PROJECT SKY- LOW IMPACT INSTALLATION APPLICATION REPORT

Document Reference: 7000_C0306_1

	Name	Job Title	Date
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Revision History

Revision	Date	Changes
1	21/07/2021	First issue

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1.0 INTRODUCTION

This document is intended to be read in conjunction with the application form for a Part B1 – Standard facilities permit for the proposed Project Sky, Q Park, GL5 5HT. The document provides a general description of the proposed facility and sets out as per Appendix 1 in Form B1 and the associated guidance how the facility meets the criteria for a low impact installation.

1.1 Project Sky – General description

The concept of Project Sky is to use commercially available apparatus to manufacture the materials required to grow gem quality diamonds. The origin of these materials will be atmospheric air and water. The method by which the diamonds are made is via microwave plasma chemical vapour deposition (CVD) whereby the process gases introduced into a reaction chamber in a pre-determined mix are converted into a gas plasma and carbon is deposited atomic layer by atomic layer onto a seed crystal. To provide a sense of scale see **Figure 1** showing an operator working with one of the five operational CVD machines currently installed at the site.

Figure 1

The ingredients required to grow diamonds are the gases hydrogen (H_2), carbon dioxide (CO_2), methane (CH_4), nitrogen (N_2) and argon (Ar). Ultimately most gases will be manufactured on site; hydrogen will be made from splitting water, while CO_2 and N_2 will be harvested from air in the atmosphere at the site. The CH_4 will be manufactured onsite by feeding the locally harvested CO_2 and H_2 into a biological process reactor. The Ar is the exception as it will be purchased from an established manufacturer and delivered to the site. Helium (He) gas will also be present on site as an inert substance that can be used for flushing and leak testing.

At the time of writing the systems required to create the facility described above are at a non-commercial research and development phase and the application for a standard facilities permit is in anticipation of the facility becoming a commercial operation.

2.0 LOW IMPACT INSTALLATION CRITERIA

The following subsections 2.1 to 2.11 replicate the headings A to K as set out in Appendix 1 – Low impact installation checklist within the form EPB: Application for an environmental permit Part B1 standard facilities permit and provides explanation and evidence on how each of these criteria is met.

2.1 Management techniques

The installation has low environmental impact during all phases of the process including start up and shut down. Essentially all the criteria set out in sections 2.2 to 2.11 below can be met without reliance on significant management effort. In practical terms if in the unlikely event all the project staff were to leave the site running unmanaged for an extended period there is no plausible adverse environmental impact and the equipment's which make up the project would default to their standby modes. Furthermore, the environmental management systems have been certified under ISO 14001:2015. See **Appendix A** which is a copy of the certificate of registration for the Green Britain Group of which Sky is a subsidiary.

2.2 Aqueous waste

The liquids produced during the processes undertaken at Sky are as set out in the table below:

Item	Equipment	Description of liquid output	Maximum anticipated volume	Reference document if applicable
1.	ITM – Hydrogen Electrolyser	Water	Electrolyser has the capacity to produce 0.25 m^3/hour and typically operates for 2 hours/week producing 0.5m^3/week	**Appendix B** D950-0005-02 - Ecotricity - Technical description of the hydrogen plant Ref. Table 2
2.	Climeworks – Carbon dioxide production	Condensate	Equipment has the capacity to produce 0.25m^3/day – and typically operates for up to 3 days per month producing 0.75m^3/month	**Appendix C** V09__InterfaceManual_Ecotricity Ref. Condensate table pg. 8
3.	HYSYTECH/KRAJETE Methanogenesis plant	Water and residual bulk chemicals and trace elements discharged to an intermediate bulk container (IBC) To be removed by a registered waste carrier	0.15m^3/6 months from bio-reactor adsorbant filters - For concentrations of bulk chemicals/trace elements see **Appendix D** Sodium Hydroxide is used to clean the equipment and outgoing solution that follows this process contains: Sodium Hydroxide Water and traces of Na_2CO_3 - product of	**Appendix D** ECT.01.18.PRS0203.REV03 Ref. Section 1.3

			the reaction of the sodium hydroxide with the CO_2 inside the gas. Na_2S, product of the reaction of the sodium hydroxide with the H_2S inside the gas	

2.3 Abatement systems

The gas production equipment does not rely on active abatement systems to air though there is potential for nominal release to air in certain conditions such as start up. The table below details potential outputs from each of the relevant pieces of project equipment.

Item	Equipment	Potential release to air	Source
1.	ITM – Hydrogen Electrolyser	The hydrogen electrolyser can vent Hydrogen (0.09Nm^3/day) and Oxygen (9.6Nm^3/day) based on operating 8 hour per day. However, the proposed use of this equipment is 2 hours/week.	**Appendix B** D950-0005-02 - Ecotricity - Technical description of the hydrogen plant Ref. Table 7.2
2.	Climeworks – Carbon dioxide production	Not applicable – The equipment does not vent any gas to air	**Appendix C** V09__InterfaceManual_Ecotricity Ref. Exhaust air table pg. 5
3.	HYSYTECH/KRAJETE methanogenesis plant	The methanogenesis plant produces by volume 95% CH_4 with small quantities (<0.001%) of H_2, CO_2, H_2S NH_3 and H_2O which are removed with passive adsorbent filters later removed by a registered waste carrier (Ref. Item 3 Section 2.2 of this report)	**Appendix D** ECT.01.18.PRS0203.REV03 Ref. Section 1.3
4.	CVD machines	Each CVD machine has an exhaust system which predominantly releases hydrogen to air via a 10mm ID stainless steel pipe. An analysis of these gases has been undertaken by Gas Analysis Services Ltd **Appendix E** and commentary **Appendix F** has been provided on the same by the consultancy D&N Installations & Design Ltd	**Appendix E** Gas Analysis Services Ltd report N210312 D&N H2 RGC4583 A **Appendix F** – Commentary from D&N Installations & Design Ltd

2.4 Groundwater

There are no fugitive emissions into the ground from the installation. The coolant systems do contain antifreeze in the form of non-toxic glycol antifreeze Coolflow DTX (ref. **Appendix G**). In the event of an accidental the spill kits maintained on site include the facility to cover local storm drains to avoid contamination.

2.5 Producing waste

Waste production from the site is nominal and less than the values set out in the Environment Agencies Guidance notes on part B1 – Standard facilities permit. **Appendix H** provides a scan of a waste transfer note for the ICB's mentioned in Section 2.2 to provide an indication on the volumes being produced.

2.6 Using energy

The installation does not consume energy at a rate greater than 3MW. The grid connection for the site is 1.2 MW and a copy of the grid connection agreement is included as **Appendix I**. No energy is produced onsite through the combustion of fuels.

2.7 Preventing accidents

As per section 2.4 there is an emergency plan for a polluting spillage in place to prevent fugitive emissions to surface water or land and this is included within **Appendix J**.

2.8 Noise

There is low potential for causing offence due to noise. As part of the planning permission process a noise planning assessment was carried out by the consultant Hoare Lea (see **Appendix K**). The report found that subject to the introduction of an acoustic barrier to the north of the site which has been installed the predicted noise levels are below or similar to typical day or night-time background noise levels in the area.

2.9 Emissions of polluting substances

As per section 2.3 and 2.4 there are no emissions of polluting substances. The nature and source of emissions are provided in sections 2.3 and 2.4.

2.10 Odours

None of the activities which make up the installation are known to give rise to smells. There is no history of odour complaint from the installation.

2.11 History of keeping to the regulations

There is no history of enforcement actions against the project.

APPENDICES

A.	ISO14001 Certificate Green Britain Group EMS 733351 2021 June
B.	D950-0005-02 - Ecotricity - Technical description of the hydrogen plant
C.	V09__InterfaceManual_Ecotricity
D.	ECT.01.18.PRS0203.REV03
E.	Gas Analysis Services Ltd report N210312 D&N H2 RGC4583 A
F.	D&N Installations & Design Ltd commentary on CVD exhaust gas
G.	coolflow-dtx-pds
H.	Scan of waste transfer note
I.	7000_C_0151 Signed connection agreement
J.	Emergency Plan - Polluting Spillage
K.	6755_P0002_01_Q Park - Noise planning Assessment

APPENDIX A

ISO14001 Certificate Green Britain Group EMS 733351 2021 June

Certificate of Registration

ENVIRONMENTAL MANAGEMENT SYSTEM - ISO 14001:2015

This is to certify that:

Green Britain Group Ltd
Lion House
Rowcroft
Stroud
GL5 3BY
United Kingdom

Holds Certificate Number: EMS 733351

and operates an Environmental Management System which complies with the requirements of ISO 14001:2015 for the following scope:

The design, project management and maintenance of wind turbine and solar panel installations. Customer service provision for energy supply, electric vehicle charging networks and mobile phone network. Trading of energy on the UK market and provision of smart metering. Manufacture and management of maintenance for small scale windmills. The management of electric vehicle charging network. The design and production of vegan chilled and frozen food for the catering industry. The stadium and event management of Forest Green Rovers football club. The manufacture of gem quality diamonds using carbon captured from the atmosphere.

