, resulting in a total thermal input of 80.73MW_{th}. The engines will burn mains (natural) gas as the fuel with no backup fuel (gas oil) provided.

The proposed engines will fall under EPR as:

Part A(1) Combustion Activities

Part 2 of Schedule 1, Section 1.1 relates to Combustion Activities (i.e. those combustion activities that require permitting under the EPR). Section 1.1 Part A(1)(a) states:

- ▶ “Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.”

Further guidance on the definition of 50MW is provided in the regulations, as follows:

- ▶ “For the purpose of Part A(1)(a) of this Section, where 2 or more appliances with an aggregate rated thermal input of 50 megawatts or more are operated on the same site by the same operator those appliances must be treated as a single appliance with a rated thermal input of 50 megawatts or more.”

Appliances operated on the same site by the same operator must be aggregated. This aggregation rule also applies to the use of multiple small generating units where the thermal input exceeds 50MW. Current EPR Combustion Sector Guidance³ and the Regulatory Guidance Notes⁴ states that there is no de minimis threshold for excluding smaller combustion units, and units rated <3 MW_{th} and standby plant should be included in the aggregation. The sector guidance states that the thermal input threshold relates to gross rather than net calorific value of the fuels used.

It is important to note that the regulations make no distinction between standby plant and full time operating plant, the permitting requirement is linked to the rating only. Specific reference is made to the permitting of standby plant (i.e. operating hours of the plant are not relevant in determining the need for a permit).

The Industrial Emissions Directive (IED) covers large combustion plants under Schedule 15A, Regulation 35(2)(i) to the Directive, which states:

- ▶ 'A large combustion plant means a combustion plant with a total rated thermal input of 50 megawatts or more to which Chapter III of the Industrial Emissions Directive applies';

It is important to distinguish between a 'combustion plant' and a 'combustion installation' under the IED. A combustion plant is considered under the IED as being defined with the 'common stack' approach⁵ (i.e. that one chimney or stack, regardless of the number of flues contained therein, is one 'plant'). A combustion installation is a site on which there may be multiple combustion plants (i.e. stacks) for one industrial complex.

All EPR Part A(1) combustion activities (i.e. with a rated thermal input of >50MW_{th}) are subject also to the requirements of the IED. The only exception to this is if an installation, although above 50 MW_{th} rated thermal input when all the combustion units in are aggregated, is less than that figure when individual units of less than 15 MW are discounted⁶. In this case EPR would still apply but not the requirements of IED.

Proposed Medium Combustion Plant Directive

The proposed engines will each have an electrical output of 1.3MW and a thermal input of 2.99MW (gross), these engines are well below the threshold for large combustion plant unless aggregated. The proposed Medium Combustion Plant Directive (MCPD) has been developed to cover all combustion plant with thermal ratings between 1MW and 50MW and the emission limit values proposed within the MCPD are therefore appropriate to use for the engines at the proposed site, Although the site will be regulated as a Part A(1) activity.

2.3 Proposed Permit Activities

The proposed permit details are given in Table 2.1 below.

³ EPR 1.01 How to comply with your environmental permit. Additional guidance for Combustion Activities. Environment Agency, March 2009.

⁴ Regulatory Guidance Note 2 – Understanding the meaning of regulated facility, Environment Agency, March 2013

⁵ The aggregation rules for large combustion plants states that: 'Where the waste gases of two or more separate combustion plants are discharged through a common stack, the combination formed by such plants shall be considered as a single combustion plant and their capacities added for the purpose of calculating the total rated thermal input.'

⁶ The aggregation rules for large combustion plants states that: 'For the purpose of calculating the total rated thermal input of a combination of combustion plants referred to in paragraphs 1 and 2, individual combustion plants with a rated thermal input below 15 MW shall not be considered.'

Table 2.1 Viridis 178 Ltd Swansea – Proposed Permitted Installation Activities

Installation Reference Number	Installation Schedule 1 References	Description of the Activity
EPR-CP3630AJ	S1.1 A1 (a) - Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts	Operation of 27 gas fired spark ignition engines generating 34.7MW of electricity for export to the local distribution network with a combined thermal input of 80.73MW _{th} .

2.4 Type of Application

Based on the guidance given in the regulations and detailed in Sections 2.2 and 2.3 above, Viridis will apply for a bespoke installation permit to operate an Energy Activity.

2.5 Applicable Guidance

Table 2.2 identifies the main guidance considered to apply to the Environmental Permit application for SCA, including:

- ▶ European Commission Integrated Pollution Prevention and Control (IEPR) reference documents on best available techniques (BAT), known as “Bref Notes”;
- ▶ Department for the Environment, Food and Rural Affairs (Defra) guidance on the EPR Directive (2008/1/EC)⁷ 2010; and
- ▶ Environment Agency guidance on environmental permitting.

Table 2.2 Applicable Regulations and Guidance

Publisher / Document Type	Title	Version / Date
European Bref Notes	Integrated Pollution Prevention and Control Reference Document on Best Available Techniques For Large Combustion Plants	July 2006 (Revised draft June 2013)
	Medium Combustion Plant Directive	December 2013
Legislation / Defra	Environmental Permitting (England and Wales) Regulations 2010 (SI 2010 No. 675), as amended.	December 2013
	Environmental Permitting (England and Wales) Regulations 2010 (SI 2010 No. 675), as amended.	April 2010.
	Environmental Permitting (England and Wales)(Amendment) Regulations 2012 (SI 2012 No. 630)	April 2012.
	Environmental Permitting (England and Wales) (Amendment) 2013	February 2013.
	Environmental Permitting (England and Wales) Regulations 2013 (Amendment No. 2) (SI 2013 No. 766)	March 2013.
	Environmental Permitting (England and Wales) Regulations 2015 (SI 2015 No.918)	March 2015

⁷ Previously known as Directive 96/61/EC. Directive 2008/1/EC is a codified version of Directive 96/61/EC.

Publisher / Document Type	Title	Version / Date
	Environmental Permitting Guidance, Core Guidance, For the Environmental Permitting (England and Wales) Regulations 2010.	Version 5, 7 March 2013.
	Industrial Emissions Directive EPR Guidance on Part A Installations	February 2013.
Environment Agency	Regulatory guidance series RGS EPR 1: Understanding the meaning of operator.	Version 4.0, April 2010.
	Regulatory guidance series RGS EPR 2. Understanding the meaning of regulated facility.	Version 2.1, February 2012.
	Regulatory guidance series RGS EPR 4: Setting standards for environmental protection.	Version 3.0, November 2011.
	Regulatory Guidance Series RGS EPR 8: Changes in operation.	Version 3.0, March 2011.
	EPR 1.00: How to comply with your environmental permit.	Version 5.0, August 2012.
	EPR 1.01: How to comply with your environmental permit: Combustion Activities	March 2009.
	EPR H1: Environmental risk assessment for permits: Overview.	Version 2.1, April 2011.
	EPR H1: Environmental risk assessment for permits: Annex A - Amenity and accident risks from installations and waste operations.	Version 2.1, December 2011.
	EPR H1: Environmental risk assessment for permits: Annex F - Air emissions.	Version 2.2, December 2011.
	EPR H2: Energy Efficiency	Version 3, February 2002.
	EPR H3: Noise	Version 3, June 2004.
	EPR H4: Odour	Version 1, March 2011.
	EPR H5: Site Condition Report	Version 2, August 2008.
	Assessment of Monitoring Arrangements: Emissions to Air	Version 3 – January 2010
	Technical Guidance Note (Monitoring) M1: Sampling Requirements for Stack Emissions Monitoring	Version 6 – January 2010
	Technical Guidance Note (Monitoring) M2: Monitoring of Stack Emissions to Air	Version 6 – January 2010
		Version 8.1 – December 2011
	Technical Guidance Note (Monitoring) M18: Monitoring of discharges to water and sewer	Version 3 – May 2012
Other	British Standard BS 4142: 2014 'Rating industrial noise affecting mixed residential and industrial areas'	2014

2.6 Application Report Structure

The application process as prescribed by the NRW requires the completion of a number of forms; A, B2, B3 and F.

These require information on operator and technical issues for the application and the financial implications of the operator.

The nature of the information required for several sections of these forms means that a more comprehensive response in terms of detailed descriptions and assessments are needed than can be entered onto the forms. Therefore, in order to submit coherent and logical descriptions of the proposed variation to NRW, this report contains appropriate supporting information which provides responses to the following application form sections as shown in Table 2.3.

Table 2.3 Location of Information Required for Bespoke Installation Application Forms B2 and B3

Application Form Section	Where Addressed in this Report
Application for an Environmental Permit – Part – B2 – General – a bespoke permit EPC2 Version 4, October 2011)	
2. About your proposed changes	
2a Type of variation	Section 2.3
2b Proposed activities	Section 3, 4 and 5
3. Your Ability as an operator	
3d Management systems	Section 5.1
5. Supporting information	
5a Provide a plan for the site	Figure 2.2
5c Non-technical summary	Page i (before Contents)
6. Environmental risk assessment	Section 8 and H1 submission on cd version of application
Application for an Environmental Permit – Part – B3 – a bespoke permit EPC2 Version 4, October 2011)	
1. What activities are you applying for?	Sections 3 and 4
1a Types of activities	Sections 3 and 4
2. Emissions to air, water and land	Section 4.1
3. Operating techniques	Section 5
3a Technical standards	Section 2.5
3b General requirements	Sections 3 and 5
3c Types and amounts of raw materials	Section 5.2
4. Monitoring	Section 6
4a Measures for monitoring emissions	Section 6
4b Point source emissions to air	Section 4.1
6. Resource efficiency and climate change	Section 7
6a Described basic measures for improving energy efficiency	Section 7.1
6b Breakdown of changes to energy activities use	Section 7.1
6c Climate change levy agreement and improving energy efficiency	Section 7.1
6d Raw and other materials and water use	Section 5.2

Application Form Section	Where Addressed in this Report
6e How producing waste will be avoided	Section 5.3

2.7 Best Available Techniques

The over-riding principle under the EPR and EP regime is the use of Best Available Techniques (BAT) to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.

The term 'Best Available Techniques' is defined (using the definition in Article 2 of the IPPC Directive) as follows:

- ▶ **Best** means most effective in achieving a high general level of protection of the environment as a whole but not at a disproportionate cost;
- ▶ **Available** means those techniques that are developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, as long as they are reasonably accessible to the operator; and
- ▶ **Techniques** include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

The BAT principle takes into account the environmental benefits associated with a particular technique and also the financial costs of implementing such a technique. The cost-effectiveness of each measure is established to allow ranking and comparison to establish whether the BAT point is clearly identifiable.

As noted above, BAT is regarded as the techniques which will deliver the highest level of overall environmental protection, and are available to the relevant industrial sector, being able to be practically applied at a proportionate cost.

The Environment Agency/NRW has published guidance to allow operators to use a common approach to balancing these issues, called H1 guidance. Using this guidance and the associated software tools, an evaluation can be made of the environmental impact from a particular activity and an assessment made of the relative merits of different techniques to address a particular issue, most frequently how to effectively minimise emissions.

BAT will be considered throughout this application; at a high level in terms of determining the technology to be implemented, at an operational level addressing the techniques and technology to be used on the installation and at a procedural level detailing how the site will be managed and how management arrangements are to be applied for environmental protection.

3. About the Proposed Development

Viridis has a contract to supply electrical power via the recent capacity mechanism auction. These plants will operate on a short-term basis meeting peak capacity shortfalls within the electrical distribution network. They are expected to operate for 1000 – 1500 hours per years, typically some 1250 hours per year, but when called by the National Grid, they have to reach maximum power output within 2 minutes and supply electricity for the duration of the call period. Typically a call period are less than an hour, but on occasion for up to 5 hours, normally between the hours of 7am and 9 pm.

Viridis proposes to install twenty seven gas fired spark ignition engines each with approximately 1.3MW export electrical output (~2.99MWth). Engines offer a number of advantages over other combustion techniques for this type of application including short duration to full power output, high levels of availability, reliability, high generation efficiency and the possibility to match the electrical requirements with the number of operational engines.

3.1 Description of the Proposed Development

The proposed Viridis power plant at the Westfield Industrial Estate, Timet, will be operated and managed by Viridis. The proposal will be to install and operate up to 27 engines each with an electrical generation capacity of approximately 1.3MW. The engines will operate on natural (mains) gas burning 367 m³/h of gas per engine. The total thermal input will be 80.73MW, equivalent to 8,560 m³/h of gas consumed, with a combined electrical export of 34.7MW. The engines will provide a high level of availability and reliability, with a rapid response from cold to full power, as required by the electrical supply contract. Any maintenance will be carried out during periods outside of the call-off contract or Viridis will declare the site unavailable for the duration of the maintenance.

3.2 Engines

The power plant will be commissioned during 2016 and will consist of two phases of development, one of 14 and one of 13 Jenbacher J420 engines, or similar, resulting in a total installed capacity of approximately 80.73MW thermal input. Each engine will burn natural gas, which will be transported to site via underground HDPE pipes from the local gas distribution system with the resultant electricity being exported via a transformer to the main electrical distribution grid.

The engines will operate on the principle of lean-burn combustion as that offers a combination of high power, high efficiency and reduced exhaust emissions. This will be achieved through the controlled combustion of a homogenous and lean mixture of gas and air in a compact combustion chamber. The gas feed pressure can be varied to keep the energy supply to the engines constant. To improve the performance of the engines a turbo charger and associated items of equipment will be used to boost the air pressure, hence allowing more fuel to be used and increasing power outputs.

The engine will burn natural gas and the calculation of the natural gas consumption uses the electrical output of the engine and the quoted electrical efficiency. These two parameters allow an energy requirement in terms of kW thermal input to be calculated. From "Technical data on fuel: Engineering for energy: 7th edition: 1977, R W Rose - Table 5.15 Properties of Typical Gaseous Fuels" 1m³ of natural gas has a calorific value of 30 – 38 MJ/m³ (net value) (1 MW = 1 MJ/s). Dividing the energy requirement of the engine per second by the calorific value, and applying appropriate unit conversions, produces the gas requirement/consumption in terms of cubic metres per second. Once operational the installed gas meter can be used to verify the thermal input of the site.

Each engine will be connected to an electrical generator with a design electrical gross output of approximately 1.3 MW. Each unit will also have an air blast cooler, silencer and stack mounted on top of the engine container. The containers will be designed to minimise the noise levels emitted by the engines.

A simplified diagram of the engine is shown in Figure 3.1 and a photograph of a similar engine to those being proposed is shown in Figure 3.2.

Figure 3.1 Engine Generating Set

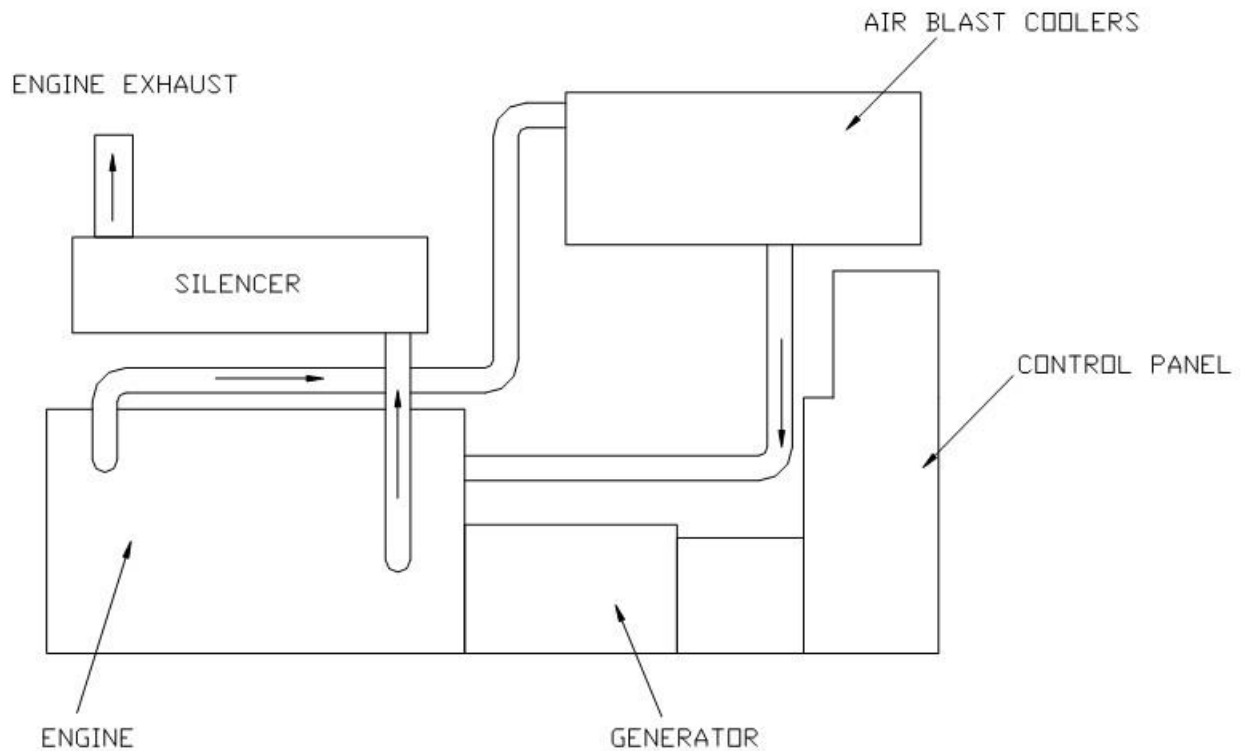


Figure 3.2 Photograph of the Proposed Engine Generating Set



To control the combustion within the engine an electronic engine management system will be used. The key parameters recorded by the control systems that will be used to manage the operation of the power plant (and hence can be considered to be surrogate environmental monitors) are summarised below:

- ▶ Natural gas flow,
- ▶ Gas pressures,
- ▶ Cylinder temperatures and pressures, and
- ▶ Oil temperature and pressures.