For and on behalf of BSI:

Andrew Launn, EMEA Systems Certification Director

Original Registration Date: 2020-07-13
Effective Date: 2020-07-13
Latest Revision Date: 2021-04-28
Expiry Date: 2022-08-20

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BSI Assurance UK Limited, registered in England under number 7805321 at 389 Chiswick High Road, London W4 4AL, UK.
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Certificate No: EMS 733351

Location	Registered Activities
Green Britain Group Ltd Lion House Rowcroft Stroud GL5 3BY United Kingdom	The design, project management and maintenance of wind turbine and solar panel installations. Customer service provision for energy supply, electric vehicle charging networks and mobile phone network. Trading of energy on the UK market and provision of smart metering. Manufacture and management of maintenance for small scale windmills. The management of electric vehicle charging network. The design and production of vegan chilled and frozen food for the catering industry. The stadium and event management of Forest Green Rovers football club. The manufacture of gem quality diamonds using carbon captured from the atmosphere.
Ecotricity Group Ltd Q Park Bath Road Woodchester Stroud GL5 5HT United Kingdom	Manufacture and management of maintenance, for small scale windmills. The design and production of vegan chilled and frozen food for the catering industry. The manufacture of gem quality diamonds using carbon captured from the atmosphere.
Ecotricity Group Ltd Plot 2 Nottingham Road Louth LN11 0WB United Kingdom	The maintenance of wind turbine and solar panel installations.
Ecotricity Group Ltd Imperial House Station Road Stroud GL5 3AP United Kingdom	Customer service provision for energy supply.
Ecotricity Group Ltd Unicorn House 7 Russell Street Stroud GL5 3AX United Kingdom	Customer service provision for energy supply, electric vehicle charging networks and mobile phone network.

Original Registration Date: 2020-07-13

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Certificate No: EMS 733351

Location	Registered Activities
Forest Green Rovers F C The New Lawn Smiths Way Nailsworth, Forest Green Stroud GL6 0FG United Kingdom	The stadium and event management of Forest Green Rovers football club.

Original Registration Date: 2020-07-13

Effective Date: 2020-07-13

Latest Revision Date: 2021-04-28

Expiry Date: 2022-08-20

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APPENDIX B

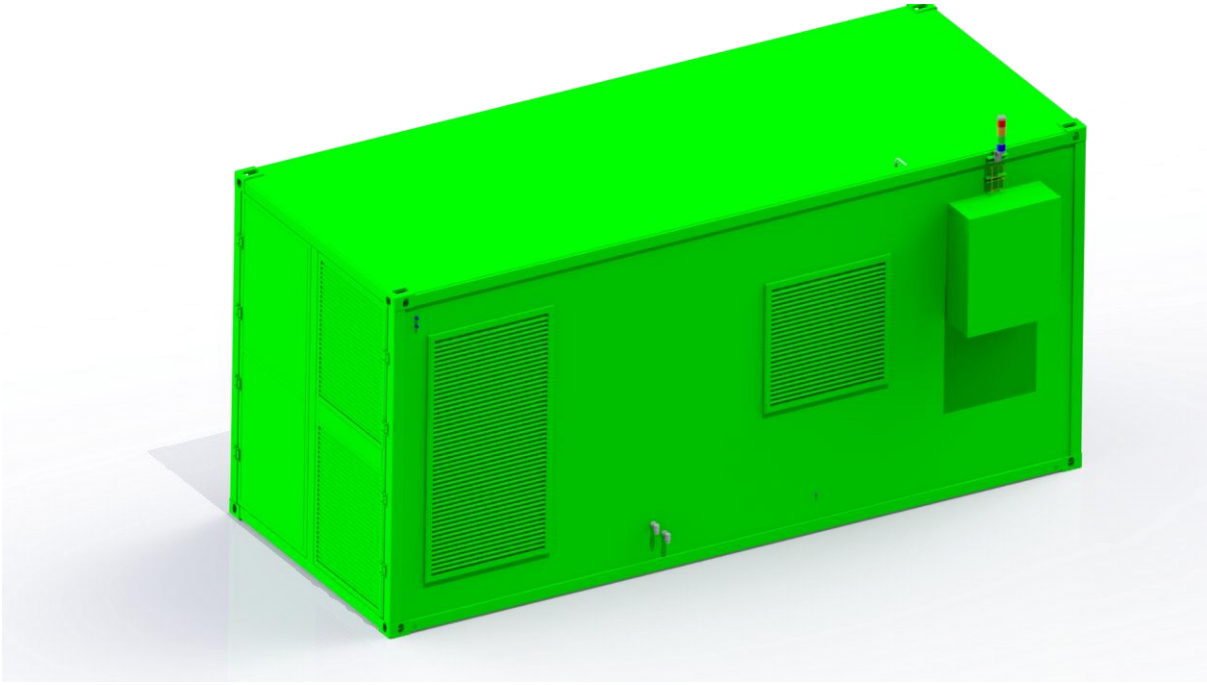
D950-0005-02 - Ecotricity - Technical description of the hydrogen plant

ITM POWER
Energy Storage | Clean Fuel

Ecotricity
Technical description of the hydrogen plant

CONFIDENTIAL

10th February 2017



www.itm-power.com

TECHNICAL DESCRIPTION OF THE HYDROGEN PLANT

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1 Introduction

This document describes the general scope and operation of the ITM electrolyser plant. It provides some detail of the key components and aspects of the safe design, and it proposes a general layout for the equipment. Consideration is given to a suitable arrangement of plant functions and to possibilities of future expansion and scale up.

2 Main components of the hydrogen plant

2.1 Electrolyser

Parameter	Value
Total Max. Hydrogen Flow Rate	5kg/day
Hydrogen Pressure	15 bar
Hydrogen Purity	99.999%
Oxygen Pressure	Ambient
Electrical Power Supply	400V AC, 50Hz, 3 phase
Power Rating	35kW
Maximum time at full rating	24hrs per day (100%)
Set point adjust	Via external signal or HMI
Water Requirement	Potable mains drinking water or rainwater >2bar
Packaging	20’ ISO container
Operating Conditions	-15°C to 40°C
User Interface	Touch screen HMI
Connectivity	Profinet

Table 1 ITM HPAC40 Electrolyser - Technical specification table

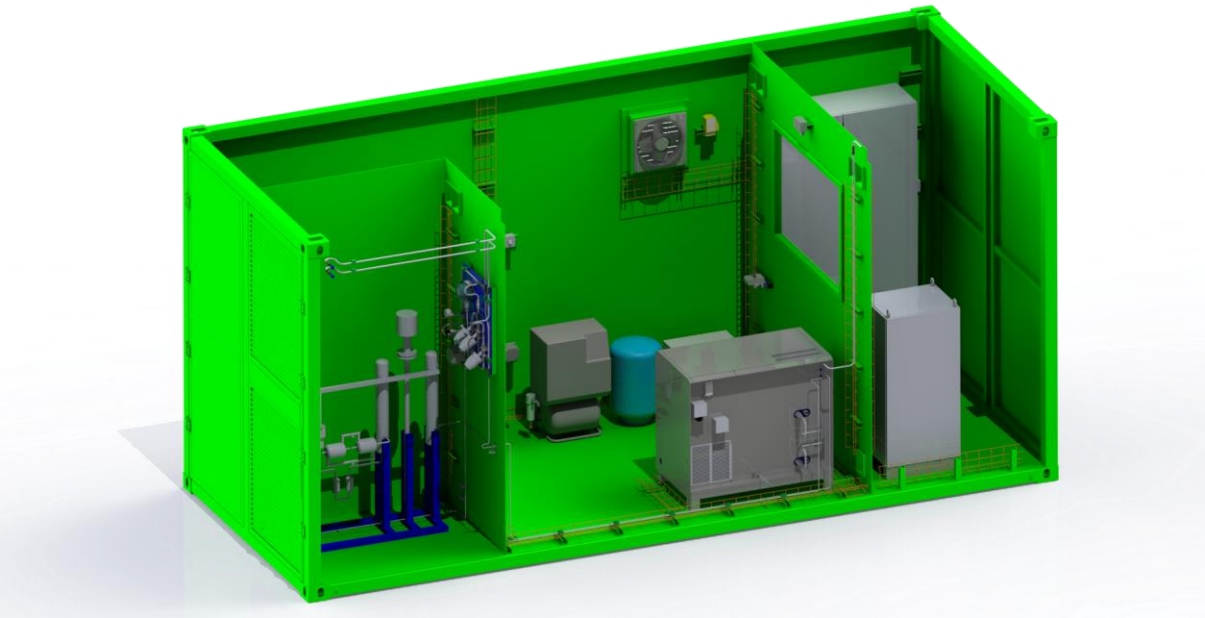


Figure 1 ITM HPAC40 Electrolyser and Dryer Container – Isometric view of main components

3 General description of the process plant operation and control system

3.1 General description of the process plant operation

The ITM Power HPAC40 electrolyser installation generates hydrogen at 15 bar from mains water and purifies the hydrogen gas to 99.999% using the associated gas dryer. The plant requires just electrical power and water.

The customer provided water is purified to high purity deionised water via a DI filtration system and this water is then supplied to the HPAC40. The purified water is stored within the HPAC40 in a water tower that also supplies the water process pump and acts as a separator for the returning water and oxygen gas from the electrolyser stack.

The required water, without oxygen bubbles, is drawn from the bottom of the tank into the process circulation pump. This pumped flow requires heat removal (through a plate heat exchanger) prior to entering the electrolyser stack. The heat exchanger is also fed with a coolant to remove the heat from the process water, which is pumped via an external water chiller.

The stack contains 48 electrolysis cells, each with its individual 'Proton Exchange Membrane' and associated engineering materials and catalysts. When the DC power is supplied to the stack, oxygen gas is generated on one side of the membrane and hydrogen gas on the other.

Oxygen is returned to the water separator at atmospheric pressure and then vented to a safe location. The produced hydrogen is very wet, due to the movement of water through the membranes with the protons, and this water needs to be separated out.

The electrolyser gas passes to a water separator, where the bulk of the water is left and the wet gas is passed through a small gas chiller and then a coalescer. This process aids in the removal of the water, however in order to achieve the required gas purity level, a hydrogen gas dryer is required post HPAC40. The water that is left in the separator vessel is recycled back to the process water tower to return to the electrolysis process. The humid hydrogen gas passes through a desiccant dryer to become extremely dry. The dryer uses thermal regeneration cycles and requires no loss of gas.

The dry gas will leave the dryer and associated equipment (with the gas purity monitored via a moisture transmitter), and it is anticipated that the gas will be stored within a customer provided buffer tank at 15bar.

Running independently to the main operation of the plant, a number of utilities are required to secure its correct functioning:

Process pneumatic system: Provides compressed air for the actuation of pneumatic valves.
Utility cooling: Provides cooling for both the HGas hydrogen electrolyser and the gas dryer.

The control system alarms and goes to shutdown if manually initiated; or if there is any evidence of malfunction or process deviation. Three different types of shutdown can take place depending of the level of danger detected in the plant:

- Shutdown 1 - Operator shutdown via the HMI or over the Profinet, or control system detects that the buffer tank filling is complete. Plant shutdowns and hydrogen gas is vented. System enters "idle" state after successful hydrogen venting.

- Shutdown 2 - Control system detects a process deviation. Plant shuts down and hydrogen gas is vented. System enters "idle" state after successful hydrogen venting. Alarm state is recorded and requires manual intervention to clear.

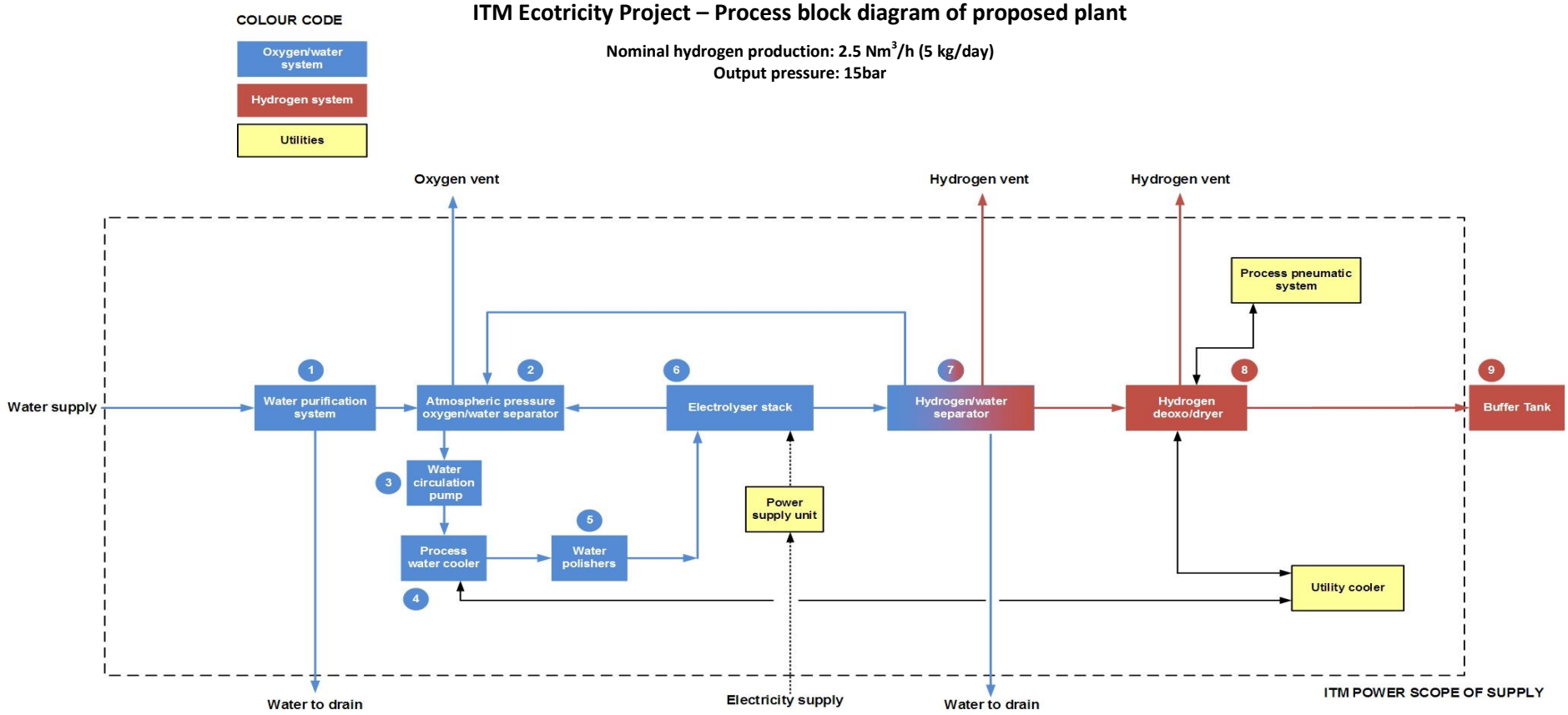
- Shutdown 3 Any of the emergency stop switches has been activated or control system detects a safety critical deviation (hydrogen leak or fire). Plant is de-energised, which imply a subsequent rapid vent of hydrogen.

The plant will vent any hydrogen during shut down in order to prevent a loss of containment. The exception is the Buffer Tank.

© ITM POWER PLC

ITM Ecotricity Project – Process block diagram of proposed plant

Nominal hydrogen production: 2.5 Nm^3/h (5 kg/day)
Output pressure: 15bar



	1	2	3	4	5	6		8	9
Function	Purification of mains water	Process water top up and oxygen venting	Circulation of water through oxygen side of the stack	Maintain process water within optimum temp. range	Process Water Filter	**Generation of hydrogen gas from process water**	Separation of water from hydrogen and water recirculation	Removal of trace oxygen and water from hydrogen	Storage of Hydrogen gas
Estimated design parameters	Water production: ~120 L/h Rejection rate: ~2/1	Volume: 20 L Pressure: 1 barg	Flow: ~20 L/min Pressure: ~4 bar	Temp. range: 50 to 55 °C Cooling duty: ~5 kW	N/a	Hydrogen gas – 2.5Nm^3/hr @15bar	Volume: 1.5L Pressure: 15 barg	99.999% purity <1 ppmv oxygen <2 ppmv water	15bar Volume TBC

Figure 2 Process block diagram of the hydrogen plant

3.2 Operational safety

3.2.1 Safety functions of the control system

The electrical components that have been identified as critical functions and communicate with the PLC through a failsafe channel are: emergency stop buttons, hydrogen sensors and smoke detectors. The location of these safety critical instruments throughout the plant is indicated in the Figure below.

The activation of any of these instruments triggers a Shutdown 3 or safety shutdown: the plant is fully de-energised, i.e. power is fully isolated from the system. Pressurised hydrogen system is vented to atmospheric pressure via fail open valves, reducing both hazards associated with hydrogen leaks and those associated with electrical equipment. Power to the plant can only be returned by authorised personnel: the control room needs to be unlocked to gain access to the control panel and a master key is required to re-engage the isolation switch.