These measurements will be used by the engine management system to adjust the engine ignition timing, air flow from the turbocharger and temperatures in the system. The engine management system can be set to achieve maximum power or to operate in lean burn mode reducing emissions. Viridis will operate the engines in lean burn mode reducing emissions of oxides of nitrogen. If any of the measured process parameters exceed levels specified in the process control manuals, alarms will be raised and the operators informed. In a serious fault condition (low pressure, electrical distribution failure, etc.) the plant will shut down to prevent uncontrolled emissions. For less serious fault conditions, once the fault is cleared, the engines may automatically restart. If the alarm is raised during periods when the site is unmanned, the automatic telemetry will contact the operators to inform them of the fault condition and operators will aim to attend site within 2 hours of notification.

During start-up and shut down the process emissions may change. However, the time taken for the plant condition to change will be relatively short and any peak emissions will be also short term. Typically, the engine will take less than 2 minutes to reach operating conditions from a cold start, the electrical supply contract requires a 2 minute delay between the call and power being exported.

Viridis considered other types of combustion sources prior to selecting the engines, the Table 3.1 below summaries the advantages for each type of generator and the reason for the final selection. The contract for the National Grid required that from the call to full generation output is achieved within a 2 minute period that requirement means that the three potential options for the site are open cycle gas turbine and reciprocating engines, the engines achieve higher electrical efficiencies and the gas fired engine doesn't require onsite fuel storage and is therefore considered to be the best option for this duty.

Table 3.1 Generator Options

Parameter	Steam Turbine – Coal/oil/biomass	Steam Turbine - Gas	Gas Turbine – open cycle	Gas Turbine – combined Cycle	Reciprocating Engines - gas	Reciprocating Engines - oil
Size of single unit	Medium to Large	Medium to Large	Small to Medium	Medium to Large	Small to Medium	Small to Medium
Energy Efficiency • Electrical Efficiency	25-35%	25-35%	20-25%	45 – 65%	40 – 45%	35-45%
Load Matching	Medium	Medium	Good with multiple units	Medium	Good with multiple units	Good with multiple units
Speed to full output	Slow	Slow	Fast	Medium to slow	Very Fast	Very fast
Operational Experience	Well documented	Well documented	Well documented	Well documented	Well documented	Well documented
Reliability / maintenance	Good	Good	Good	Good	Good	Good
Fuel Storage	Large on-site storage required	None	None	None	None	Large on-site Storage required
Overall site specific BAT compliance	Low	Low	Medium	Low	High	High

4. Emissions to Air, Water and Land

This section describes how the release of any substances from the proposed power plant that might cause harm will be prevented or reduced to achieve a high level of protection to the environment. The system overall is designed to:

- ▶ Comply with the environmental standards and regulations;
- ▶ Maximise the protection of the environment, by preventing and reducing releases to a practical minimum; and
- ▶ Be adaptable to changes or evolution in environmental standards within the constraints of the operational profile.

Throughout the text, specific reference is made where abatement or control measures may be affected by normal and abnormal operation, specifically the effects of starting and stopping the plant. However, the whole plant is designed to be started quickly and achieve stable operation within a few minutes and once stopped the emissions will immediately cease. Within both the control systems and operational activities, provision is made for abnormal shutdowns, but these are not envisaged to take place frequently.

There are no significant point source releases to water or sewer from the power plant, (only a minor releases during maintenance activities that will be discharged to sewer or removed from site by the maintenance team or a licensed contractor.) and, therefore, comparison with BAT is not considered to be appropriate.

The potentially significant point sources releases from the power plant are primarily to air. This section provides the following information on all of the emissions from the proposed site.

- ▶ Point source emissions to air;
- ▶ Point source emissions to surface water and sewer;
- ▶ Point source emissions to groundwater;
- ▶ Fugitive emissions to air;
- ▶ Fugitive emissions to surface water and sewer;
- ▶ Fugitive emissions to groundwater; and
- ▶ Odour.

4.1 Point Source Emissions to Air

The only point source emissions to air from the Viridis power plant arise from the combustion of mains gas in the engines. The proposed engines will consume approximately 8,560 m³ of mains gas per hour when operational. Each of the proposed engines will have the capability to consume approximately 317 m³ of mains gas per hour.

All 27 of the proposed spark ignition gas engines are of same design and specification and are similar to those to be used on other sites to be operated by Viridis for power generation. These engines will provide the following key features:

- ▶ Mechanisms to control the combustion processes within the engine(s);
- ▶ Key parameters will be recorded by the engine management system of the generating plant; and
- ▶ An automated response of the mains gas generating plant to address serious fault conditions.

Details of the point source emissions to air arising from the proposed installation of the spark ignition gas engines at the Viridis power plant are provided in Tables 4.1 and 4.2 below. A comparison of the proposed operational measures with the indicative BAT requirements for point source emissions to air is provided in Table 4.3.

Table 4.1 Point Source Emissions to Air

Emission point number	Location	Nature of emissions	Further consideration?
A1 to A28	Jenbacher J420 Engine No. 1 to 27	NO _x , CO ₂ , CO	✓

Table 4.2 Point Source Emissions to Air Considered Further

Release Point	Type	Location	Effective height M	Efflux velocity m/s	Total Flow		Temp °C
					m ³ /hr (actual conditions)	Nm ³ /hr (at reference conditions)	
A1 to A28	Point Source	On Engine Containers (1 to 27)	7.2	38.0	9,684	11,070	450

The point source releases to air are shown in Figure 4.1 (see Appendix B).

It is proposed that the exhausts from all of the engines will discharge vertically via individual stacks (7.2m) on the top of each engine container.

The plant will generate electricity under the Capacity Mechanism to meet peaks in power demand on the National Grid. This will be one of several such facilities operated by Viridis in the UK. On average, the plant will operate for a maximum of 5 hours per day at peak times, sometimes much shorter durations, and for some 1000 - 1500 hours per year (based on historical data and projections from DECC the average maximum operation would be 1250 hours per year). They will not necessarily operate every day.

The volume flow rates for the engines are calculated from the inlet gas quality, the electrical generation, engine efficiency and exhaust temperature. These calculations are based on information given in the NRW Guidance on monitoring protocols, the manufacturers data and are summarised below.

The electrical output (kW_e) is divided by the generation efficiency (%) to calculate the thermal input required by the engine (kW_{th}).

Using the calorific value of mains gas (MJ m⁻³), the amount of gas required per second to provide the thermal input can be calculated (m³ s⁻¹).

To calculate the exhaust gas flow rate, the stoichiometric theoretical waste gas volume (m³ m⁻³) for mains gas is multiplied by the mains gas feed rate (m³ s⁻¹) resulting in the exhaust gas volume (Nm³ s⁻¹) at 0% oxygen content, dry gas and 288K.

Using the equations given in Environment Agency technical guidance note M2 this exhaust gas volume is corrected to reference conditions (m³ s⁻¹) then multiplied by the emission limit value (mg m⁻³) to produce a pollutant mass emission release rate (g/s) required by the air dispersion model.

The exhaust gas volume flow rate (Nm³ s⁻¹) is then corrected using the same equations to actual exhaust conditions (Am³ s⁻¹). Dividing this parameter by the cross-sectional area of the discharge point (m²) provides the actual efflux velocity (m s⁻¹).

The reference conditions quoted in the table are 273 K, 101.3 kPa, 15% oxygen content for the engines, based on the emission limit values and assumptions given in the proposed Medium Combustion Plant Directive.

Benchmark Emissions to Air

The proposed process at Viridis's power plant involves the combustion of mains gas; this is a standard fossil fuel of known combustion and emission characteristics. It is expected that the main emissions to air from the generating plant will include:

- ▶ Oxides of nitrogen;
- ▶ Carbon dioxide;
- ▶ Carbon monoxide; and
- ▶ Methane.

Other emissions will be nitrogen and water vapour. The process will have a total thermal input of approximately 80.73MW_{th} based on and all 27 engines operating with an electrical efficiency of ~43%. Viridis is committed to monitoring its pollutant releases and has an appropriate management structure in place to ensure monitoring is effectively carried out on a representative number of engines and reported to the NRW. Table 4.3 below gives the proposed benchmark values for the proposed spark ignition engines within the power plant compound. As the engines will have thermal inputs of approximately 2.99MW it is proposed to use the benchmark emission limit values that are included in the proposed MCPD for these engines. The MCPD is intended for small thermal input engines and is appropriate for the engines on this installation operating within the capacity mechanism.

Table 4.3 Benchmarks for Releases to Air for the Proposed Spark Ignition Engines

Pollutant	Release Point	Proposed Benchmark mg m-3
Oxides of nitrogen	Stack A1 to A27	190 (506)
Carbon monoxide	Stack A1 to A27	375 (1000)
Note: All emission concentrations are quoted at reference conditions of 273 K, 101.3 kPa, 15 % oxygen content and dry gas, the figure in brackets is the equivalent concentration at 5% reference oxygen content.		

Table 4.4 gives the expected inventory of releases to air for the Viridis Power Plant based on the engine emissions being at the limit values given in Table 4.3.

Table 4.4 Inventory of Releases to Air (based on Emission Limit Values)

Release Point number	Substance	Emissions ⁽¹⁾			Continuous (C), or intermittent (I) (%)	Calculated (C), measured (M), or estimated (E)	Comments: Current release, variability, EQS / benchmark
		m ³ /hr	mg/m ³	tonnes/year ^(2,3)			
Engine Stack A1 to A27	NO _x	11,070	190	2.39	I (<14%)	C	The values given here are for engines operating at the emission limit values.
	CO	11,070	375	4.73	I (<14%)	C	As above
	CO ₂	11,070	53,320	672	I (<14%)	C	Calculated based of combustion efficiency

Note 1 At reference conditions of 273K, 101.3kPa, 15% oxygen content and dry gas for the engines and 273K, 101.3kPa.

Note 2 Figures are calculated based on the engines operating for 1250 hours per year with the engine operating at the limit values.

Note 3 Per Engine

Following discussions with NRW at the pre-application meeting the emissions of NO_x was identified as the pollutant of primary concern, the following section, the following sections describes the formation of NO_x and possible reduction options.

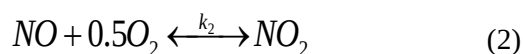
NO_x in Combustion Processes

There are three recognised mechanisms leading to the formation of NO_x during combustion:

- ▶ **Fuel-NO_x** – formed from the oxidation of chemically bound nitrogen in the combusted material;
- ▶ **Prompt-NO_x** – formed very quickly as a result of the interaction of nitrogen and oxygen with some of the active carbon species derived from the fuel in the flame; and
- ▶ **Thermal-NO_x** – formed from the disassociation of atmospheric oxygen and nitrogen at high temperature (> 1000°C).

Of the three mechanisms, fuel-NO_x and thermal-NO_x are the most important in most combustion applications.

The most important reactions for producing NO and NO₂ in flames are:



Equilibrium reaction constants for the formation of NO and NO₂ by reactions (1) and (2) at varying temperatures are given in Table 4.5.

Table 4.5 Equilibrium Constants for the Formation of NO and NO₂ at Different Temperatures

Temperature (K)	k ₁ (dimensionless)	k ₂ (atm ^{-1/2})
300	7x10 ⁻³¹	1.4x10 ⁶
500	2.7x10 ⁻¹⁸	4.9
1000	7.5x10 ⁻⁹	0.11
1500	1.07x10 ⁻⁵	0.011
2000	4x10 ⁻⁴	3.5x10 ⁻³
2500	3.5x10 ⁻³	1.8x10 ⁻³

The subsequent equilibrium concentrations of NO and NO₂ can be obtained from:

$$[NO] = (k_1 [N_2] [O_2])^{0.5} \quad (3)$$

$$[NO_2] = k_2 [N_2] [O_2]^{0.5} \quad (4)$$

Substituting the values of k₁ and k₂ from Table 4.5, and utilising equations (3) and (4), Table 4.6 details the equilibrium concentrations of NO and NO₂ at varying temperatures and varying starting oxygen and nitrogen ratios.

Table 4.6 Equilibrium Constants for the Formation of NO and NO₂ at Different Temperatures

Temperature (K)	[NO] (ppm)		[NO ₂] (ppm)	
	78% N ₂ , 21% O ₂	78% N ₂ , 4% O ₂	78% N ₂ , 21% O ₂	78% N ₂ , 4% O ₂
300	3.4x10 ⁻¹⁰	1.5x10 ⁻¹⁰	2.2x10 ⁻⁴	9.5x10 ⁻⁵
500	6.7x10 ⁻⁴	2.9x10 ⁻⁴	1.5x10 ⁻³	6.5x10 ⁻⁴
1000	35	15	2	1
1500	1324	578	7	3
2000	8094	3533	13	6
2500	23944	10450	20	9

Analysing Table 4.6, it becomes evident that:

- ▶ NO becomes the predominant component of NO_x at temperatures greater than 500K;
- ▶ Concentrations of NO_x increase exponentially with increasing combustion temperature; and
- ▶ For a given temperature, concentrations of NO_x increase as a square root function of the oxygen content in the combustion atmosphere.

These observations are explained by the *Zeldovich* mechanism. This mechanism also dictates that NO_x formation increases linearly with the residence time at high temperature. Thus, NO_x formation is increased with:

- ▶ Flame temperature;
- ▶ Residence time at high temperature; and
- ▶ Oxygen content at high temperature.

Thus, engine manufacturers will seek to reduce each of these in order to reduce NO_x formation. The modification of the combustion process to reduce NO_x formation in this way is termed primary reduction. Alternatively, post combustion clean-up of the exhaust gases may be utilised to reduce NO_x emissions; these are termed secondary reduction methods. Emission control methods using each of these approaches are described in the following sections.