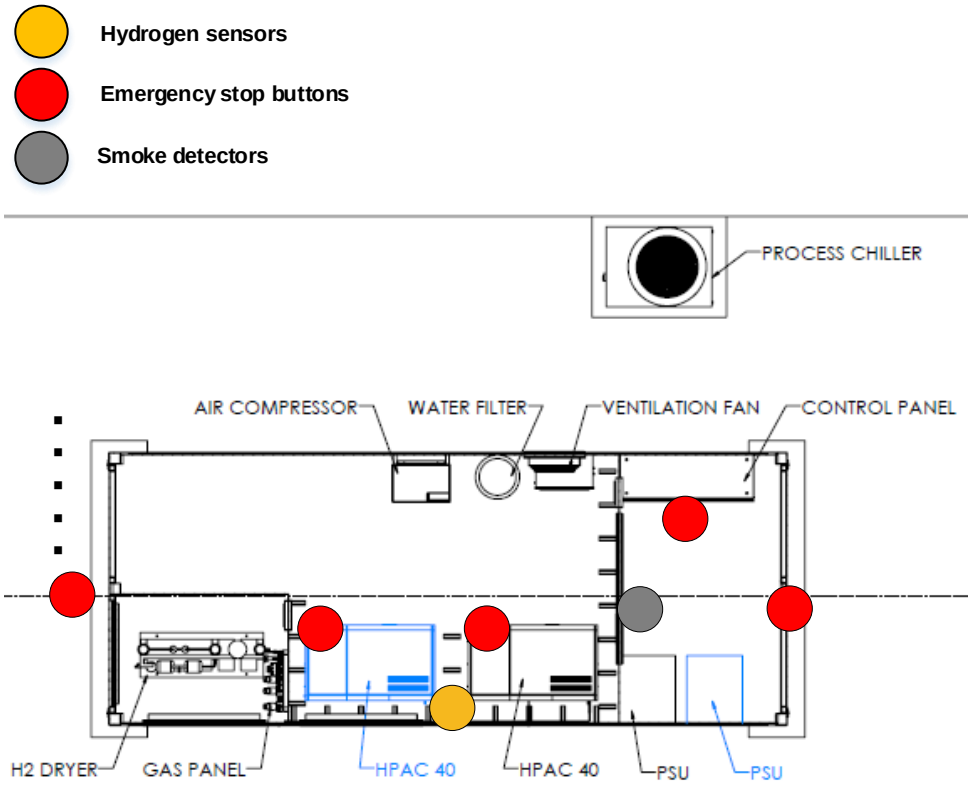


Figure 3 Location of hydrogen sensors, smoke detectors and emergency stop buttons throughout the plant. (Items drawn in blue show additional but not confirmed equipment)

- Smoke detectors: a smoke detector is located in the control room.
- Hydrogen sensors: the plant has one hydrogen sensor that is located in the ceiling of the hydrogen generation room. A detection of more than 25% of the lower flammability limit of hydrogen (i.e. 1% of hydrogen in air) would instigate a plant shutdown.
- Emergency stops: an emergency stop button is located in every room, due to the presence of powered machinery or a flammable gas hazard, and also at points of exit from the building.

It has to be noted that emergency stop buttons are also present on the chiller unit. However, these just operate the safety circuit of the chillers.

3.2.2 Hazardous zones and ATEX ratings of components

The HPAC40 electrolyser creates a Zone 2 of negligible extent within itself by using a high local ventilation rate. Hydrogen created by the stack is immediately routed to the dryer room and buffer tank area by seamless lines, therefore the larger hydrogen generation room cannot be exposed to hydrogen leaks.

The dryer room is a Zone 2. Small leaks cannot be ruled out so all components used are adequately ATEX rated for the hazardous area classification of its intended location (i.e. ATEX II 3G for gas group IIB + H_2 or IIC, or better).

Similarly all hydrogen bearing components outside the building are also sited in a Zone 2. Typically external hazard zones of 1 to 2 m are suitable for external components at low pressure.

Care should be taken to ensure all non ATEX sources of ignition, such as external lighting or ventilation intakes, are outside of these zones.

3.2.3 Leak detection

There are two methods for hydrogen leak detection: gas detectors and pressure drop detectors. Leaks in the HPAC40 room can be detected by the gas sensor mounted above the equipment just below the roof. The electrolyser plant and dryer have an additional layer of protection as it will alarm if the system pressure unexpectedly drops. This is active during generation but performs an additional test at the end of plant generation where it holds pressure before venting it.

3.2.4 Design safety studies

A number of different hazard studies are performed by ITM Power as part of the design phase. These include:

- HazOp
- Semi-Quantitative Risk Assessment (LOPA)
- Operational Risk Assessments
- Flammable gas safety study
- Pressure safety study

These safety studies will be referenced to local and national safety requirements.

4 Electrical architecture

4.1 Supply requirements

The plant requires a 3 ph, 400 V, 50 Hz supply. The plant must remain continually energised even when not electrolysing; this is to ensure basic plant health protection functions are not interrupted. The estimated plant power consumption is provided in Table 2.

	Max power draw at ambient temperature <5°C (kVA)
Plant electrolysing at 100 % (one HPac)	45
Plant electrolysing at 100 % (two HPac's)	70
Plant in idle/standby	5

Table 2. Average power load of the hydrogen plant

An extended period without power risks permanent damage to the plant. For this reason it is recommended a back–up power source be provided (typically a diesel generator). A separate socket inlet is provided for a back-up source. Interlocking is used to ensure the backup source cannot be paralleled with the main inlet supply.

5 Plant Control System

The plant control system is based on S7 PLCs. A failsafe, S7-300 PLC in the main control panel, automates the overall plant and provides the safety critical control functions (monitoring of E-stops, H2 detector, smoke detector). A local HMI is located on the front of the main control panel for process visualisation and control.

An S7-1200 PLC is located in each HPac. This PLC automates the HPac and acts as a slave to the master PLC in the main control panel. All PLCs and the HPac power supplies are linked by ProfiNet.

5.1 Safety

Safety critical sensors (emergency stop buttons, gas detectors and smoke detectors) are interfaced to failsafe PLC channels. In the event of a critical alarm, failsafe PLC output channels are used to de-energise the plant (using a shunt trip) and open the vent line.

Provision will also be made for a hardwired plant safety report to the customer, and a site shutdown input to enable an emergency shutdown.

5.2 Remote Access

The customer may interface to the plant remotely over fieldbus. This enables stop/start/demand commands to be passed to the plant and process variables and performance data to be reported back. A Gateway will be installed enabling the plant to connect to any of the industry standard fieldbus topologies.

6 General description of plant ventilation

Ventilation is essential for many areas of plant operation. Some areas can use natural ventilation but many areas require it to be forced by using air fans.
A diagram showing the required ventilation is shown below.

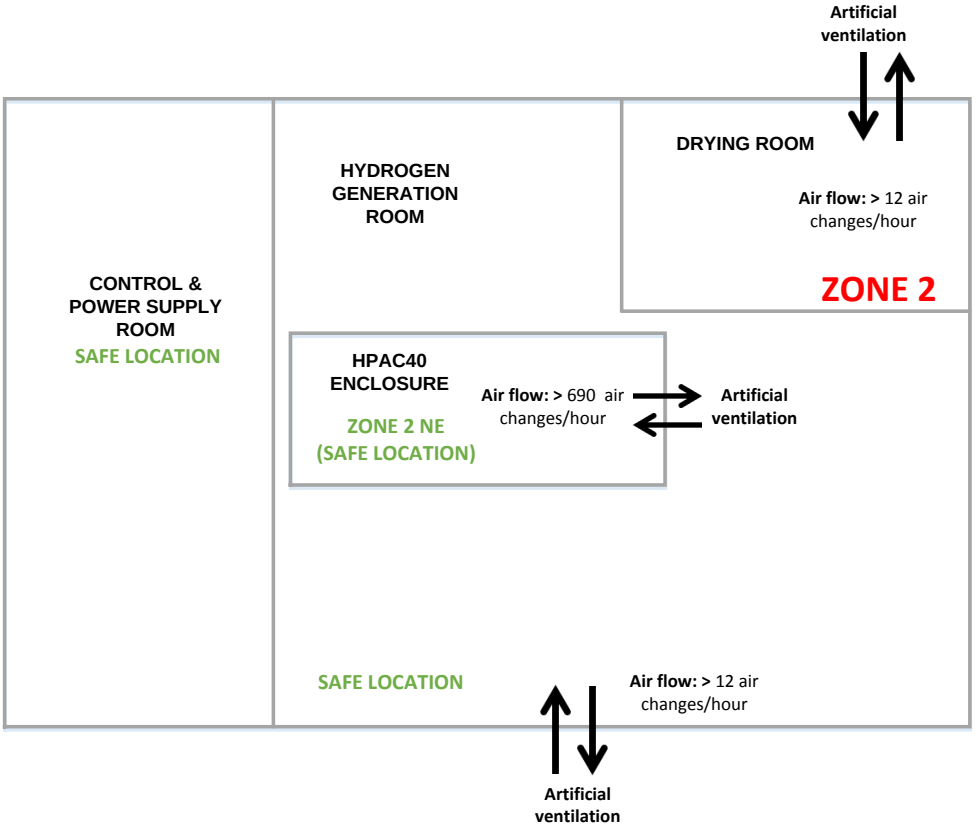


Figure 4 Plant ventilation

The Hydrogen Generation Room enclosure requires 'fresh air' at all times. In order to provide this a fan is required to circulate a minimum of 12 air changes per hour. The HPAC40 enclosure requires a high degree of ventilation in order to achieve a 'Zone 2 of Negligible Extent'. This category of zone dilutes any leak before it has chance to create a zone of flammable gas.

The Drying Room houses the majority of the hydrogen bearing parts and is therefore a Zone 2. Leaks are possible so a minimum air exchange rate of 12 changes per hour is required to dissipate any release.

7 Environmental Impact

7.1 Hazardous fluids

There are a number of fluids contained within the hydrogen plant that could be considered hazardous. A summary table for these components is showed in the table below.