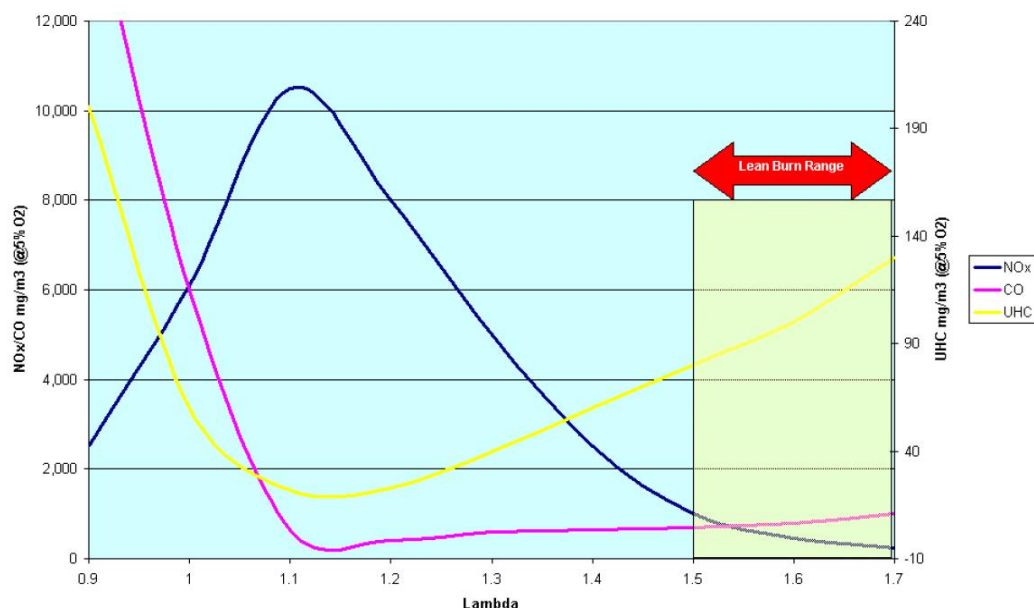
Primary Reduction Methods

Lean Burn Operation

An effective method of reducing NO_x emissions from a gas engine is the lean burn concept. High temperature combustion with high oxygen availability promotes NO_x formation. Operating a lean combustion mixture, with a low fuel-air ratio and excess air in the combustion chamber, helps to reduce peak flame temperature and, thus, reduces NO_x formation.

Engine manufacturers express the ratio of air to fuel in the combustion chamber as lambda (λ), with a λ value of 1.0 representing stoichiometric conditions. Values less than 1.0 represent a rich mixture with more fuel than air, whilst values greater than 1.0 represent a lean mixture with more air than fuel. Historically, engine manufacturers have preferred to operate near to stoichiometric conditions, with a λ value slightly less than 1.0, as this deters knock (premature combustion), reduces thermal stress and improves combustion efficiency. However, flame temperatures are greatest under stoichiometric operation and NO_x formation is at its highest under these conditions. As λ values increase above 1.1, NO_x emissions decrease (Figure 4.1).

Figure 4.1 Effect of Air to Fuel Ratio (Lamda) on Emissions from Gas Engines



However, lean burn operation is not without detriment; combustion efficiency is reduced and lean burn combustion is relatively unstable and may result in misfire.

The proposed spark ignition engines forming the Viridis Plant will operate in a lean burn regime and, are therefore considered to be BAT for the control of combustion generated NO_x.

Engine Tuning

As stated above, NO_x concentrations produced from combustion processes are dependent upon a number of factors. However, for gas engines, one of the key criteria is ignition timing angle, or the number of degrees before top dead centre (BTDC) at which ignition occurs. Generally, engines are tuned to produce the highest efficiency possible as this has the greatest impact in respect of carbon dioxide (CO₂) reductions. However, this is at the expense of higher NO_x concentrations.

In general, decreasing the timing angle reduces NO_x emissions. However, decreasing the timing angle also reduces efficiency and increases the concentrations of carbon monoxide (CO) and unburnt hydrocarbons (HC) in the exhaust gas. In addition, detuning can cause engine operational issues and may invalidate the engine manufacturer's warranty.

The reduction in efficiency following detuning of engines to reduce NO_x concentrations in the exhaust gas is manifested as an increase in fuel consumption. Typically, for every 250 mg Nm⁻³ (@ 5% O₂ content) reduction in NO_x concentration, a 1-2% increase in fuel consumption results. However, for some engines this may be as high as 2-3% (Environment Agency, 2005). The engines proposed for this site will comply with the proposed emission limit values given in the MCPD.

As detuning the engines may increase CO emissions to a level where they too may require additional reduction and reduce the available power output, thereby increasing the number of engines required, this method is not considered to be BAT to ensure compliance with the expected permit NO_x emission limit values.

Engine Management Systems

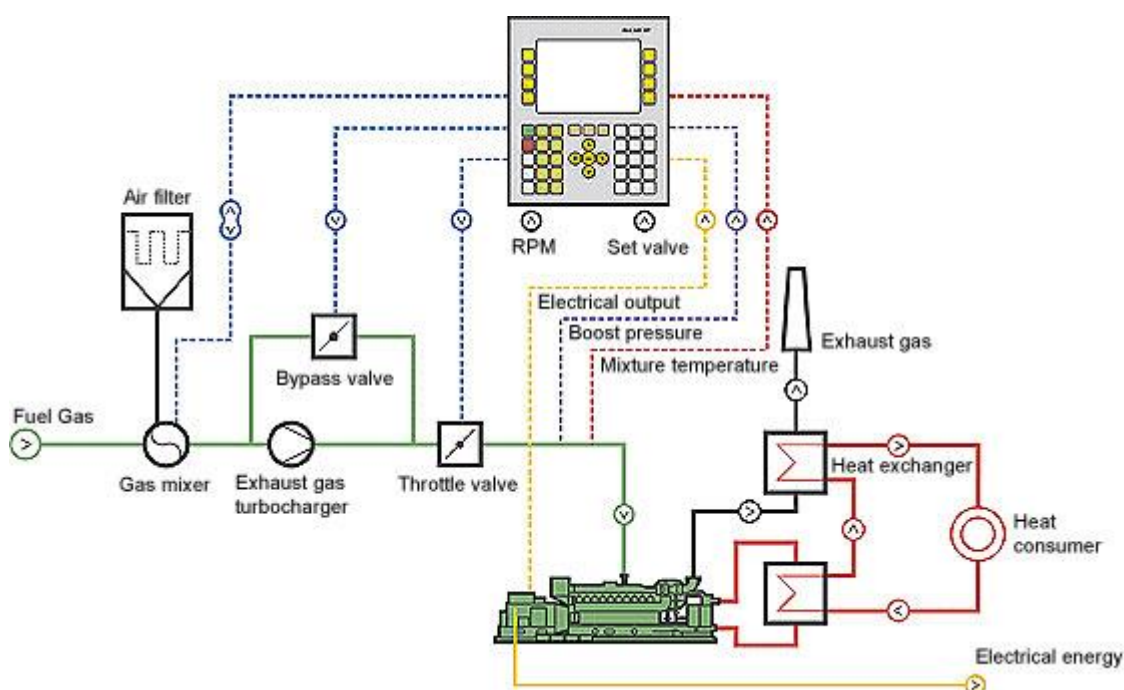
Modern gas engines come equipped with electronic engine management systems to continuously control and balance the combustion process. Continuous, computer controlled adjustment of parameters such as ignition timing and airflow from the turbocharger is achieved by the installation of analogue or digital transducers at key locations within the engine and sampling of key parameters typically takes place every 50

ms. The operator can adjust the engine management system to produce specific operating conditions. A schematic of a typical engine management system is depicted as Figure 4.2.

The operating conditions chosen through an engine management system must achieve the balance between greater efficiency and NO_x production. Engine management system on modern spark ignition engines can typically be set to operate with NO_x emissions of 190 mg/Nm^3 (@ 15% O_2), { $\sim 500 \text{ mg/Nm}^3$ (@ 5% O_2) } and therefore be compliant with the emission limit values given in the MCPD.

The spark ignition engine forming the Viridis power plant will be modern variant with sophisticated controls for managing engine performance (fuel/air ratio, ignition timing etc.). Configuring this system to produce a NO_x output corresponding to 190 mg/Nm^3 will ensure compliance with the expected permit NO_x emission limit values.

Figure 4.2 Typical Engine Management System Schematic on Modern Gas Engines



Exhaust Gas Recirculation (EGR)

Exhaust gas recirculation (EGR) is an effective method in controlling NO_x emissions. By recirculating exhaust gas into the air inlet, more inert mixture is fed into the engine which reduces peak flame temperatures and NO_x formation. However, this also reduces engine output and combustion efficiency.

Recirculating 5-10% of the exhaust gas into the air inlet can reduce NO_x emissions by 15-45%. However, this method of NO_x control is not recommended for lean burn engines as EGR reduces full load efficiency and reduces the lean combustion limit (Environment Agency, 2005). Consequently, EGR is not considered to be BAT for ensuring compliance with the expected permit NO_x emission limit value at this site.

Water Injection (WI)

Injection of de-ionised water before the main combustion chamber is a proven technique to control NO_x emissions in large industrial and marine diesel engines. Water may be introduced directly into the cylinders by separate injection or by humidification of the charge air. The effect of both types of treatment is to reduce peak flame temperature and this can reduce NO_x output by 20-60%.

A specialist water purification plant is required for this option since the injected water must be free from any material which may cause corrosion or abrasion of the internal engine structure. In addition, rusting of

components, owing to residual free water when the engine is shutdown, is also a possibility. The mass ratio of water to fuel is generally in the region of 0.8-1.0. Thus, water usage becomes a significant operating cost.

Water injection is also considered a proven technique in reducing NO_x output from reciprocating engines. However, as stated in Environment Agency (2005):

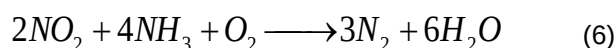
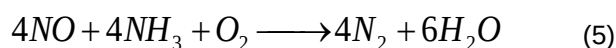
“The use of these types of techniques is, however, limited to CI engines⁸ and also by numerous problems which make their introduction impractical in most circumstances”.

Consequently, WI is not considered to be BAT for ensuring compliance with the expected permit NO_x emission limit values for this proposed site.

Secondary NO_x Reduction Measures

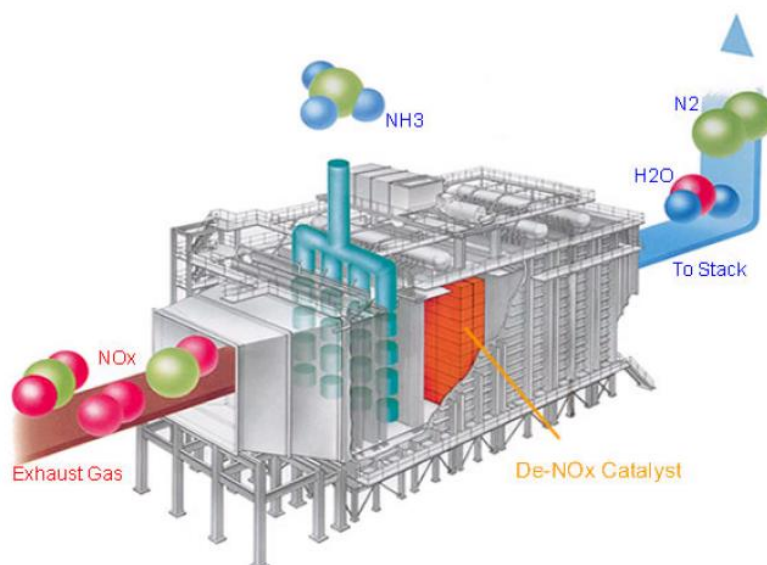
Selective Catalytic Reduction (SCR)

Selective Catalytic Reduction (SCR) is a process by which NO_x is removed from the exhaust gases following combustion. SCR operates by injecting ammonia (NH₃), or high purity urea, into the exhaust gas stream. The NH₃ is adsorbed on to the surface of a catalyst (typically containing copper or titanium compounds) and reactions on the catalyst surface reduce NO_x to molecular nitrogen (N₂):



SCR processes can typically achieve NO_x reductions of 80-90%. Figure 4.3 provides a schematic of the SCR process.

Figure 4.3 SCR Process Schematic



The SCR catalyst operates in an ideal temperature band (200-500°C) and its location within the overall combustion process is, therefore, of crucial importance. This can make SCR difficult to retrofit to existing

⁸ Compression ignition engines

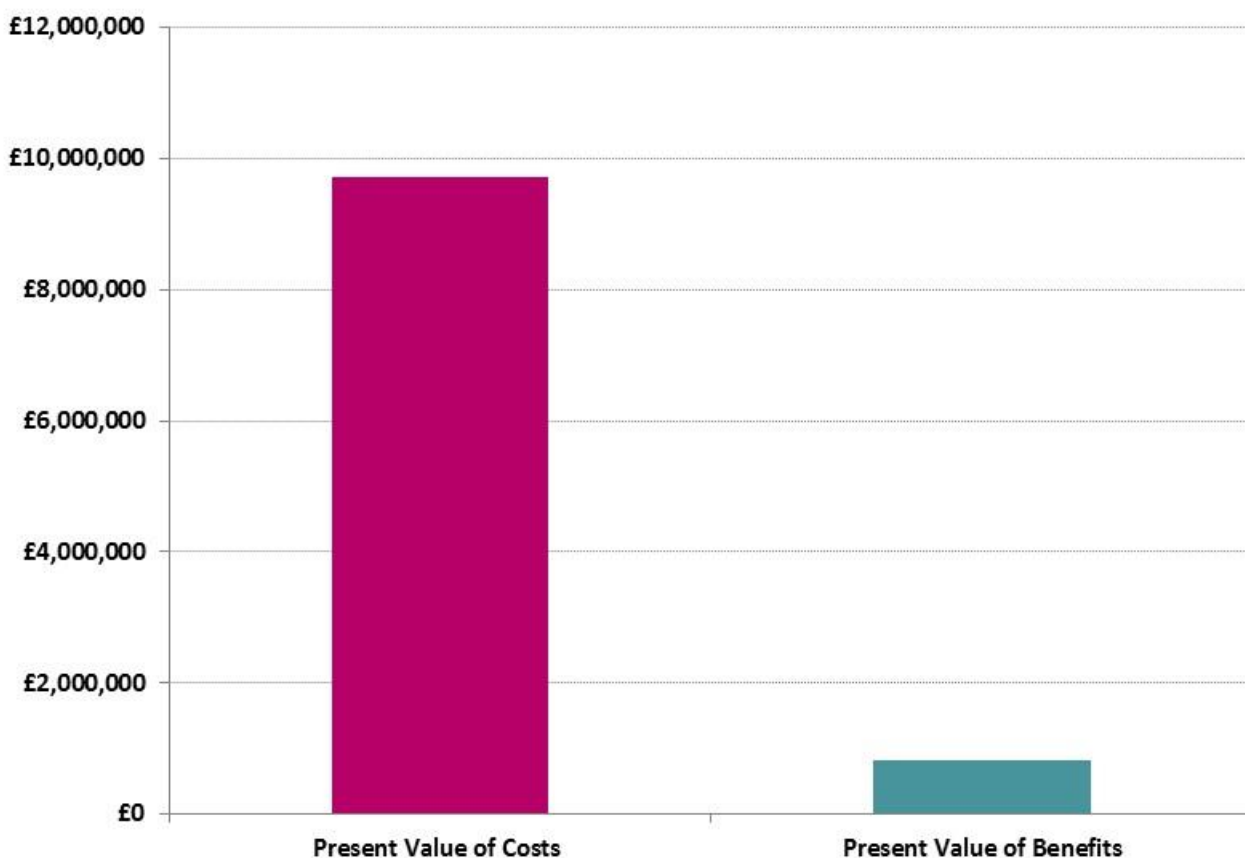
applications. The catalyst is also very sensitive to sulphur concentrations within the exhaust gas; the sulphur can react directly with the catalyst reducing its NO_x reduction efficiency and ammonia and sulphurous compounds can react to produce ammonium sulphate particles, which can build up on the surface of the catalyst and result in catalyst deactivation.

Not all NH₃ is used in the reduction process; some passes through the catalyst and is emitted directly to atmosphere. This process is known as ammonia slip and may result in environmental hazards if feedback mechanisms are not in place to prevent the overdosing of NH₃ during the SCR process.

The installation and operation of an SCR plant is at significant economic cost. Initial capital costs in the form of an ammonia storage installation, dosing system, NO_x monitoring and civil works, and operational costs associated with ammonia usage and catalyst replacement may prove prohibitive in certain situations.

Until recently, the use of SCR on spark ignition engines had not been widely practiced or marketed on a large scale commercial basis. Engine manufacturers and distributors such as Caterpillar and Clarke Energy have since introduced their SCR technology to the UK gas engine market. Environment Agency guidance (Environment Agency, 2005) provides indicative capital and operating costs for SCR installed on combustion processes. For a process capacity of less than 40 MW_e, the indicative capital cost for a SCR process is 125 £ kW_e⁻¹ with an operating cost of 0.0022 £ kWh⁻¹. For the spark ignition engines proposed, the indicative cost of installing an SCR unit would have an associated CAPEX of £4,625,000 (based on an electrical output of ~40,000 kW_e) and an annual OPEX of £79,200 (based on 14% annual availability i.e. 1250 hours per year), every 5 year the catalyst will require replacement at a cost of £2,313,000 per replacement. Based on removing 90% of the NO_x, this is an overestimate as the SCR system will only start operating once the system and, in particular, the catalyst in the SCR system is at temperature, which take approximately 30 minutes, the reduction will be 65 tonnes of NO_x per year. Assuming a 15 year operational life, a discount factor of 3.5% (HM Treasury Green Book) and the damage cost £955/tonne of NO_x 2010 base year (Valuing impacts on air quality: Supplementary Green Book, May 2013) Figure 4.4 shows the present value cost and present value benefits from installing SCR abatement on the Viridis Power Plant over the 15 year expected life.