Component	Fluid	Type	Environmental characteristics	Estimated volume (L)
Utility coolers	Secondary Refrigerant Antifreeze (28% v/v)	Coolflow DTX (Ethylene Glycol)	Non-toxic and readily biodegradable.	30

Table 5 - Hazardous liquids inventory in the hydrogen plant

Location	Fluid	Estimated volume (NL)
Hydrogen generation room	Hydrogen	22.5
Hydrogen generation room	Oxygen	3
Drying Room	Hydrogen	61

Table 6 - Hazardous gases inventory in the hydrogen plant

7.2 Emissions in normal operation

The plant has three main emissions in normal operation: hydrogen, oxygen and clean wastewater.

Location	Fluid	Estimated volume (Nm^3/day)*
Hydrogen venting	Hydrogen	0.09
Oxygen venting	Oxygen	9.6
Water drains	Water	2

*Values estimated considering a continuous operation of 8 hours per day.

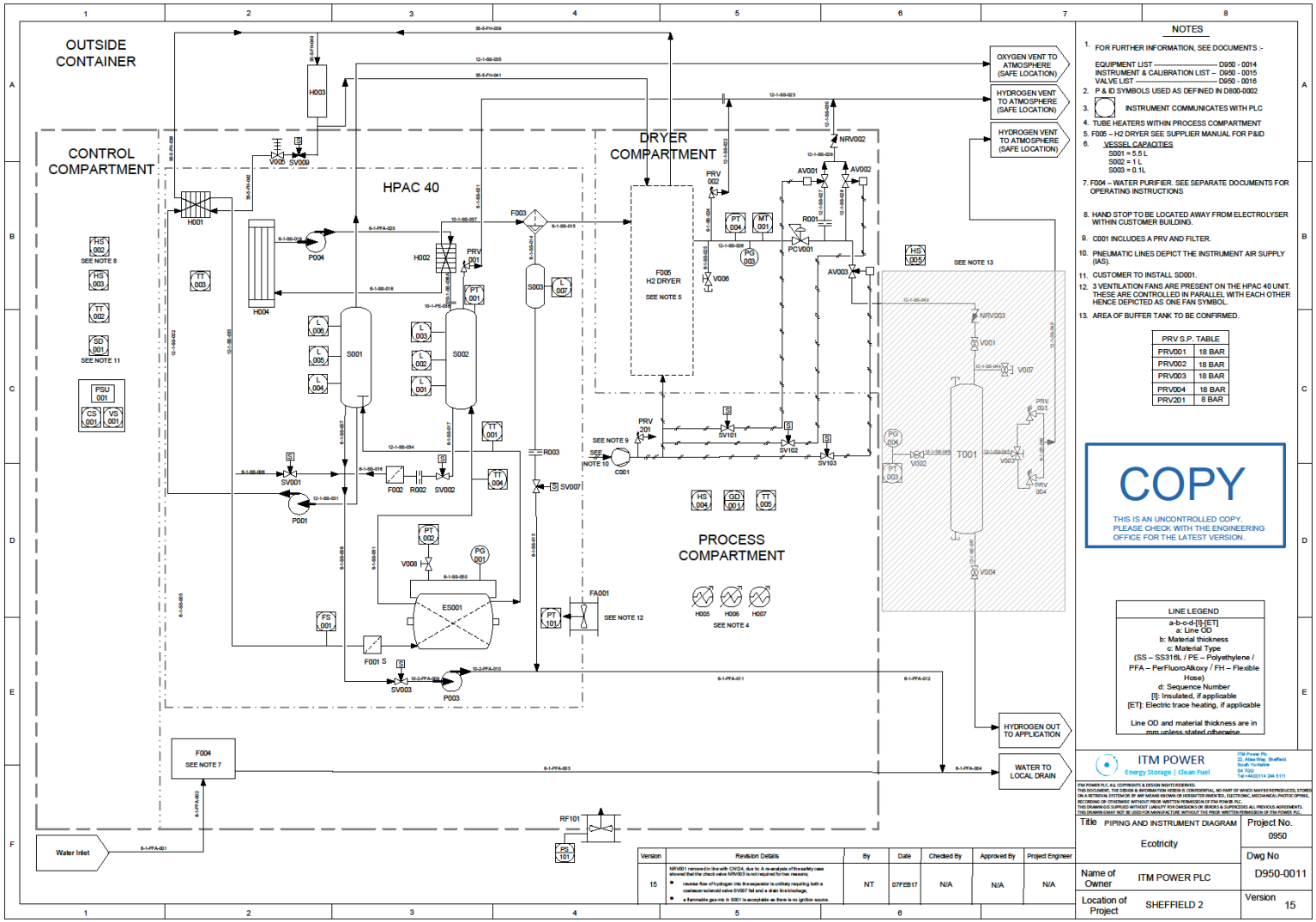
Table 7 - Hazardous gases inventory in the hydrogen plant

Waste water is created by the water purification system and the drying plant. This water is potable but is typically sent to drain. The anticipated waste-water flowrate from the ITM electrolyser is 240 L/h.

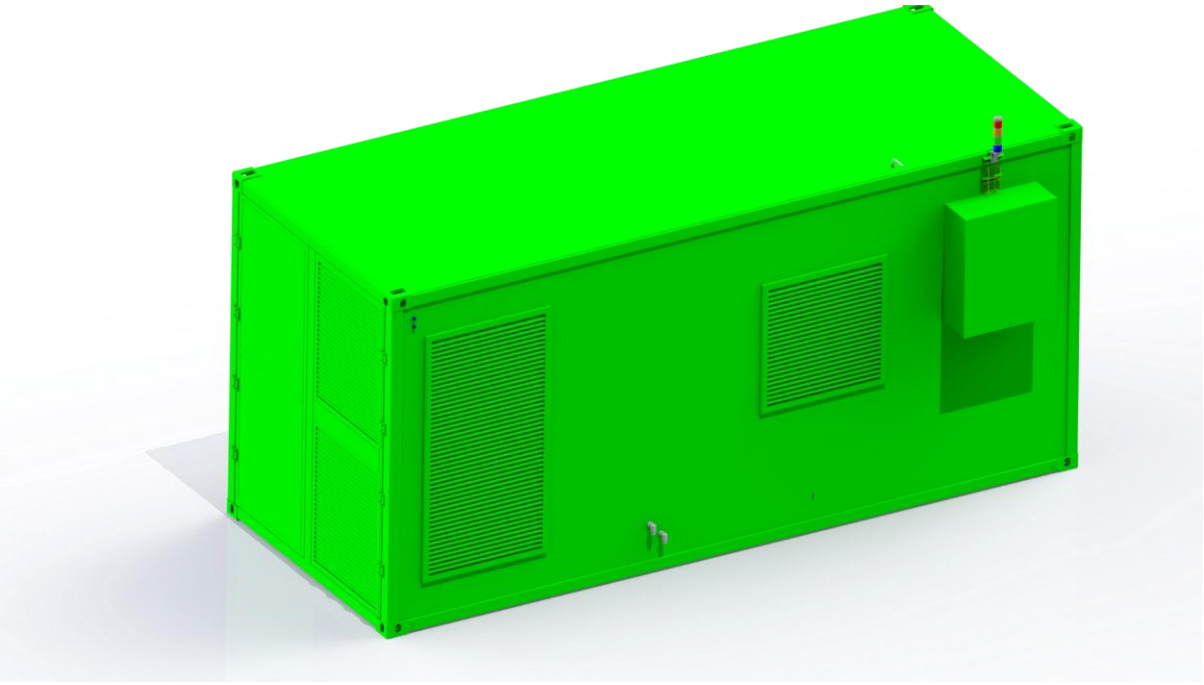
7.3 Noise

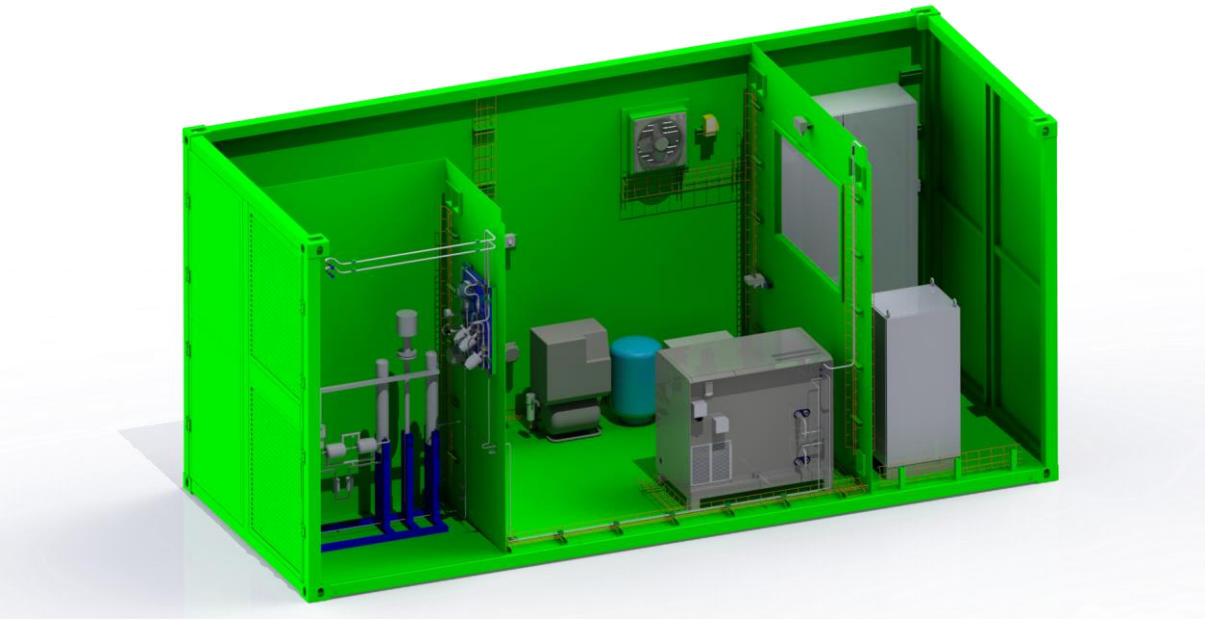
It is anticipated that the plant will generate in normal operation a level of noise below 80 dB(A) at 1 meter outside the container.

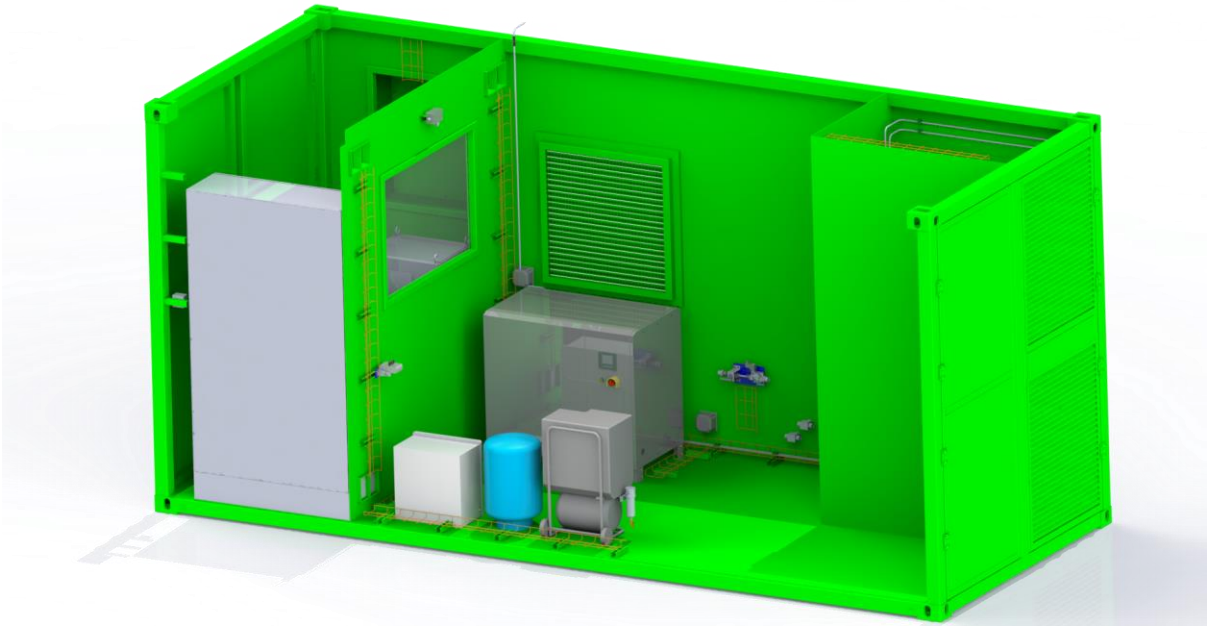
APPENDIX A – Provisional P&ID



APPENDIX B – Provisional equipment layout drawings







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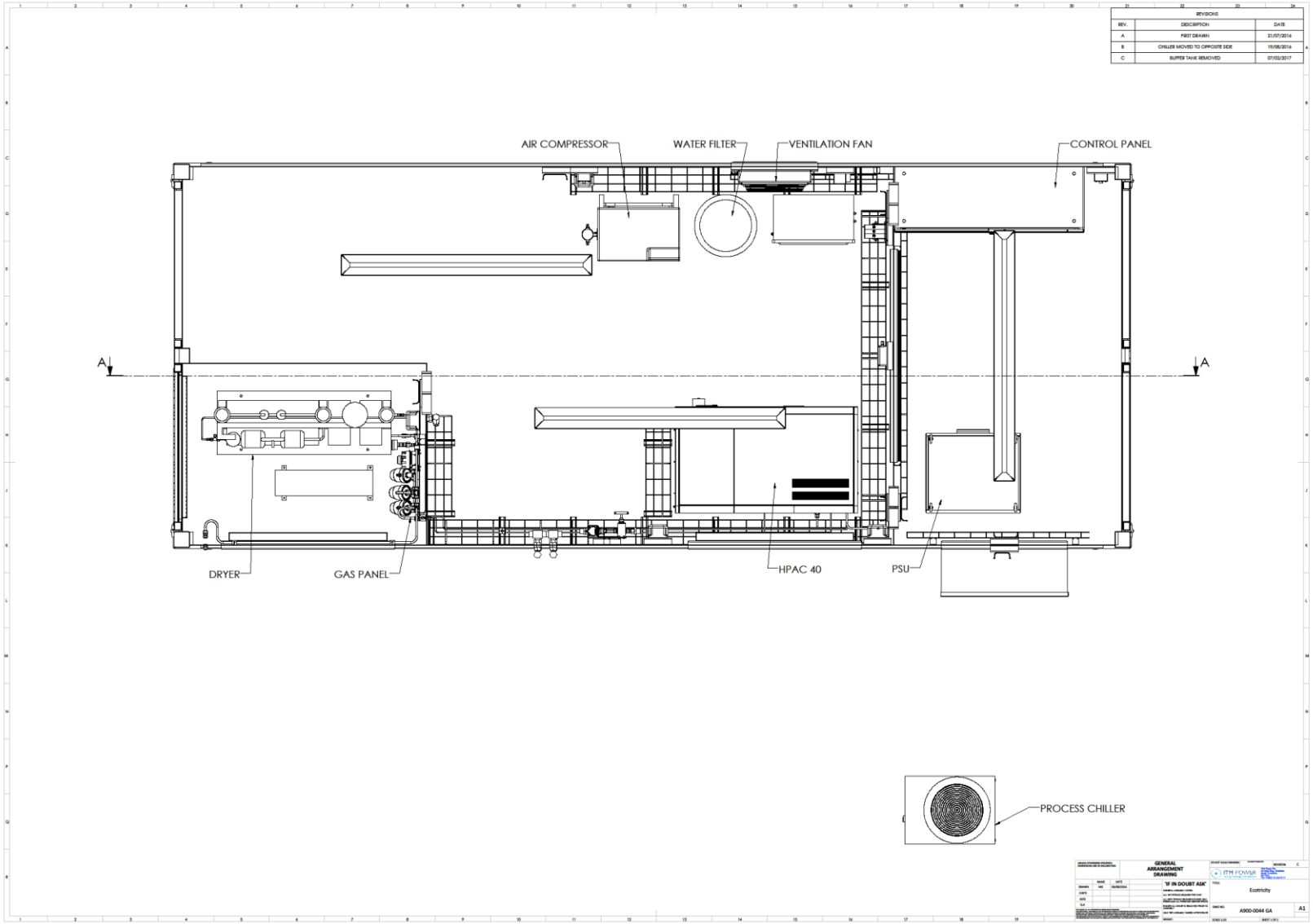
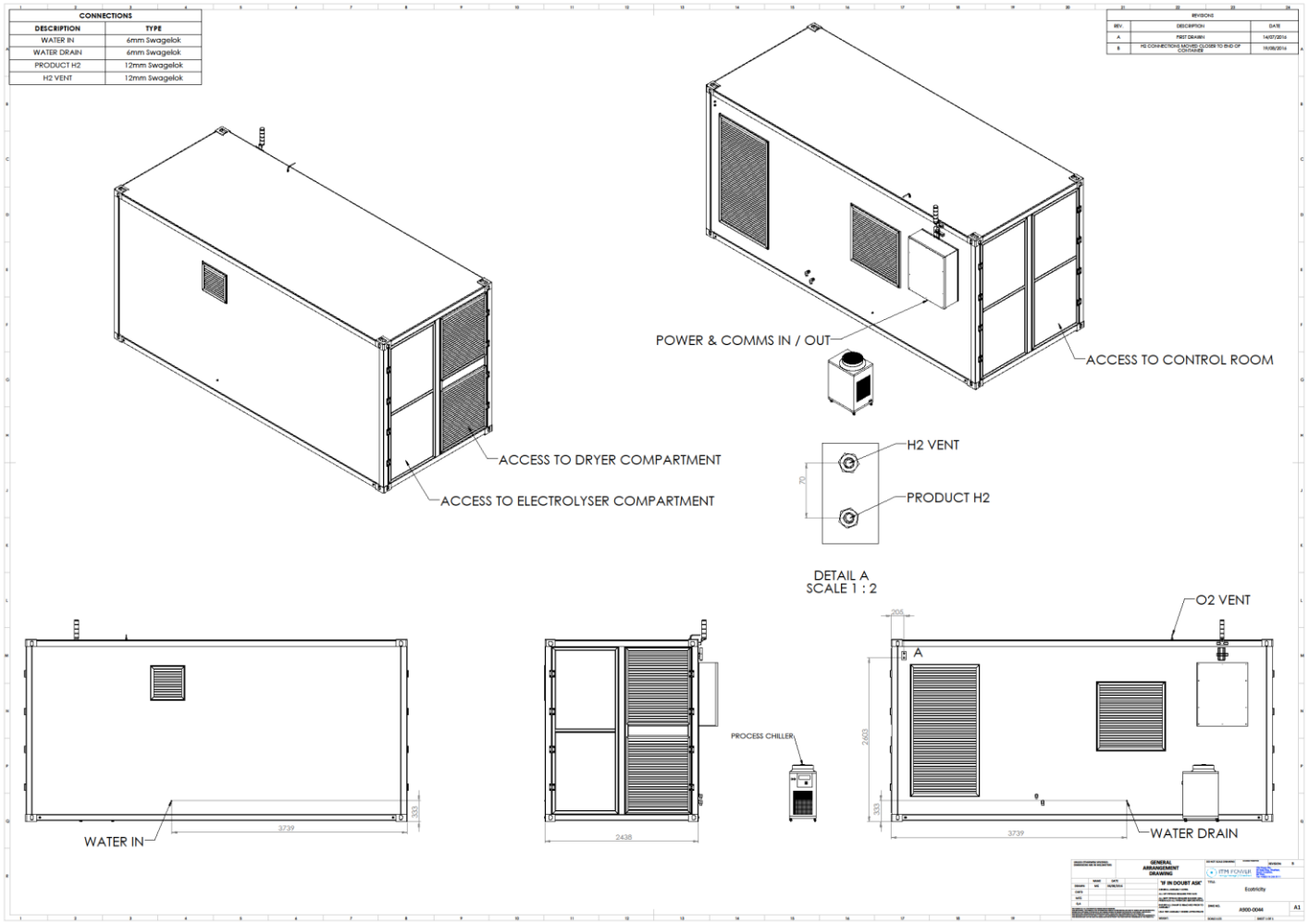
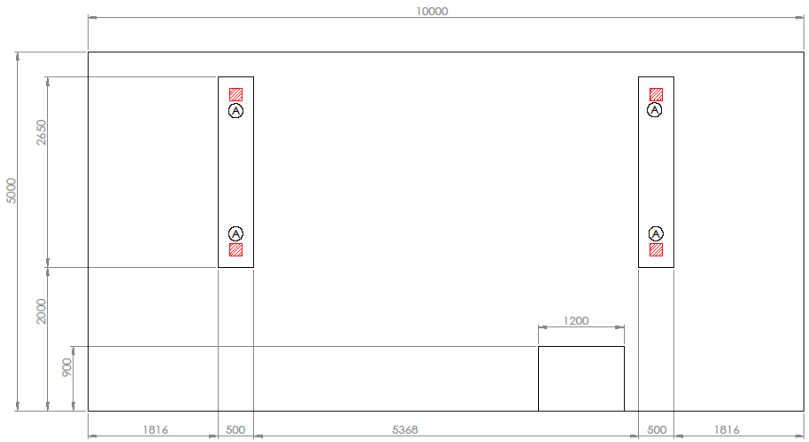