Figure 4.4 Costs and Benefits of Installation SCR on the Capacity Mechanism Power Plant Spark Ignition Engines

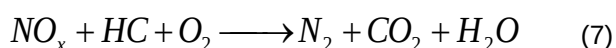


However, these costs are exclusive of any civils work.

These costs are, therefore, prohibitive and it is not considered commercially feasible or BAT to install SCR for the small reduction in NO_x emissions over the design life of the plant.

Non-Selective Catalytic Reduction (NSCR)

Non-Selective Catalytic Reduction (NSCR) uses a precious metal catalyst (typically platinum/rhodium) without injected reagents to reduce NO_x emissions in an exhaust gas stream. This process is also highly effective at reducing HC and CO emissions. NSCR is commonly referred to as a three way converter and is similar to catalytic converters found on motor vehicles. The process targets the reduction of NO_x, CO and HC through the following reactions:



NSCR removal efficiencies for NO_x can be greater than 90%. However, NSCR is only effective under stoichiometric or fuel-rich combustion conditions where the combustion gas is nearly depleted of oxygen. This factor makes NSCR unsuitable for lean burn applications. Consequently, NSCR is not considered BAT for ensuring compliance with the compliance with the expected emission limit values.

Lean NO_x Trap (LNT) Catalysis

To overcome the limitations of NSCR in lean burn conditions, lean NO_x trap (LNT) catalysis (also referred to as NO_x adsorber catalysis) has been successfully applied to diesel reciprocating engines and natural gas turbines and, on these applications, has demonstrated NO_x reductions > 90%.

Lean NO_x traps operate by storing NO_x on the catalyst under lean exhaust conditions and then releasing and reducing the NO_x to N₂ under rich conditions. The lean and rich modes of operation are termed sorption and regeneration stages, respectively.

In order to obtain the rich conditions required during the regeneration stage, the excess oxygen in the exhaust must be combusted by injecting fuel into the exhaust system upstream of the NO_x trap and catalytically combusting the fuel and oxygen. Minimising fuel use during the regeneration stage is important since the fuel used during the regeneration process provides no useful energy and, thus, represents a fuel penalty to the engine operator.

Parks et al. (2004) conducted studies to investigate the feasibility of installing LNT catalysis to reduce NO_x output from natural gas engines. They concluded that LNT catalysis can achieve high (> 90%) NO_x reduction efficiencies in exhaust from lean burn natural gas engines when natural gas is used as the source for regeneration of the NO_x trap. Fuel penalties in the order of 1-5% were observed but these were dependent upon system geometry and catalyst volume. Optimum performance of LNT catalysis during these trials was limited to a narrow temperature range of 450-550°C, with temperatures below this suffering from poor methane oxidation and temperatures above this suffering from reduced storage capacity of the NO_x trap.

As LNT is still an emerging technique for natural gas engine applications, and as there are very few, if any, suppliers that offer this technology to the UK market, it would be difficult to advocate this option as BAT.

Improved Dispersion Characteristics

The ground level concentration of pollutants emitted from a stack is a function of many individual variables but these can be summarised into three main components:

- ▶ Pollutant mass emission rate;
- ▶ The dispersal efficiency of the atmosphere, primarily governed by wind speed and the degree of atmospheric turbulence; and
- ▶ The dispersal characteristics of the stack release, primarily governed by efflux velocity, efflux temperature and physical stack height.

The ground level concentration of pollutants emitted from a stack is inversely proportional to the physical height of the stack and the degree of plume rise following stack release, with the degree of plume rise being directly proportional to two parameters known as the buoyancy flux and momentum flux of the release. Buoyancy flux is primarily related to the efflux temperature, with a high temperature release having a greater buoyancy flux than a low temperature release, whilst momentum flux is primarily related to the vertical velocity of the release, with a release having a high vertical efflux velocity experiencing a greater momentum flux than that of a release with a low vertical efflux velocity. Thus, it follows that, for a constant mass release rate and for an atmosphere with a specific dispersal efficiency, increasing the efflux temperature or vertical efflux velocity will result in a reduction in ground level concentration.

However, improved dispersion characteristics would not reduce the stack emission concentrations the impacts of the emissions are included in the H1 impact assessment using detailed dispersion modelling.

BAT Abatement Options Summary

Table 4.7 summarises the options identified in the sections above for reducing NO_x and CO emissions, and assesses whether each option is feasible for the Viridis Power Plant.

Table 4.7 Options Screening for Viridis Power Plant

Option	Feasible? (Yes/No)	Reason Not Considered Feasible
PRIMARY REDUCTION METHODS		
Lean Burn Operation	Yes	The engines forming the Viridis Power plant already operate in a lean burn combustion regime
Engine Tuning	Yes	The proposed engines will have the engines tuned to achieve the best compromise between emissions and efficiency and further tuning is not BAT
Engine Management System	Yes	The engines forming the Viridis Power Plant will have engine management systems installed.
Exhaust Gas Recirculation (EGR)	No	EGR is not appropriate for lean burn gas engines as this reduces full load efficiency and reduces the lean combustion limit
Water Injection (WI)	No	Water injection for gas engine applications is limited to compression ignition variants only, not spark ignition
SECONDARY REDUCTION METHODS		
Selective Catalytic Reduction (SCR)	No	Prohibitive financial costs will mean that this option is not commercially viable
Non Selective Catalytic Reduction (NSCR)	No	NSCR is only effective under stoichiometric or fuel-rich combustion conditions where the combustion gas is nearly depleted of oxygen. This makes it unsuitable for the lean burn gas engines forming the Viridis Power Plant
Lean NO_x Trap Catalysis (LNT)	No	LNT is still an emerging technique for natural gas engine applications and there are very few, if any, suppliers that offer this technology to the UK market. Thus, it would be difficult to advocate this option as BAT

The comparison against typical BAT requirements is shown in Table 4.8 below.

Table 4.8 Typical BAT for Point Source Emissions to Air

BAT Requirement	Gas Generation Compound Activity
The main chemical constituents for all emissions should be identified.	The precise composition of the exhaust gases from release points A1 to A27 is unknown, but typically will contain NO _x , CO ₂ , CO, O ₂ , N ₂ and VOCs (methane). Monitoring of the emissions from a representative sample of the proposed engine will be undertaken annually.
The dispersion capability of vent and chimney heights should be assessed and an assessment made of the fate of the substances emitted to the environment.	See Appendix E on H1 assessment and Appendix A for full Air Quality Assessment report.
Visible emissions and water vapour plumes should be avoided.	None of the emissions from additional release point A1 to A27 will be visible. The proposed engines will operate on mains gas that is considered to provide clean combustion and is considered to have negligible releases of smoke and particulate matter to the environment.
The emissions benchmarks in the relevant activity-specific guidance describe levels that are achievable using BAT. Appropriate techniques should be used to ensure the emissions in the permit are met.	Emission benchmarks for spark ignition engines are specified in the Medium combustion plant directive for gas engines). The engine manufacturers guarantee that the engine can comply with these limits and monitoring of the emissions from a representative sample of the proposed engine will be undertaken to demonstrate this. Refer to above for details of emission benchmarks and a site specific inventory of releases to air.

Note: BAT requirements taken from "How to Comply" "Point Source Emissions to Air" in Annex 3 of Getting the Basics Right (Environment Agency, 2010).

4.2 Point Source Emissions to Surface Water and sewer

There are no point source discharges to surface water or sewer from the proposed site.

Oil

The proposed engine containers are fully bunded to prevent uncontrolled releases from the engine or during maintenance of the engine. External chemical storage i.e. antifreeze and oil tanks (if installed) are 110 % externally bunded tanks or the individual drums will stand on drip trays and hard standing and any spillage would be removed by a licensed contractor. Typical examples of the oil storage tanks are shown in Figure 4.5.

Figure 4.5 Typical bunded Oil Storage Tanks



4.3 Point Source emissions to Groundwater

There are no direct or indirect emissions to groundwater of List I or List II substances from this installation.

Mineral oils are the only List I or List II substances kept on site and the nature of their storage and use is discussed fully in the SCR Appendix C and in Fugitive Releases, Section 4.5 below. There is no potential for these to be released into groundwater directly.

The engine containers and oil storage are fully bunded to prevent uncontrolled releases from the engine during maintenance or breakdown.

4.4 Fugitive Source emission to Air

The major raw material will be mains gas; this will be piped to the site via a number of underground pipes from the mains gas distribution system. Fugitive releases of mains gas are limited to the isolation valves and intermittent safety release valves on the gas system. The gas pipes above ground and the isolation valves will be inspected daily and any noticeable release repaired. The gas supply pipework is designed to operate at a pressure of 6 bar, during normal operation the system within the site boundary will operate under vacuum (-0.2 to -0.3 bar), therefore the risk of pipework leakage is minimised.

Table 4.9 reviews current operation against BAT requirements.

Table 4.9 BAT for Fugitive Emission to Air

BAT Standard	Installation Activity
Inspection of pipe system, environmental log book	Carried out routinely by Viridis staff
	Information recording system is in place

4.5 Fugitive Source Emissions to Surface Water, Sewer and Groundwater

There is little potential fugitive discharge to surface water, sewer and ground water on site. Any rain water run-off from the engine containers, gravel, internal roadways, etc. will discharge to ground via natural permeation.

There are no direct or indirect emissions from the Viridis installation to groundwater of List I or List II substances as set out in the Groundwater Regulations 1998.

Table 4.10 reviews current operation against BAT requirements.

Table 4.10 Indicative BAT Requirements for Fugitive Emissions to Water

BAT Standard	Installation Activity
All above ground tanks should be bunded and regularly inspected	All tanks are double skin and are in bunded areas with 110% of the tanks capacity located on hard standing The engine containers are bunded and this will prevent any fugitive emissions during maintenance of the engine.

4.6 Point Source Emissions Land

There are no point source emissions to land from the proposed installation.

4.7 Odour

The proposed engines will use mains gas as a fuel, this is class as a very low sulphur fuels and will not give rise to any odorous discharges. Therefore, no odour assessment has been carried out.

5. Operating Techniques

5.1 Environmental Management on Site

Management Techniques

Viridis operate a number of capacity mechanism power plants in the UK using mains gas as a fuel, some of which are below the permitting threshold. Viridis have an experienced team in operating various power generation sites without significant environmental impact or incident. This good performance is due in part to the proactive management of the workforce and the dedication of the workforce since operations commenced.

Viridis do not currently operate a formal certified environmental management system currently. However, they do have a clear environmental policy (see Appendix B) and operate a programme of continuous improvement in environmental performance.

Viridis, however, recognises the importance of managing environmental impacts and a documented system is in place. This system is for company use and covers all aspects of managing and monitoring environmental performance. Staff at all levels have access to this system. This system will include targets that are agreed by individuals and teams. This existing management system will be implemented at the proposed power plant with appropriate changes to ensure that it will be compliant with the permit.

Each team and the individual's within the team have defined roles and responsibilities to ensure that all aspects of environmental performance of the plant are managed, controlled and reported in a timely manner to fully comply with the regulatory controls placed on the plant. This includes regular audits of site operations by senior members of the company and the outcome of the audits are reported to the Operations Director.

Staff at all levels receive the appropriate training for their responsibilities and records of this training are kept at head office. This includes recognition of the environmental impacts of the process they are responsible for. Where additional training is identified this is added to a training needs matrix and this is regularly reviewed, normally every twelve months. This ensures impacts are controlled and rigorously minimised. Where the process requires specific input, the manufacturers of the process plant will be involved in the training.

Viridis recognises the importance of documented procedures covering the operation and maintenance of the proposed power plant site and these procedures are included as part of the Health, Environmental, Safety and Standards (HESS) Manual, which are regularly reviewed and updated as required. Documentation is based on the experience of the operators and the maintenance manuals provided by the engine manufacturers. Although there is no formal external audit of the procedures, regular internal audits are carried out, sometimes these use a third party or a member of the Viridis Management team. The results of these audits are recorded and reported to senior management and where appropriate corrective action is implemented.

This information is disseminated to the operators via an update using the intranet system.

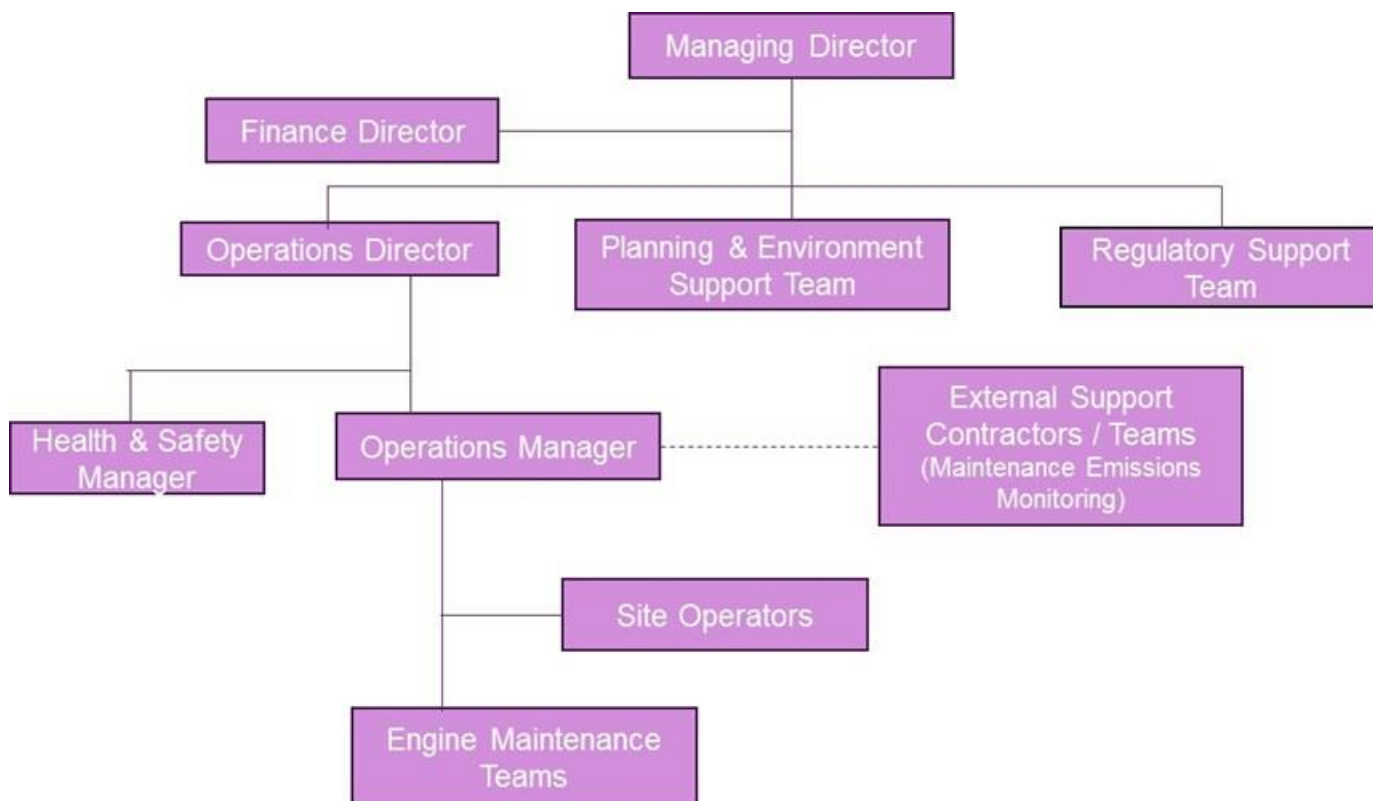
A summary of the information in the HESS manual is given below:

- ▶ Company procedures;
- ▶ Health policy and procedures;
- ▶ Environmental policy and procedures;
- ▶ Safety policy and procedures; and
- ▶ Standards Manual.

Personnel and Responsibilities

The structure of the organisation at Viridis as regarding the management of the environmental performance of the site is set out below:

Figure 5.1 Management Structure for Viridis 178 Ltd



The Operations Director and the line / area managers have responsibility for the environmental performance of all the operations controlled by Viridis, and this is part of their role. They also ensure that any reporting requirements in the proposed permit are complied with. This includes reporting to the Regulator in the correct format and in a timely manner. This is covered by a written management procedure. For the Viridis power plant the day to day responsibility for environmental performance is delegated to the lead operator with support from the Operations Manager and the Environmental Support Team.

The process operates intermittently, when required by the National Grid, up to 5-hours per day, typically 5-days per week, with expected operational hours within a 12 month period of 1000 - 1500 hours, the engines will be available to be called by the National Grid at any time apart from maintenance periods. Some of the call periods will be short duration less than 30 minutes with a maximum duration of a few hours.

Viridis has a team of nominated operators who together with other Viridis site operators in the country, form a team who work closely together on all Viridis sites. The operators will call to the sites on a routine basis, say weekly, or following an operational period, and between them provide an on-call back-up for evenings, weekends and holidays at this and other sites.

The plant is designed to operate unattended with process parameters being monitored continuously by the engine management system. Engine operating logs are stored electronically. The site is manned at intermittent times during normal operation and if alarms are raised corrective action will be taken by the operator.

All records are available for the history of each engine in electronic format or can be supplied as paper copies. These logs will be kept for a minimum period of 4 years as required by the Guidance. Each of the engine process operating system is designed to shut down in the event of a serious fault condition, which is outside the parameters that the engine management system can compensate for. The trip automatically signals the operators via a relay over the telephone network if necessary. If an engine shuts down, the automatic valves on the gas supply close preventing the release of mains gas to the atmosphere and combustion ceases, preventing emissions to air. Subject to the type of alarms, the generator will either:

- ▶ Restart automatically when the fault has cleared (usually external grid disturbance),
- ▶ Restart remotely following the operators intervention via a lap top, or
- ▶ The operator will visit the site to rectify the fault and will then restart the generator.

Compliance with Other Environmental Legislation

The Environmental Manager is responsible for keeping abreast of current legislation. This is done through keeping up to date with changes in industry standards, regulations and guidance, any changes are recorded in a register of legislation that is kept at head office.

A summary of the information in the Operations and Legislation manual is given below;

- ▶ Company procedures;
- ▶ Health policy and procedures;
- ▶ Environmental policy and procedures;
- ▶ Safety policy and procedures; and
- ▶ Standards Manual.

This Operations and Legislation manual includes the roles and responsibilities of staff at all levels along with reference guides and material safety data sheets.

Training

Viridis aims to ensure that all employees are in possession of the knowledge, skills and experience necessary to perform their role in accordance with the company's operating procedures and in full compliance with the law.

Training needs are identified by the employees' immediate supervisor or line manager.

Training needs specific to individual work areas are identified using a skills matrix approach which identifies the skills and tasks required within the area, for example engines, low voltage systems, high voltage systems, etc. The operator is assessed for competence against each of the skill requirements and the supervisor must sign off each skill area once the operator has demonstrated his competence.

For each internal training course held a Training Record is issued. The Training Record includes a statement of understanding, which the employee signs to confirm that he/she has attended the course and understood the subject matter.

Induction training is carried out by the responsible line manager and consists of introduction to the Company's Environmental Health & Safety Policy and description of emergency response and spill prevention procedures.

All appropriate staff at Viridis will have or have already received specific training in engine operation and gas management, environmental impact of the process as well as health and safety. The operators have a detailed understanding of the operational procedures for the site for both normal and abnormal operation before operation of the site commences. This training is based on and provided by the engine manufacturer's data or in-house team as appropriate. As part of the training, operators receive specific instructions relating to those aspects of plant operation that have the potential for a negative impact on the environment. In

cases where an operator has an additional training need identified during the routine review or at any other period, support will be given by the Operations Manager and/or Environmental Manager. Alternatively the operators can use the engine manufacturers or their agents as a reference source for information relating to specific engine operational issues.

A review of training needs for the operators as well as the Operations Manager/Environmental Manager to meet the requirements of the Environmental Permit will be undertaken on the issuing of the permit and an appropriate training package developed and delivered within a suitable timeframe.

Maintenance Programme

The Operations Manager has the ultimate responsibility for the effective maintenance of plant throughout the company. The Viridis Operations team is responsible for the day-to-day maintenance operations. However, accurate predictions, and an understanding of how much maintenance time will be required is very difficult to achieve, due to the variability of operation, the frequency of start-up and shut-downs and potential problems encountered during the life of the plant.

Engines

Chemical analysis of the engine oil will be carried out on a regular basis and this will form part of the preventative maintenance regime. This will indicate when oils need changing and can show possible wear or defect to engine components.

All regular maintenance will be completed on the time scale specified by the equipment manufacturer and practical experience in the field but typically will be 1,000 hours for an oil change, 10,000 hours for a spark plug change and 30,000 hours for a major overhaul. This high level of preventative maintenance is designed to avoid unscheduled down time, maximising the plant availability and its ability to abate emissions, and maintain an efficient level of operation between overhaul services. The operators will complete record sheets when they visit the site, and these will highlight any issues that may require operator intervention outside of the routine maintenance program.

The minor services last approximately half a day per engine up to a major services that can last a number of days.

The Viridis maintenance team or another approved contractor (Engine Manufacturer or authorised maintenance team) carry out all maintenance on the engine and generators. Any waste generated by the maintenance is removed from site for recycling and or disposal.

Unplanned Maintenance

Unplanned maintenance generally covers breakdown and other emergency situations and is initiated by a divergence from normal operating parameters, as specified by the manufacturers. This provides the safety information required for the operators to assess the hazards involved and to take the necessary precautions against identified hazards.

Environmental Complaints

Complaints of an environmental nature may come from a number of sources which includes Viridis staff; Regulators; Neighbours and the local community; and Contractors.

Employees will direct **all complaints** to the Operations Manager or the Environmental Manager. These may take the form of written letter, e-mail, telephone conversation or verbal.

For all types of complaints, the name, date, description of complaint and proposed solution/suggested improvement will be obtained wherever possible. A standard reporting form is available within the documented procedures in the HESS manual.

The Operations Manager will be responsible for ensuring that action is taken and for liaising with the relevant regulatory bodies (where appropriate). He will ensure that any justifiable complaint is investigated and work

is undertaken to resolve the issue. He will also provide an appropriate response to the complainant in a timely manner detailing the reason behind the issue and the actions taken to resolve the matter.

Information regarding complaints will be recorded to allow determination of an appropriate response (*corrective action*) and to determine what measures need to be taken in the future to prevent its reoccurrence (*preventive action*). These records will be maintained as part of the management system for a minimum of 4 years. The complaints procedure is detailed in the HESS manual.

Table 5.1 reviews proposed operational management system against BAT requirements for management systems.

Table 5.1 Indicative BAT Requirements for Management Systems

BAT standard	Installation activity
Operations and Maintenance	
Effective operational and maintenance systems should be employed on all aspects of the process whose failure could impact on the environment, in particular there should be: • Documented procedures to control operations that may have an adverse impact on the environment; • A defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate; • Documented procedures for monitoring emissions or impacts; • A preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major 'non productive' items such as tanks, pipework, retaining walls, bunds, ducts and filters; and • The maintenance system should include auditing of performance against requirements arising from the above and reporting the result of audits to top management.	The company operates a documented but not certified management system that covers all aspects of the operation of the mains gas combustion process. This is part of the manual with site-specific systems where appropriate to control environmental impacts and identify responsibilities. A preventative maintenance regime is operated by the company with support from the engine suppliers. This will ensure the combustion process operates within design parameters and minimise the emissions to the environment. Contractors whose work may impact on the environment are required to sign a Permit to Work, which covers "Work which poses a risk of environmental pollution". Team Leaders / Engineering Managers are responsible for ensuring contractors comply with the requirements of the Permit while on-site.
Competence and Training	
Training systems, covering the following items, should be in place for all relevant staff, • Awareness of the regulatory implications of the Permit for the activity and their work activities; • Awareness of all potential environmental effects from operation under normal and abnormal circumstances; • Awareness of the need to report deviation from the Permit; • Prevention of accidental emissions and action to be taken when accidental emissions occur; and • The skills and competencies necessary for key posts should be documented and records of training needs and training received for these posts maintained. The key posts should include contractors and those purchasing equipment and materials; Where industry standards or codes of practice for training exist (e.g. WAMITAB) they should be complied with.	The details of staff training is covered in the HESS manual and records are kept by Viridis of completed training.

BAT standard	Installation activity
Accidents / incidents / non-conformances	
There should be an accident plan as described in Section 2.8 which: - Identifies the likelihood and consequence of accidents; and - Identifies actions to prevent accidents and mitigate any consequences There should be written procedures for handling, investigating, communicating and reporting actual or potential non-compliance with operating procedures or emission limits. There should be written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions. There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up.	Emergency Procedures Manual is available. This is held by the duty operator. This is covered in part by the HESS manual, future development of the manual will improve the documentation of the accident plans and this will include any requirements from the Environmental permit once issued.
Organisation	
The following are indicators of good performance which may impact on the Regulator's resources, but not all will necessarily be insisted upon as Permit conditions: The company should adopt an environmental policy and programme which: - Includes a commitment to continual improvement and prevention of pollution; - Includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and - Identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the Permit. - The company should have demonstrable procedures (e.g. written instructions) which incorporate environmental considerations into the following areas: The control of process and engineering change on the installation; Design, construction and review of new facilities and other capital projects (including provision for their decommissioning); Capital approval; and Purchasing policy. The company should conduct audits, at least annually, to check that all activities are being carried out in conformity with the above requirements. Preferably, these should be independent. The company should report annually on environmental performance, objectives and targets, and future planned improvements. Preferably, these should be published environmental statements.	Viridis have issued an Environmental Policy signed by the General Manager, which meets the requirements of Environmental Permit. This policy has been made available to all personnel. The environmental management system and procedures will be regularly updated as part of the development of the HESS manual The plant has a design life of 25 years. When components require replacement, the environmental impact of the options will be considered.

BAT standard	Installation activity
The company should operate a formal Environmental Management System. Preferably, this should be a registered or certified EMAS/ISO 14001 system (issued and audited by an accredited certification body).	
The company should have a clear and logical system for keeping records of, amongst others:	
Policies	
Roles and responsibilities	
Targets	
Procedures	
Results of audits	
Results of reviews	

5.2 Raw Materials

Due to the nature of the process only a limited number of raw materials expected to be used on site, most are maintenance chemicals that are used in small quantities. Table 5.2 lists the typical raw materials used for maintenance. The other main raw materials will be mains gas and water.

Material Safety Data Sheets (MSDS) are available for all products used on this site. These will be available electronically in the HESS manual and paper copies will be made available in the sites control room. Copies of all MSDS are given in Appendix C. All other chemicals will only be used on site during maintenance and will brought to and removed from site by the maintenance team / company.

Table 5.2 Raw Material Inventory

Item	Use	Storage type/quantity	Annual usage (kg)	Risk Phrase	Environmental Impact
Natural Gas	Fuel	None	11,470,000		Global warming potential, toxic
Water	Domestic Make up water	None	30,000		None
Antifreeze	Antifreeze	10x25 litre drums	5,040	R22, R63	Material is not reported as causing adverse effects in the environment. Biodegradable
Lubricating oils	Top up oils for the plant	5000 litre 110% externally bunded tank, if installed, or 22 x 220 litre drums	28,000	R53	Potential to penetrate soil and contaminate water courses, not readily biodegradable
Turbonycoil	Lubricating oil	25 litre drums	1,664		

Viridis may install 5,000 litre fresh oil and waste oil internally bunded tanks to allow for bulk deliveries of lubrication oil. This oil would then be transferred by the maintenance team in an oil bowser, or similar system, for filling the individual oil tanks within the engine containers. During all loading and unloading

operations of the potential oil tanks a trained operator will be present and a spill kit available. The operator will be trained in the correct use of the spill kits. Viridis will decide if oil tanks are required based on operational experience and the running hours of the engines, although this may take a number of years operational experience.

The manufacturers specify the majority of the chemicals (lubricating oils, antifreeze, cleaning chemicals, etc.) for operational purposes and as such there are only a limited range of alternative suppliers and chemicals that can be used. When alternatives are investigated the alternative supply does not offer significant advantages in terms of either quality, performance, cost or environmental impact, but Viridis will continue to review the use of chemicals as part of the formal management procedure.

Any deliveries of maintenance chemicals arrive on site and the delivery vehicle enters the site compound and parks in a designated area. This area would contain any accidental spillage during the loading and unloading operation, particularly involving lubricating oils and waste oils. A trained operator will be present onsite during all load/unloading activities to ensure procedures are followed and spill kits will be available, with the operator trained in the appropriate use of the kits. These chemicals will only be delivered as required and in small quantities, it is not expected that a significant volume, if any, will be stored on site due to the infrequent operation of the engines.

Waste Minimisation (minimising use of raw materials)

Most chemicals and materials used on site in activities that can generate waste are required for maintenance and as such the quantities and the manufacturers specify the types of chemicals used. Further waste minimisation opportunities are limited due to the nature of the activities.

Water Use

Water to site will be supplied from the town's water supply system. Water will only be used for make-up water for the engines and domestic use by the operators. The predicted monthly average water use is approximately 2.5m³. The actual quantity is determined by the amount of antifreeze required and use by the operators for general site activities. Any leaking engine cooling water will be collected and removed as required by a licenced contractor. Effluent from the amenity block is collected in a 4,000 litre plastic above ground effluent tank and the effluent is expected to be emptied once a year by a waste contractor.

5.3 Waste Handling and Storage

A policy of minimum waste generation is practised at all Viridis sites. Unavoidable wastes will, however, arise on site and include domestic waste, used engine air inlet filters, waste oil filters, waste oils and maintenance chemicals.

These will be stored on site before being removed by an authorised waste disposal contractor, or the engine manufacturers or their agents, as appropriate.

General waste is expected to be removed by the site operator, this will include packaging, paper, mess room bins and other general waste. Before removal, general waste will be collected in wheelie bins. Approximately two wheelie bins will be removed from site every month. It does not include empty chemical drums or barrels. If due to operational requirements significant amounts of additional general waste are generated, a 1.5 m³ or larger skip will be hired and once the skip is full it will be removed from site by agreement with the waste contractor.

Used empty chemical drums and barrels will be returned to the supplier or disposed of via a disposal contractor.

All substances will be handled and conveyed on site to prevent spillage, dust releases or generation of odours. Viridis will ensure that their responsibilities under Duty of Care are fully complied with.

Waste Management Techniques

The majority of the wastes generated by the operation of the Viridis Power Plant will be as part of routine maintenance or general office type wastes. There is little potential for additional recycling as where possible the waste oil's, chemicals, etc. will be removed by waste/recycling contractors.

Table 5.3 below indicates the expected fate of the wastes.

Table 5.3 Waste Disposal and Recycling

Waste Stream	Final treatment or Disposal Route	Disposal Company	Distance from Site	Treatment method	Comments
General Waste	Landfill	Local waste management company ^A	<10km	Disposal	Minor quantities removed by operator, additional waste generated removal by a skip less than yearly
Lubricating oils	Recycled	Oil recycling Company ^A	150 miles	Recycling	Approximately 28,000 l per year
Empty Drums	Recycling	Supplier	-	Recycling	-
Domestic Effluent	Waste Water Treatment	Local waste management company ^A	-	Pre treatment	Approximately 10 m ³ per year
Oil Filters / absorbents	Landfill/ Recycling	Local waste management company ^A	-	-	One wheelie bin per 2 months

Notes A – Local companies to be identified and NRW will be informed prior to commissioning of the Viridis Power Plant

5.4 Accidents and Consequences

The safe operation of Viridis Power Plant is underpinned by a comprehensive emergency plan to cater for a range of potential emergencies, a detailed induction plan for each competent person and identified training requirements to give operators the necessary skills to work in safety. These are covered in detail within the site's Operational Manual, a copy of this will be available on the Viridis intranet system.