APPENDIX C – Electrolyser connections drawing



APPENDIX D – Provisional building foundations

REVISIONS		
REV.	DESCRIPTION	DATE
A	FIRST DRAWN	21/07/2016
B	BUFFER TANK PADS REMOVED	06/02/2017



NOTES:
CONCRETE PADS RAISED 50MM TO BE PROVIDED TO SUPPORT CONTAINER & PROCESS CHILLER

STATIC LOAD TABLE			
ITEM	DESCRIPTION	STATIC LOAD (KG)	NOTES
A	ELECTROLYSER	7000	LOAD DISTRIBUTED EVENLY OVER 4 POINTS

FINISH: GENERAL ARRANGEMENT DRAWING — DEBUR AND BREAK SHARP EDGES — DO NOT SCALE DRAWING — 3rd ANGLE PROJECTION — REVISION B

ITM POWER Energy Storage | Clean Fuel

	NAME	DATE
DRAWN	MG	14/07/2016
CHKD		
MFG		
Q.A		

'IF IN DOUBT ASK'

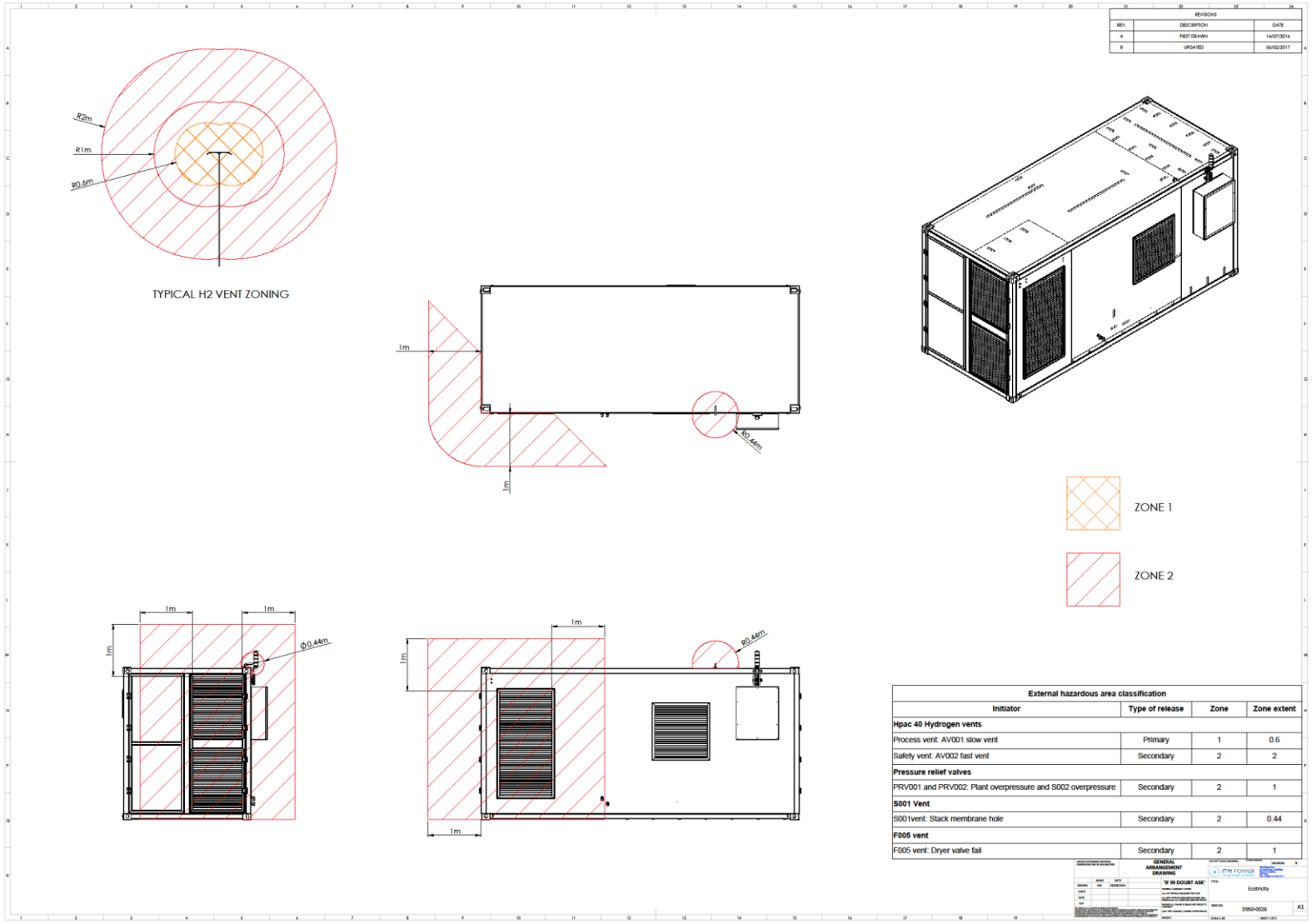
GENERAL ASSEMBLY NOTES:
ALL NPT FITINGS REQUIRE PTFE TAPE
ALL BSPP FITINGS REQUIRE BONDED SEAL PRESHAVE ALL PIPEWORK BEFORE FITTING
ENSURE ALL SWARF IS REMOVED PRIOR TO ASSEMBLY
LEAK TEST ASSEMBLY WHERE APPROPRIATE