In terms of identifying environmental hazards and assessing the risks in a way which meets the requirements of the Environmental Permit application, accidents and their environmental consequences have been assessed based on:

- ▶ Severity of the environmental impact; and
- ▶ The likelihood of the event occurring.

Methodology

The methodology used to assess the identified hazards was adopted from the Environment Agency Guidance Note: '*H1: Environmental Risk Assessment and the Appraisal of BAT*'.

The potential environmental risks were evaluated using the following methodology:

- i. Potential consequence of accident;
- ii. Likelihood of accident; and
- iii. Risk classification.

The 'Potential Consequence of Accident' gives an indication of the sensitivity of a given receptor to a particular source or contaminant of concern under consideration. It is a worst case classification and is based on full exposure via the particular linkage being examined.

'Likelihood of Accident' is an assessment of the probability of the selected source and receptor being linked by the identified pathway. This assessment is ranked based on site-specific conditions.

The 'Risk Classification' column is an overall assessment of the actual risk, which considers the likely effect on a given receptor, taking account of both of the previous rankings and controls present on site. The criteria are set out in Table 5.4 below.

Table 5.4 Risk assessment criteria

Potential Consequences of Action	
Severe	Acute harm to human health. Short-term risk of pollution of sensitive water resource (e.g. major spillage into controlled waters). Impact on controlled waters e.g. large scale pollution or very high levels of contamination. Catastrophic damage to buildings or property (e.g. explosion causing building collapse). Ecological system effects – irreversible adverse changes to a protected location. Immediate risks.
Medium	Chronic harm to human health. Pollution of sensitive water resources (e.g. leaching of contaminants into controlled waters). Ecological system effects – substantial adverse changes to a protected location. Significant damage to buildings, structures and services (e.g. damage rendering a building unsafe to occupy, such as foundation damage).
Mild	Non-permanent health effects to human health. Pollution of non-sensitive water resources (e.g. pollution of non-classified groundwater). Damage to buildings, structures and services (e.g. damage rendering a building unsafe to occupy, such as foundation damage). Substantial damage to non-sensitive environments (unprotected ecosystems e.g. crops).
Minor / Negligible	Non-permanent health effects to human health (easily prevented by appropriate use of PPE). Minor pollution to non-sensitive water resources. Minor damage to non-sensitive environments (unprotected ecosystems e.g. crops). Easily repairable effects of damage to buildings, structures, services or the environment (e.g. discoloration of concrete, loss of plants in a landscaping scheme).
Likelihood of Accident	
High likelihood	An event is very likely to occur in the short term, and is almost inevitable over the long term OR there is evidence at the receptor of harm or pollution.
Likely	It is probable that an event will occur. It is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	Circumstances are possible under which an event could occur. It is by no means certain that even over a longer period such an event would take place, and less likely in the short term.
Unlikely	It is improbable that an event would occur even in the very long term.
Potential significance	
Very High Risk	Severe harm to a receptor may already be occurring OR a high likelihood that severe harm will arise to a receptor, unless immediate remedial works/mitigation measures are undertaken.
High Risk	Harm is likely to arise to a receptor, and is likely to be severe, unless appropriate remedial actions/mitigation measures are undertaken. Remedial works may be required in the short term, but likely to be required over the long term.
Moderate Risk	Possible that harm could arise to a receptor, but low likelihood that such harm would be severe. Harm is likely to be medium. Some remedial works may be required in the long term.

Low Risk	Possible that harm could arise to a receptor. Such harm would at worst normally be mild.
Very Low Risk	Low likelihood that harm could arise to a receptor. Such harm unlikely to be any worse than mild.

The potential significance for each accident is calculated from the following matrix included as Table 5.5. 'Moderate' residual risk and above requires possible remedial measures / control mechanisms to mitigate the risk.

Table 5.5 Significance of accident risk

Matrix		Likelihood			
		Unlikely	Low Likelihood	Likely	High Likelihood
Potential consequence	Minor/ Negligible	Negligible	Negligible	Low	Moderate/Low
	Mild	Negligible	Low	Moderate/Low	Moderate
	Medium	Low	Moderate/Low	Moderate	High
	Severe	Moderate/Low	Moderate	High	Very High

The assessment of risk of potential accident and incident scenarios are shown in Table 5.6 below:

Table 5.6 Assessment of Accidents and Their Environmental Consequences

Hazard	Receptor	Pathway	Risk Management	Probability of Exposure	Consequence	What is the overall risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard get to the receptor?	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	How likely is this contact?	What is the harm that can be caused?	What is the risk that still remains? The balance of probability and consequence
Failure of Engine Management System	Increased emissions to air	Dispersion through the air	Design of engine management system and the monitoring of the system parameters Continuous monitoring of process parameters and automatic reporting of exceedance of process parameters, automatic shutdown of engine and alarm condition raised.	Likely	Mild	Moderate / low
Gas leak into plant	Increased emissions to air	Dispersion through the air	Design and fabrication standards Gas alarms adjacent to the engines Inspection and maintenance Routine operator inspection Firefighting systems Response procedure	Likely	Mild	Moderate / low
Leak of lubricating oil during manual transfer	Potential for contamination of groundwater Potential for fire	Dispersion through the ground and air	Minimum of flanged connections where pipework used Design standards Impervious operational areas	Low	Minor / Negligible	Negligible
Fire from ignition of lubricating oil leak	Smoke, toxic combustion products in fire-fighting run-off water	Dispersion through the air	Design and fabrication standards Gas alarms adjacent to the engines Inspection and maintenance Routine operator inspection Firefighting systems Response procedure	Likely	Mild	Moderate / low

Hazard	Receptor	Pathway	Risk Management	Probability of Exposure	Consequence	What is the overall risk?
Vibration from out of balance rotating machinery	Transmitted vibration					
Spill/leak of chemicals for engine water treatment	Potential for contamination of groundwater	Dispersion through the ground and air	Minimum of flanged connections Design standards Impervious operational areas Training in unloading practices Size of delivery to reduce number of deliveries/unloading operations Routine operator checks	Low	Minor / Negligible	Negligible
Equipment/plant item fire e.g. electric motor, cabling	Smoke, combustion products potentially released to atmosphere	Dispersion through the air	Design and fabrication standards Gas alarms adjacent to the engines Inspection and maintenance Routine operator inspection Firefighting systems Response procedure	Likely	Mild	Moderate / low

Reviewing the information in tables 5.6 shows that none of the risks identified would be classed as unacceptable. The highest risk is from the manual transfer of lubricating oils.

The information and assessments contained in the Viridis Power Plant Operational Plan are adequate to meet the EPR requirements as detailed in How to comply with your Environmental Permit (Environment Agency, version 6 - 2013) and Horizontal Guidance H1 annex A, and, therefore, they are considered to meet BAT. Viridis will prepare a dedicated Environmental Accident Management Plan for the site and that will be issued to NRW prior to commissioning of the engines. This is confirmed by the comparison with indicative BAT in Table 5.7 below.

Table 5.7 Indicative BAT for Accident Management Plans

BAT Requirement	Gas Generation Compound Activity
Develop an AMP and implement it if an accident occurs. Review the plan at least every 4 years. Identify events or failures that could damage the environment. Assess how likely they are to happen and the potential environmental consequences. Action to minimise the potential causes and consequences of accidents. If an accident happens, implement the AMP, find out why the accident happened and take action to stop it happening again, review the AMP and tell the Environment Agency.	The Viridis Power Plant AMP is underpinned by the site's Operational Manual. Emergency Preparedness details the main environmental accident hazards that could occur on site and what measures would be implemented to prevent/minimise pollution. Viridis has documented environmental risk assessments, operational procedures and emergency plans, which cover the operations within the mains gas generation compound. At the next four yearly review the AMP will be updated to reflect the new installed equipment.

5.5 Noise Assessment

Due to the nature of the combustion activities, engines within acoustic enclosures, the intermittent operation of the engines mainly avoiding night time periods and the remote location of the installation (refer to Figures 2.1 and 2.2), significant noise beyond the site boundary is not expected. Therefore, in accordance with How to Comply with your Environmental Permit, a written Noise Management Plan for the operation of the gas plant is not necessary.

The installation and operation of the engines within the generation compound has had a BS 4142 acoustic assessment of the site undertaken by Clover Associates and this forms part of this application. The full assessment is appended at Appendix E.

This assessment has been carried out at the nearest receptors and a background noise survey was conducted during Thursday 30th April 2015 and Friday 1st May 2015 at a location representative of the nearest sensitive receptors.

The plant has been designed to minimise noise and vibration impact on the local sensitive receptors, including the local residential properties closest to the site. Measures adopted to minimise noise include initial plant specification, careful siting of noise sources and the use of acoustic enclosures, etc.

The assessment has shown that the proposed installation would result in a noise rating level of 4dB below the local background. According to BS4142 is indicatives that the proposal will have a low impact.

Based on the above, it can be reasonably concluded that, with respect to noise, the Viridis Power Plant compound will give rise to "no pollution" as defined in the EPR.

Table 5.8 below summarises the risk assessment for noise emissions based on Annex A of H1 and H3.

Table 5.8 H1 Risk Assessment for Noise

Hazard	Receptor	Pathway	Risk Management	Probability of Exposure	Consequence	What is the overall risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard get to the receptor?	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	How likely is this contact?	What is the harm that can be caused?	What is the risk that still remains? The balance of probability and consequence
To Air						
Noise emission from engines motors, fans, vehicles, etc.	Local population – protection from impact of noise	Air dispersion	Design and specification of motors, fans and pumps, key plant items within buildings Distance to noise sensitive receptors ~800m Incorporation of inspection and maintenance programme into proposed procedures Site management and operational personnel will be responsible for responding to complaints to address immediate issue and prevent recurrence	Low likelihood	Local population – noise impact, nuisance, loss of amenity. – Negligible	Very Low, see assessment above

5.6 Closure

The Viridis Power Plant will be expected to be operational for the next 25 years. The issues of plant decommissioning, site clearance and remediation were included in the original design for the power plant. The impacts of the site on soil or groundwater are likely to be limited due to the small inventory of chemicals/potentially hazardous materials, the provision of effective containment measures and the high level of maintenance and housekeeping.

The proposed maintenance and housekeeping will be developed to comply with BAT, and the design and operational procedures will mitigate against any significant impact to the soil and groundwater beneath the site.

A Site Closure Plan will be developed by Viridis which will be updated as and when material changes occur. The Site Closure Plan will include the following basic elements that are directly applicable to the site:

- ▶ Procedures and plans for the flushing of the process and removal of process fluids and chemicals from the site;
- ▶ A site plan of any drains/tanks that will be left in place;
- ▶ Plans for the removal of any harmful substances off-site;
- ▶ Methods of dismantling engines and transformers; and
- ▶ Methods of removal of the buildings (if applicable).

In the course of the demolition activities, materials, plant, equipment, etc. would be recovered for recycling as far as is practicable, bearing in mind their service life and ability to be refurbished, design standards, etc. The demolition will use practices applicable and accepted at the time and will be consistent with safety requirements for demolition.

5.7 Site Security

The site will be available for operation at any time apart from maintenance periods. The site is usually unmanned with occasional visits from the operator.

The site will be enclosed by a security fence and acoustic barrier with a 24 hour security system including a continuously monitored CCTV. Access to the site will be restricted to authorised staff only, however the site is remote from main residential areas and security is not expected to be a major operation issue.

5.8 Site Condition

The assessment of the condition of the site is contained within the attached site condition report (SCR) and this specifies the state of the site prior to operation of the process under the permitting regime.

There is a requirement to ensure that the site does not deteriorate from the level defined in the SCR, and as part of the post permit site monitoring and controls, Viridis will manage and keep records of all future activities or issues as required. However, upon closure of the site, it may be necessary to carry out verification investigations to confirm the soil and groundwater condition at the site. Any such actions would form part of the site closure plan.

6. Monitoring

This section describes the proposed monitoring strategy for emissions monitoring from the proposed power plant.

Periodic Emissions Monitoring

Pollutant emission levels are dependent on the combustion conditions within the plant and the quality and quantity of the fuel. The emissions are controlled by the plant design, comprehensive engine management system and adherence to appropriate operating parameters and the use of a very low sulphur content fuel, mains gas. Based on the typical composition of the mains gas and the parameters to be monitored, as given in the Environment Agency's and NRW's guidance for monitoring emissions, Sector Guidance and the MCPD, the proposed monitoring parameters are given in Table 6.1. The MCPD covers spark ignition engines with an electrical output of approximately 1.3MWe, and is applicable to the engines at the Viridis Power Plant. As there will be up to 27 engines on site, that will be identical in manufacture, operation, maintenance and fuel it is proposed to sample 15% of the engines during each annual periodic sampling test, i.e. 5 to 6 engines with the emission results being applied to all of the engines on site.

All testing will be undertaken by a MCertS accredited test team.

Process operating parameters (e.g. fuel flow, power output, temperatures, etc.) will be continuously monitored by the control systems and a record of the process parameters will be stored on computer for a period of at least 4 years.

Table 6.1 Proposed Sampling Methodologies

Parameter	Reference Methodology	Technique
Nitrogen Oxides (NO _x)	ISO 10849: 1996	Chemiluminescence or similar
Carbon Monoxide (CO)	BS EN 15058 / ISO 12039	Non Dispersive Infra-red (NDIR) or similar
Flow	BS EN 13284 / BS ISO 16911	Pitot tube and appropriate manometer
Temperature		"k" type thermocouple and digital temperature indicator

Viridis is committed to monitoring its pollutant releases and has an appropriate management structure in place to ensure monitoring is effectively carried out and reported to the NRW.

From the MCPD for gas engines below 5MW_{th} input, Table 6.2 indicates typical emission limits and the detection limit of testing techniques for gas generation plants.

Table 6.2 Typical Emission Limits for the Process Based on the Annual Sampling of Engines

Pollutant	Typical Emission Limit mg/Nm ³	Approximate Detection Limit mg/Nm ³
@ 15 % O ₂ (dry gas)		
NO _x	190 (506)	2
CO	375 (1000)	2

Emission Limit values quoted at 273K, 101.3kPa, 15% oxygen content and dry gas. The figures in brackets shows the equivalent emission limit value for reference conditions of 273K, 101.3kPa, 5% oxygen content and dry gas.

Environmental Monitoring (Beyond the Installation)

There will be no environmental monitoring beyond the site boundary.

7. Energy Efficiency and Climate Change

7.1 Energy

This section summarises the energy impacts from the Viridis Power Plant and has been produced using “Horizontal Guidance Note H2 Energy Efficiency” and the Energy Efficiency Directive. The process is a net exporter of electricity and only during start-up is electricity required from the local distribution system, the plant is expected to operate for approximately 1000 - 1500 hours per year as additional generation to the grid and anytime during the day, but typically operational will be expected during peak periods, 7am to 9pm Monday to Friday. The operational hours are based on historical data issued by the National Grid and may vary from those quoted during actual operation.

Energy Management

The proposed development at the Viridis power plant will result in a total of upto 27 Jenbacher J420 mains gas spark ignition engines being present on site.

The manufacturers quote an electrical generation efficiency of approximately 43% resulting in a thermal input required by the engines of 80.73 MWth. As the engines only operate around 1000 - 1500 hours per year as a rolling 5 year average, a detailed cost benefit analysis has not been undertaken as allowed within the Regulations, but for completeness a high level assessment has been included. An assessment has been made of the potential for the use of heat from the engines, by considering the quality, opportunities and potential benefits and impacts. The maximum potential useable thermal output from the installation, based on manufacturer's information, would be approximately 32 MWth, this would be in the form of low grade (less than 90°C) hot water. To utilise this heat would require an industrial site or other users that require this amount of hot water on an intermittent basis. There are no suitable facilities that could use this low grade heat within 1 km of the site, the nearest will be the proposed Swansea Harbour District Heating network that is some 7 km from the site, it would not be economic to install distribution pipelines for this unpredictable intermittent heat load. If this situation changes and a suitable end user can be identified and a commercial agreement reached, the use of heat recovery will be reassessed. Alternatively additional heat extraction and electrical generation could be considered, this is often based on using an organic Rankin cycle system. If an appropriate technology is available the operator may consider this in future. If it is developed a separate variation application would be submitted.

The use of this heat would reduce the exhaust gas temperature to approximately 180°C. Reducing exhaust temperature would increase the environmental impact of the emissions on the local environment.

Therefore, at this stage, the installation of heat recovery units to generate the low grade heat, or additional electricity, for export to local users is not considered to be a viable option.

Energy Consumption

The energy use on site will be monitored via comparing the electricity generated to the electricity exported and the gas purchased. Meter readings will be recorded on weekly log sheets and the data storage system for process control. The expected energy consumption is summarised in Table 7.1.

Table 7.1 Annual Energy Balance for Viridis Power Plant (based on 34.7MWe export ~ 27No. 1.286 MWe engines)

Energy Source	Generated (MWh)	Exported (MWh)	Imported (MWh) ⁽²⁾	Delivered (MWh)
Mains Gas	-	-	-	91,960
Electricity	39,540	38,659	1,510	-
Electricity primary	-	-	3,624 ⁽¹⁾	-

Note 1: Primary Conversion Factor 2.4 taken from H1

2: Estimated imported power

The imported electricity is used during start-up and for other parasitic loads, once the engines have started no more electricity will be imported.

An estimate of the expected imported power has been made based on the operational experience of Viridis and the manufacturer's data. All lighting and heating is taken from the electricity generated by the engines when they are operating.

The spark ignition engines at Viridis Power Plant will achieve an overall efficiency of approximately 41% for exported electricity.

8. Environmental Impact Assessment

The following section describes and assesses the environmental impact resulting from the installation of the proposed activities at the Viridis operated plant, and identifies the nearby receiving environments and sensitive receptors, which may be affected by discharges from these activities.

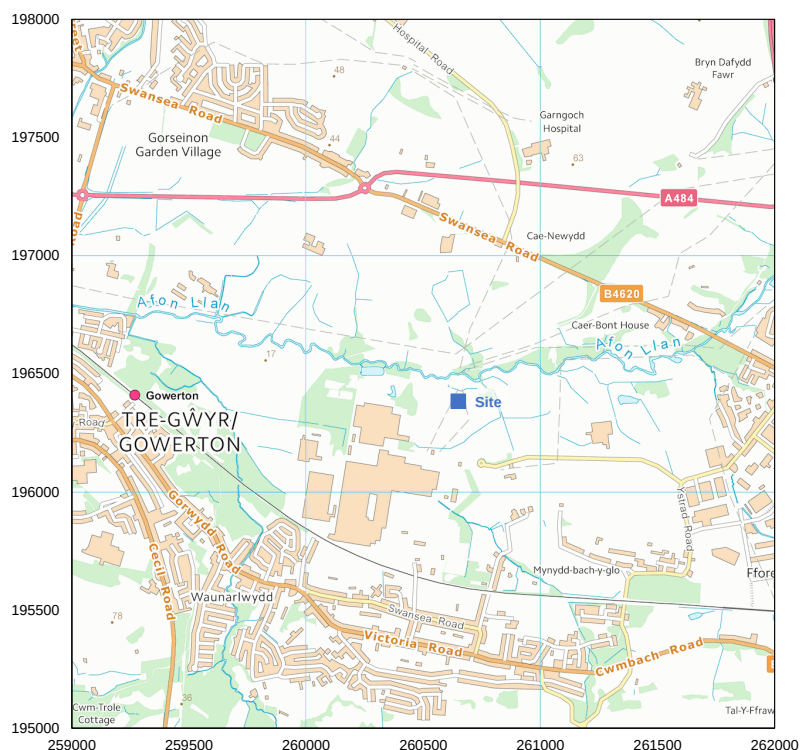
The impacts of the release from the installation are discussed in this section, and present the outputs of the H1 assessment. The H1 assessment is included in the CD version of the variation.

8.1 Location and Setting

Location

The Viridis 178 Swansea plant is to be located near Waunarlwydd, Swansea. (The site is about 1 km north of the village of Waunarlwydd and about 5 km west of the centre of Swansea. The grid reference for the site is 260650, 196383 (SS 60650 96383). Figure 8.1 provides a site location map.

Figure 8.1 Site location



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Environmentally Significant Sites

The ecological and human receptor sites considered in this impact assessment are listed in Table 8.1 below. Some of these are specifically regulated under the Habitats Regulations, see Section 8.3 below.

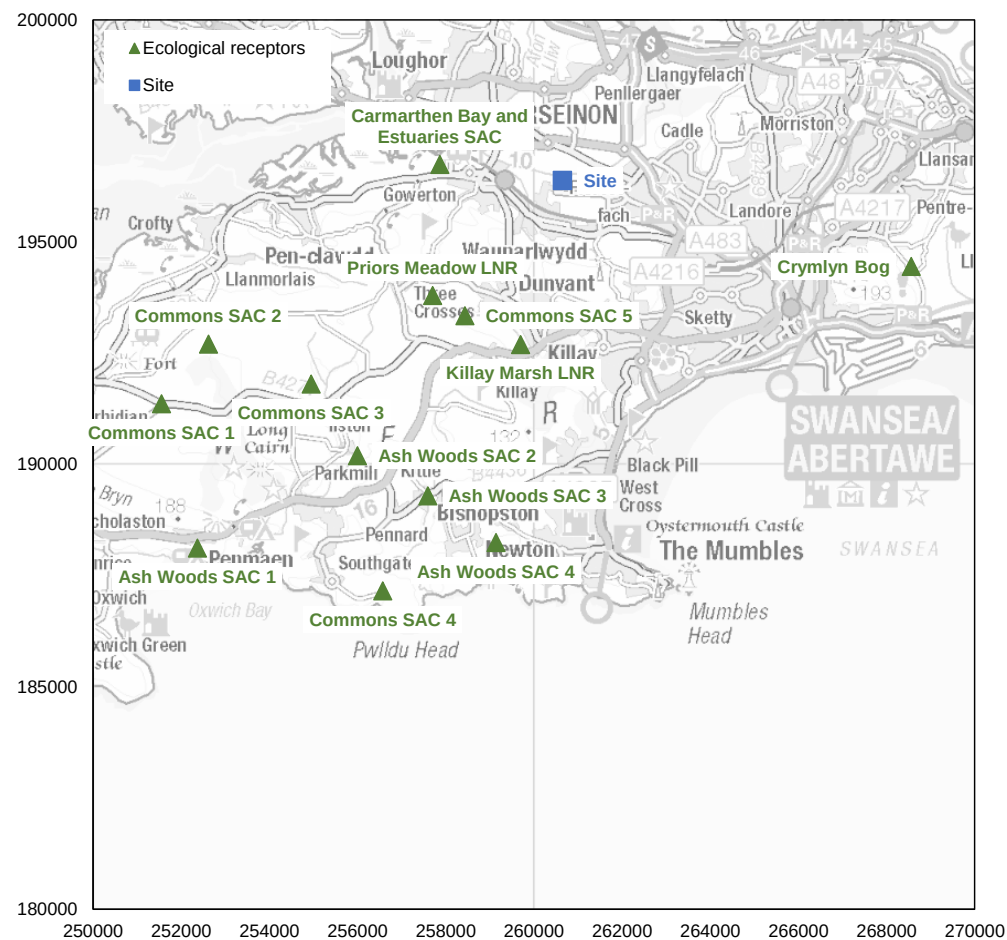
The locations of the nearest human and ecological sites are illustrated in Figure 8.2 for 2km from the site and Figure 8.3 for 10km from the site.

Table 8.1 Identification of Important and Sensitive Receptors

Screening Category	Receptor Name	Receptor Type	Distance from Site to closest point (m)	Emissions, Pathway & Potential Effect	Supporting Information
Site of Special Scientific Interest	None within 2km			Emissions: Discharges to air Pathway: Atmospheric dispersion, deposition to land Potential effect: Air emissions are regarded as insignificant on the ecological receptor.	Section 4.1 Point Sources – Emissions to Air of this document
Habitat Directives Site	SAC	Carmarthen Bay and Estuaries Crymlyn Bog Gower Ash Woods Gower Commons	2,810 8,140 7,730 3,770	Emissions: Discharges to air Pathway: Atmospheric dispersion, deposition to land Potential effect: Air emissions are regarded as insignificant on the ecological receptor	Section 4.1 Point Sources – Emissions to Air of this document
Local Nature Reserve, Local Wildlife Site, National Nature Reserves, ancient woodland	LNR	Killay Marsh Priors Meadow	3,810 3,930	Emissions: Discharges to air Pathway: Atmospheric dispersion, deposition to land Potential effect: Air emissions are regarded as insignificant on the ecological receptor	Section 4.1 Point Sources – Emissions to Air of this document
Human population(a)	Keeper's Lodge Farm Properties 1 Properties 2 Westfield Road Tir Y Farchnad Fairwood Terrace Swansea Road Hospital Caer'r-bont	Residential / Hospitals/ etc.	560 520 720 850 1,200 1,450 1,030 1,070 880	Emissions: Discharges to air Pathway: Atmospheric dispersion, deposition to land Potential effect: NO _x emissions are potentially significant.	Control measures in place are described in detail in: Section 5.5 Noise Section 4.7 Odour Section 4.1 Point Sources – Emissions to Air of this document
Sensitive watercourse	None	-	-	Emissions: Discharges to water Pathway: groundwater. Potential effect: Minimal due to control measures in place and no relevant receptor identified	Section 4 Releases to groundwater are controlled as described in Appendix C.

Screening Category	Receptor Name	Receptor Type	Distance from Site to closest point (m)	Emissions, Pathway & Potential Effect	Supporting Information
Sensitive groundwaters	Minor aquifer	-	-	Emissions: No planned discharges to groundwater but potential for oil spillages Pathway: Spillages can permeate the gravelled area of the site and enter the groundwater Effect: Potential contamination of shallow groundwater.	Described in detail in Appendix C
Sensitive area of the atmosphere	Swansea City Council has declared three Air Quality Management Areas – Closest is Fforest-fach Cross	AQMA	2km	Emissions: Discharges to air Pathway: Atmospheric dispersion, deposition to land Potential effect: No relevant air quality management areas are identified in the local area	Section 4.1 Point Sources – Emissions to Air

Figure 8.3 Locations of Ecological Sites (SPA, SAC and Ramsar) – 10km



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8.2 Emission Summary

The majority of the potential impacts are associated with emissions to air from the engines and the assessment of these is set out as follows:

- ▶ Calculation of process contributions (PC);
- ▶ Estimation of predicted environmental concentrations (PEC); and
- ▶ Conclusions of impact assessment for emissions to air.

Emissions to water are not expected to be significant.

Emissions to Air

The installation will consist of 27 engines, each within their own engine container, with individual stacks a short distance above the top of each container. Model input parameters are given in Table 8.2 and 8.3. The process data has been derived from manufacturer's performance data provided by Viridis. Emissions data are based on BAT guideline limits of 500 mg Nm⁻³ for NO_x and 400 mg Nm⁻³ for CO (for compliance with the proposed limits in the Medium Combustion Plant Directive for gas engines below 5MWth but at reference oxygen levels of 5% in the exhaust gas). Pollutants other than NO_x and CO have been screened out as unlikely to be of concern.

Table 8.2 Modelled stack characteristics

Parameter	Each engine
Release height (m)	7.2
Flue diameter (m)	0.35
Efflux velocity (m s ⁻¹)	38
Efflux temperature (°C)	450

Table 8.3 Modelled stack emission rates

Pollutant	Emission rate (per engine) (g s ⁻¹)
NO _x	0.66
CO	1.33

Capacity Mechanism contracts with the National Grid require operators to guarantee that their plant be available at specific times. This means that the engines will not be running continuously. The peak demand requirements of the National Grid vary by season and year-on-year and are not known more than a year or so in advance. For the current modelling, it was assumed that the facility would be used between the times of 07:00 and 21:00. These windows have been reflected in the model setup by setting the emission rate to 100% of the Table values during hours of the availability window, and setting the emission rate to zero outside those hours.

This procedure results in the emissions occurring for a total of 5110 hours per year. In fact, the engines will only operate for between 1000 and 1500 hours per year as a rolling average, therefore a figure of 1250 hours per year has been used in the assessment as a typical value. Therefore, when calculating annual mean concentrations, a correction factor of 1250/5110 ≈ 0.24 has been applied to the raw model results. If the plant operates for more hours the correction factor would be slightly larger.

Similarly, the facility is only expected to operate for about 5 hours per day when called. Therefore, maximum 8-hour mean concentrations have been calculated by taking the maximum one-hour concentrations and multiplying by $5/8 = 0.625$.

Air Quality Standards

EU legislation

Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe

Directive 2008/50/EC (the 'Directive'), which came into force in June 2008, consolidated existing EU-wide air quality legislation (with the exception of Directive 2004/107/EC) and provides a new regulatory framework for PM_{2.5}.

The Directive sets limits, or target levels, for selected pollutants that are to be achieved by specific dates and details procedures EU Member States should take in assessing ambient air quality. The limit and target levels relate to concentrations in ambient air. At Article 2(1), the Directive defines ambient air as:

"...outdoor air in the troposphere, excluding workplaces as defined by Directive 89/654/EEC where provisions concerning health and safety at work apply and to which members of the public do not have regular access."

In accordance with Article 2(1), Annex III, Part A, paragraph 2 details locations where compliance with the limit values does not need to be assessed:

"Compliance with the limit values directed at the protection of human health shall not be assessed at the following locations:

- a) any locations situated within areas where members of the public do not have access and there is no fixed habitation;*
- b) in accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply; and*
- c) on the carriageway of roads; and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

UK legislation

The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on the 11 June 2010 and transpose Directive 2008/50/EC into UK legislation. The Directive's limit values are transposed into the Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the Directive.

These standards are legally binding concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects of sensitive groups or on ecosystems.

Similar to Directive 2008/50/EC, the Regulations define ambient air as;

"...outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."

with direction provided in Schedule 1, Part 1, Paragraph 2 as to where compliance with the AQS' does not need to be assessed:

"Compliance with the limit values directed at the protection of human health does not need to be assessed at the following locations:

- a) any location situated within areas where members of the public do not have access and there is no fixed habitation;*
- b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply; and*
- c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The 2007 Air Quality Strategy for England, Scotland Wales and Northern Ireland provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2000.

Central to the Air Quality Strategy are health-based criteria for certain air pollutants; these criteria are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The objectives derived from these criteria are policy targets often expressed as a maximum ambient concentration not to be exceeded, without exception or with a permitted number of exceedances, within a specified timescale. At paragraph 22 of the 2007 Air Quality Strategy, the point is made that the objectives are:

"...a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except where they mirror any equivalent legally binding limit values..."

The AQOs, based on a selection of the objectives in the Air Quality Strategy, were incorporated into UK legislation through the Air Quality Regulations 2000, as amended.

Paragraph 4(2) of The Air Quality (England) Regulations 2000 states:

"The achievement or likely achievement of an air quality objective prescribed by paragraph (1) shall be determined by reference to the quality of air at locations –

- a) which are situated outside of buildings or other natural or man-made structures above or below ground; and*
- b) where members of the public are regularly present."*

Consequently, compliance with the AQOs should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

The Environment Act 1995

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an AQMA. The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

Other guideline values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

Air Quality Guidelines for Europe, the World Health Organisation (WHO)

The aim of the WHO Air Quality Guidelines for Europe (WHO, 2000) is to provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

Environmental Assessment Levels (EALs)

The Environment Agency's Horizontal Guidance Note H1 provides methods for quantifying the environmental impacts of emissions to all media. H1 Annex (f) contains long and short-term Environmental Assessment Levels (EALs) and Environmental Quality Standards (EQS) for releases to air derived from a number of published UK and international sources. For the pollutants considered in this study, these EALs and EQS are equivalent to the AQS and AQOs set in force by the Air Quality Strategy for England, Scotland Wales and Northern Ireland.

H1 Annex (f) provides a three-tiered approach to assessing the significance of emissions to atmosphere. The first stage is to 'screen out' insignificant emissions to air; these are emissions which are emitted in such small quantities that they are unlikely to cause a significant impact on the receiving environment. This procedure is detailed in Box 1.

Box 1 Screening out Insignificant Emissions to Air – Box 1
Identify which emissions can be excluded from further assessment by applying the criteria below: • Long-term Process Contribution (PC) < 1% of the relevant long-term EAL; and • Short-term PC < 10% of the relevant short-term EAL Those releases which satisfy the above criteria can be classed as insignificant and excluded from further assessment. Those releases which do not satisfy the above criteria can be classed as not insignificant and warrant further assessment.

The second stage is to assess the need for detailed dispersion modelling of emissions to air (Box 2). If the second stage indicates that further investigation is warranted, a detailed assessment of emissions to air should be undertaken using an appropriate dispersion model, such as ADMS or AERMOD (the third stage assessment). It should be noted that once a decision has been made to proceed to detailed modelling, the insignificance criteria described in Box 1 are no longer relevant and shouldn't be used in the assessment of impact. Rather, the impact assessment should focus only on achievement with the appropriate EAL.

Box 2 Identifying the Need for Detailed Modelling of Emissions to Air – Box 2

For those releases which cannot be screened by the criteria detailed in Box 1, the following approach should be used in identifying whether detailed modelling of emissions to air is required.

Long Term Impacts

1. Obtain information on the annual mean background concentrations (BG) of releases to air
2. Calculate the Predicted Environmental Concentration (PEC) of that substance by summing the PC and BG, i.e., **PEC = PC + BG**
3. Detailed dispersion modelling **is required** if **PEC > 70% of the EAL**

Short Term Impacts

1. Calculate the difference between the long-term background concentration and short-term EAL (model headroom)
2. Detailed dispersion modelling **is required** if the **short-term PC > 20% of model headroom**
3. Short-term Process Contributions not exceeding 20% of the short-term EAL “may be considered to be tolerable”.

The H1 guidance note includes an additional EAL of relevance to this assessment, namely a limit of $75 \mu\text{g m}^{-3}$ on daily mean NO_x at ecological receptors. This is based on guidance from the World Health Organization (WHO, 2000), which says:

“Experimental evidence exists that the CLE [critical level] decreases from around $200 \mu\text{g/m}^3$ to $75 \mu\text{g/m}^3$ when in combination with O_3 or SO_2 at or above their critical levels. In the knowledge that short-term episodes of elevated NO_x concentrations are generally combined with elevated concentrations of O_3 or SO_2 , $75 \mu\text{g/m}^3$ is proposed for the 24 h mean.”

8.3 Air quality impacts of the process

The atmospheric emissions of the following pollutants have been identified as requiring detailed dispersion modelling:

- ▶ Oxides of nitrogen (NO_x as NO_2); and
- ▶ Carbon monoxide (CO).

A brief description of each pollutant is given in Table 8.4.

Table 8.4 Summary of the pollutants assessed

Pollutant	Description and effect on human health and the environment	Principal Sources
Oxides of Nitrogen (NO _x)	Nitrogen dioxide (NO ₂) and Nitric oxide (NO) are both collectively referred to as oxides of Nitrogen (NO _x). It is NO ₂ that is associated with adverse effects on human health. Most atmospheric emissions are in the form of NO which is converted to NO ₂ in the atmosphere through reactions with Ozone. The oxidising properties of NO ₂ theoretically could damage lung tissue, and exposure to very high concentrations of NO ₂ can lead to inflammation of lung tissue, affect the ability to fight infection. The greatest impact of NO ₂ is on individuals with asthma or other respiratory conditions, but consistent impacts on these individuals is at levels of greater than 564 µg m ⁻³ , much higher than typical UK ambient concentrations.	All combustion processes produce NO _x emissions, and the principal source of NO _x is road transport, which accounted for 32% of total UK emissions in 2008. Emissions from power stations contributed a further 20%.
Carbon Monoxide (CO)	The toxicity of CO results in it binding avidly to haemoglobin and thus reducing the oxygen carrying capacity of the blood. In very high doses, the restriction of oxygen to the brain and heart can be fatal. At lower concentrations, CO can affect higher cerebral function, heart function and exercise capacity.	The principal source of CO is emissions from petrol vehicles, accounting for 54% of total UK emissions in 2008.

8.4 Criteria appropriate to the assessment

Air Quality Standards, Objectives, Guidelines and Critical Levels

Table sets out those AQS, AQOs and EALs that are relevant to this assessment.

Table 8.5 Air Quality Standards, Objectives and Environmental Assessment Levels

Pollutant	AQS/AQO/EAL	Averaging Period	Value (µg m ⁻³)
NO ₂	AQS	Annual mean	40
	AQS	1-hour mean, not to be exceeded more than 18 times a year (equivalent of 99.79 Percentile)	200
NO _x : Ecological Receptors	AQS	Annual mean	30
	EAL	Daily mean	75
CO	AQS	8-hour mean	10,000
	EAL	1-hour mean	30,000

Information held on the APIS website has been reviewed in order to identify the main habitat/species features and their site relevant critical loads. Information is only available for the designated sites (i.e. SACs, SSSIs etc.), not for Local Nature Reserves with no other designation. Table summarises this information.

Table 8.6 Relevant Critical Load data for the assessment

Designated sites	Main notified habitat/species features in the assessment area	Minimum nutrient nitrogen deposition critical load (kg N ha ⁻¹ y ⁻¹)	CLmaxS (keq ha ⁻¹ y ⁻¹)	CLminN (keq ha ⁻¹ y ⁻¹)	CLmaxN (keq ha ⁻¹ y ⁻¹)
Carmarthen Bay and Estuaries SAC	Atlantic salt meadows; Salicornia and other annuals colonizing mud and sand; Estuaries	20	N/A	N/A	N/A
Crymlyn Bog	Transition mires and quaking bogs	5	0.342	0.321	0.661
Gower Ash Woods SAC	Tilio-Acerion forests of slopes, screes and ravines	15	0.322	0.142	0.666
Gower Commons SAC	Euphydryas aurinia - Marsh fritillary butterfly; European dry heaths; Northern Atlantic wet heaths with Erica tetralix; Coenagrion mercuriale - Southern damselfly; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) - Purple moor-grass meadows	10	0.16	0.223	0.526

Background Air Quality

Continuous monitoring data

The City and County of Swansea has ten continuous monitoring stations within its borders, of which five measure NO₂ (a sixth, Morfa, closed in May 2011) (Swansea 2014). Most of these are roadside locations within the urban area of Swansea. One, Cwm Level Park, is an urban background location within the urban area of Swansea, approximately 5 km east of the Timet site; between 2009 and 2013 this site measured annual mean NO₂ levels between 18.5 µg m⁻³ and 23.4 µg m⁻³. These locations are considered generally unrepresentative of relevant receptors near the Timet site.

Passive monitoring data

The City and County of Swansea operates an extensive passive monitoring network consisting of diffusion tubes recording concentrations of NO₂ at approximately 250 locations within the district (Swansea 2014). All of these are at locations classified as roadside and are within urban areas, so are considered unrepresentative of relevant receptors near the Timet site.

Defra mapped background concentrations

Defra, through its contractor Ricardo-AEA, maintains a nationwide model (the Pollution Climate Mapping (PCM) model) of existing and future background air quality concentrations at a 1 km grid square resolution. The data sets include annual average concentration estimates for NO_x, NO₂, PM₁₀, PM_{2.5}, CO, SO₂ and benzene. The PCM model is semi-empirical in nature: it uses data from the national atmospheric emissions inventory (NAEI) to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data.

Annual mean background data from the PCM model for the receptors considered in this study is detailed in Table 8.7.

Table 8.7 Mapped annual mean background concentrations ($\mu\text{g m}^{-3}$)

Receptor	NO _x	NO ₂	CO	Receptor	NO _x	NO ₂	CO
Keeper's Lodge Farm	12.31	9.61	218	Carmarthen Bay and Estuaries SAC	9.57	7.63	196
Properties 1	11.66	9.13	213	Crymlyn Bog SAC	13.36	10.37	225
Properties 2	11.66	9.13	213	Gower Ash Woods SAC 1	6.26	5.07	151
Westfield Road	11.66	9.13	213	Gower Ash Woods SAC 2	7.28	5.88	163
Tir Y Farchnad	10.76	8.53	207	Gower Ash Woods SAC 3	7.90	6.34	171
Fairwood Terrace	10.76	8.53	207	Gower Ash Woods SAC 4	8.38	6.72	186
Swansea Road	12.76	9.95	220	Gower Commons SAC 1	6.35	5.15	153
Hospital	13.60	10.57	222	Gower Commons SAC 2	6.39	5.19	157
Caer'r-bont	12.31	9.61	218	Gower Commons SAC 3	6.91	5.59	159
				Gower Commons SAC 4	6.67	5.39	163
				Gower Commons SAC 5	8.77	7.02	188
				Killay Marsh LNR	10.98	8.70	194
				Priors Meadow LNR	8.04	6.46	180

Local Air Quality Management

The City and County of Swansea, under its Local Air Quality Management (LAQM) obligations, continually reviews and assesses concentrations of key air pollutants in the borough to ascertain the requirement, or otherwise, to declare an Air Quality Management Area (AQMA) (Swansea 2014). Following the review and assessments undertaken to date, the Council has declared an AQMA for annual mean NO₂ covering three parts of Swansea:

- ▶ along a section of the A483 near the junction with the A4216 at Fforest-fach Cross, approximately 2 km east of the Timet site;
- ▶ around the junction of the A4118 with the A4216 in Sketty, approximately 4 km south-east of the Timet site; and
- ▶ the Hafod district of central Swansea, approximately 5 km east of the Timet site.

The receptors included in the dispersion model, particularly Keeper's Lodge Farm and Caer'r-bont, will report the contribution from the site at the AQMA.

8.5 Impact Assessment – H1 Methodology

Process Contribution (PC) using H1 Screening (Normal Operation)

The EA software tool H1 was used to calculate the short term and long term process contributions (PC) for each of the substances released. The process contributions were then compared to the short and long term environmental benchmarks or environmental assessment levels (EAL). The releases that warrant further assessment have been identified by applying the following guidance as given in Environmental Assessment and Appraisal of BAT guidance:

$$\text{PC}_{\text{long term}} > 1\% \text{ of the long term environmental benchmark}$$

PC_{short term} > 10% of the short term environmental benchmark

Table 8.8 summarises the Process Contributions (PC) and the EALs for each substance released from up to 27 Jenbacher 420 engines, as a worst case, the operator may install the engines in two phases, but this would result in the site having a lower emission rates and hence lower impacts until all the engines have been installed. Modelled data refers to data that has been recalculated an appropriate dispersion model, see Appendix F. The long term and short term PC's have been calculated based on the distance to the nearest receptor with the highest predicted impact (Keepers Lodge), 520m to the nearest human receptor and 2800m to the nearest ecological receptor.

The assessment below gives the calculated impact of the Timet installation and a summary of the H1 assessment that is included on the CD version. For completeness the Air Dispersion Model report includes the emissions from the adjacent Short Term Operating Reserve plant.

Table 8.8 Emissions to Air – 27 Jenbacher J420 Engines as given in H1 Database

Substance	Long Term			Short Term		
	EAL / AQO's $\mu\text{g m}^{-3}$	PC $\mu\text{g m}^{-3}$	*Modelled PC $\mu\text{g m}^{-3}$	EAL / AQO's $\mu\text{g m}^{-3}$	PC $\mu\text{g m}^{-3}$	*Modelled PC $\mu\text{g m}^{-3}$
Nitrogen dioxide (human health receptor)	40	617	1.49	200	14,276	73.82
Oxides of nitrogen (ecological receptor)	30	617	0.11	75	14,276	10.69
Carbon monoxide	-	1,217	--	10,000	28,177	218

Note:

* Modelled data refers to data that has been calculated from the Dispersion Model Report see Appendix C.

- (1) For assessment against the long-term standard assumed that only 70% of the nitrogen oxides are oxidised to NO₂, and 35% of the nitrogen oxides are oxidised to NO₂ for the short-term standard.

H1 calculates % PC values, such that those values below the criteria indicated are screened from further assessment. From the initial assessment, it can be seen that some substances exceed the 1% long term benchmark and 10% short term benchmark, as shown in Table 8.9.

Table 8.9 Air Impact Screening – Engines as Given in H1 Database

Substance	Long Term EAL $\mu\text{g m}^{-3}$	Short Term EAL $\mu\text{g m}^{-3}$	Long Term			Short Term		
			PC $\mu\text{g m}^{-3}$	%PC of EAL	>1% of EAL?	PC $\mu\text{g m}^{-3}$	%PC of EAL	>10% of EAL?
Nitrogen dioxide (human health receptor)	40	200	1.50	3.73	Yes	73.9	37.0	Yes
Oxides of nitrogen (ecological receptor)	30	75	0.11	0.37	No	10.7	14.3	Yes
Carbon monoxide	-	10,000	-	-	-	218	2.19	No

Predicted Environmental Concentration (PEC)

For the substances that have been identified as requiring further assessment in Table 8.9, the long-term predicted environmental concentration (PEC) was calculated using the H1 tool. The PEC is calculated as the sum of the background concentration of the substance in air and the process contribution:

$$\text{PEC}_{\text{air}} = \text{PC}_{\text{air}} + \text{background concentration}_{\text{air}}$$

The PEC and PC values are listed in Table 8.10. The following releases are releases that have **not** been screened out by the previous H1 assessment stages.

The background concentrations have been taken from the data given in Table 8.7.

Table 8.10 Air Impact Modelling (H1 Database)

Substance	Long Term					Short Term	
	EAL	Air background conc. $\mu\text{g m}^{-3}$	PC $\mu\text{g m}^{-3}$	PEC $\mu\text{g m}^{-3}$	% PEC of EAL	PC	%PC of headroom (EAL – twice long term background)
Nitrogen dioxide (human receptor)	40	9.61	1.50	11.2	27.8	73.9	40.9
Oxides of nitrogen (ecological receptor)	30	9.57	0.11	9.68	32.1	10.7	19.2

The H1 Guidance indicates that further modelling of emissions may be appropriate for **long term** effects:

- ▶ If the long term PEC is >70% of the relevant benchmark or in locations where there is an air quality management plan.

The H1 Guidance indicates that further modelling of emissions may be appropriate **for short term** effects:

- ▶ If the short term PC is more than 20% of the difference between twice the (long term) background concentration and the relevant short term environmental benchmark.

The conclusion from the H1 assessment (Table 8.10) is that, for the emissions from Timet, none of the pollutant concentrations at human or ecological receptors requires further assessment, this is based on the air dispersion modelling report presented in Appendix F.

Emissions to Water

There are no discharges of process water from site.

8.6 The Conservation (Natural Habitats etc.) Regulations 1994

The Environmental Permitting Regulations require that the Habitats Regulations⁹ are taken into consideration and if the installation activity will have a significant effect on any of the sites protected under these regulations, the Habitats Regulations require that competent authorities (NRW) be satisfied that an appropriate assessment of such habitats has been conducted.

⁹ The Conservation (Natural Habitats, &c.) Regulations 1994 (SI 2716)

The Habitats Regulations implement the EU Birds¹⁰ and Habitats¹¹ Directives, both of which aim to protect a network of sites in the UK that have rare or important habitats and species. The sites designated under the Birds Directive are known as Special Protection Areas (SPAs), and aim to conserve the habitats that support regularly occurring migratory or certain rare or vulnerable birds, to ensure their survival and reproduction in their area of distribution. Prior to classification by the UK Government, the sites are known as potential SPAs (pSPAs). The Habitats Directive establishes the process for the designation of Special Areas of Conservation (SACs); these are sites that support habitats and/or species which are rare or threatened on a European scale. Before the SAC designation is ratified by the European Commission the sites are referred to as candidate SACs (cSACs). SPAs and SACs are collectively known as 'European sites' or 'Habitats sites' and form part of a European network known as Natura 2000.

The assessment of impacts on European Habitat sites is based on the Air dispersion modelling report in Appendix F, this shows that the ecological receptors are some distance from the site >2.8km and the process contribution will not be significant, and will be small when compared to the existing background concentrations and deposition rates. It is unlikely that the actual impact of the Viridis plant on the designated sites will cause any deterioration in the habitat at the site.

¹⁰ The Birds Directive (European Communities Council Directive on the Conservation of Wild Birds (79/409/EEC)) aims to preserve, maintain or re-establish biotopes and habitats to maintain populations of all species of wild birds naturally occurring in the Member States.

¹¹ The Habitats Directive (European Communities Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora (92/43/EEC, amended by 97/62/EC)) requires measures to be taken to maintain or restore to favourable conservation status habitats and/or species, which are rare or threatened on a European scale.





Appendix A

Natural Resources Wales Application Forms





Appendix B

Drawings and Policies





Appendix C

Site Condition Report





Appendix D

H1 (CD Only)





Appendix E

OPRA (CD Only)





Appendix F

Air Dispersion Model Report





Appendix G

Noise Impact Report