TITLE: Ecotricity Foundations

DWG NO. Ecotricity civils base — A2

SCALE: 1:35 On A2 — SHEET 1 OF 1

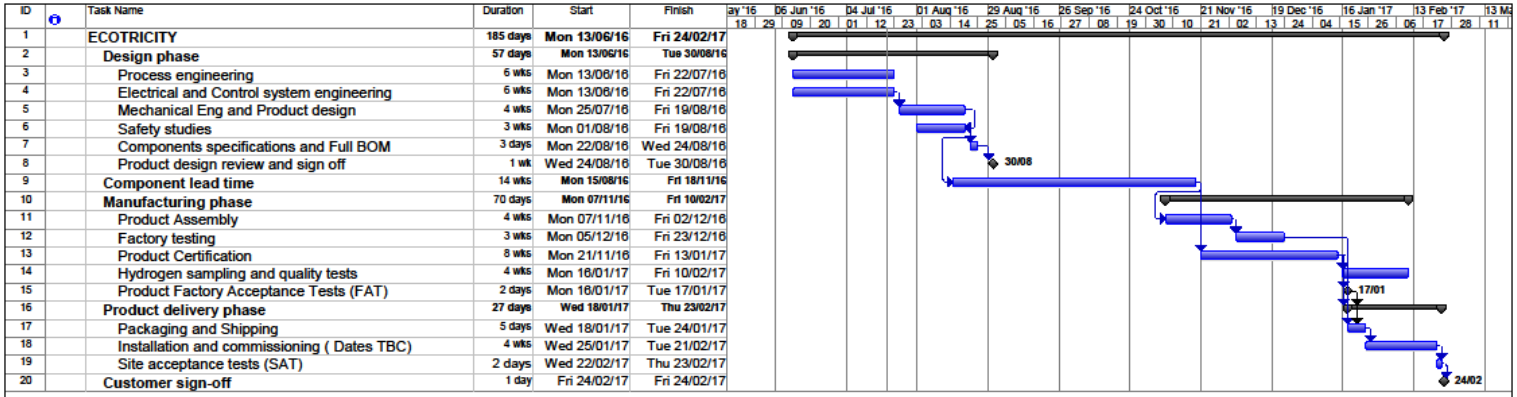
APPENDIX E – Hazardous area drawing



External hazardous area classification			
Initiator	**Type of release**	**Zone**	**Zone extent**
Hpac 40 Hydrogen vents			
Process vent: AV001 slow vent	Primary	1	0.6
Safety vent: AV002 fast vent	Secondary	2	2
Pressure relief valves			
PRV001 and PRV002: Plant overpressure and S002 overpressure	Secondary	2	1
S001 Vent			
S001vent: Stack membrane hole	Secondary	2	0.44
F005 vent			
F005 vent: Dryer valve fail	Secondary	2	1

APPENDIX F – Project plan

ID	Task Name	Duration	Start	Finish
1	**ECOTRICITY**	**185 days**	**Mon 13/06/16**	**Fri 24/02/17**
2	**Design phase**	**57 days**	**Mon 13/06/16**	**Tue 30/08/16**
3	Process engineering	6 wks	Mon 13/06/16	Fri 22/07/16
4	Electrical and Control system engineering	6 wks	Mon 13/06/16	Fri 22/07/16
5	Mechanical Eng and Product design	4 wks	Mon 25/07/16	Fri 19/08/16
6	Safety studies	3 wks	Mon 01/08/16	Fri 19/08/16
7	Components specifications and Full BOM	3 days	Mon 22/08/16	Wed 24/08/16
8	Product design review and sign off	1 wk	Wed 24/08/16	Tue 30/08/16
9	**Component lead time**	**14 wks**	**Mon 15/08/16**	**Fri 18/11/16**
10	**Manufacturing phase**	**70 days**	**Mon 07/11/16**	**Fri 10/02/17**
11	Product Assembly	4 wks	Mon 07/11/16	Fri 02/12/16
12	Factory testing	3 wks	Mon 05/12/16	Fri 23/12/16
13	Product Certification	8 wks	Mon 21/11/16	Fri 13/01/17
14	Hydrogen sampling and quality tests	4 wks	Mon 16/01/17	Fri 10/02/17
15	Product Factory Acceptance Tests (FAT)	2 days	Mon 16/01/17	Tue 17/01/17
16	**Product delivery phase**	**27 days**	**Wed 18/01/17**	**Thu 23/02/17**
17	Packaging and Shipping	5 days	Wed 18/01/17	Tue 24/01/17
18	Installation and commissioning (Dates TBC)	4 wks	Wed 25/01/17	Tue 21/02/17
19	Site acceptance tests (SAT)	2 days	Wed 22/02/17	Thu 23/02/17
20	**Customer sign-off**	**1 day**	**Fri 24/02/17**	**Fri 24/02/17**



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APPENDIX C

V09__InterfaceManual_Ecotricity

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1. INTERFACE OVERVIEW

Media	No.	Description	Connection type at CO_2 Capture Plant	Size
Ambient air	1.1	Inlet	Air intake hood of the Filter Unit	approx. 1100 mm
	1.2	Outlet	Air outtake hood of the Filter Unit	approx. 800 mm
Tap water	8.2	Inlet (for service and commissioning)	Hose nozzle, stainless steel 1.4408, DIN2999, PN10, 26 mm	DN25
	PW	Liquefaction System inlet	25.4 OD SMS Union with EPDM seal	DN15
Condensate	8.3	Outlet	Flange, stainless steel, EN 1092-1, type 11, form B, PN16	DN15
	8.4	Outlet	Flange, stainless steel, EN 1092-1, type 11, form B, PN16	DN15
	Drain	Liquefaction System outlet	25.4 OD SMS Union with EPDM seal	DN15
CO_2 product	9.0	Process Unit outlet	Flange, stainless steel, EN 1092-1, type 11, form B, PN16	DN25
	9.1	CO_2 Conditioning Unit outlet	Flange, stainless steel, EN 1092-1, type 11, form B, PN16	DN20
	Raw CO_2	Liquefaction System inlet	Flange, stainless steel, EN 1092-1, type 01, form B, PN25	DN15
	CO_2 Out	Liquefaction System outlet	Flange, stainless steel, EN 1092-1, type 01, form B, PN25	DN15
Exhaust air	9.2	Outlet	Hose nozzle, stainless steel 1.4408, DIN2999, PN10, 26 mm	DN25
	9.3	Outlet	Hose nozzle, stainless steel 1.4408, DIN2999, PN10, 26 mm	DN25
	To Vent	Liquefaction System outlet	Air outtake hood of the Liquefaction System	DN15
Electricity	10.1	Process Unit power	Connecting terminals for 5 wires (3L + N + PE)	Max 5 x 10 mm^2
	10.2	Electric Heater power	Connecting terminals for 5 wires (3L + N + PE)	Max 5 x 70 mm^2
	10.3	Refrigeration Cooler power	Connecting terminals for 5 wires (3L + N + PE)	Max 5 x 10 mm^2
	10.4	CO_2 Conditioning Unit power	Connecting terminals for 5 wires (3L + N + PE)	Max 5 x 6 mm^2

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	10.5	Potential equalization	Connecting terminal for single wire	Max 1 x 35 mm^2
	10.6	Grounding		
	10.7	Liquefaction System	Panel power connection 3 phase, terminals for 5 wires (3L + N + PE)	Max 5 x 6 mm^2
Internet	11.1	Upload / Download	RJ45 female plug	10 Mbit/s
Control interface	12.1	Control in / out (PROFIBUS)	9-pole female D SUB connector	-
	12.2	Emergency Stop	Connecting terminals for 4 wires	Max 4 x 1.5 mm^2

2. INTERFACE DEFINITION

Ambient air

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
1.1	Pressure [bar (g)]	-0.1	0	-	+0.1
	Temperature [°C]	-15	10	-	50
	Relative humidity [%]	5	60	-	99
	Volume flow [m^3/h]	0	approx. 20'000	-	25'000
	Quality	Ambient atmospheric air, not including any stream drawn from industrial processes; free of industrial dust/particles			

Tap water (for service and commissioning purpose only)

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
8.2	Delivery pressure [bar (g)]	1.5	3	-	5
	Temperature [°C]	3	15	-	40
	Volume flow [m^3/h]	0	0	-	0.5
	Hardness [° German scale]	7	8.5	-	10
PW	Delivery pressure [bar (g)]	2	2.5	-	5
	Temperature [°C]	4	15	-	18
	Flow rate [l/h]	0	8	-	10
	Hardness [° German scale]	7	8.5	-	10
	Pressure drop [bar]	0	0.5	-	1

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Condensate

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
8.3	Outlet pressure [bar (g)]	0.1	0.3	-	3
	Temperature [°C]	3	20	-	40
	Volume flow [l/h]	0	100	-	2000
	Production [l/day]	0	500	-	1000
8.4	Outlet pressure [bar (g)]	0.1	0.3	-	3
	Temperature [°C]	3	20	-	40
	Volume flow [l/h]	0	-	-	300
	Production [l/day]	0	-	-	-
Drain	Outlet pressure [bar (g)]	0.1	0.3	-	3
	Temperature [°C]	3	20	-	40
	Volume flow [l/h]	0	8	-	10
	Production [l/day]	0	200	-	250

Captured CO_2 (before and after the CO_2 Conditioning Unit, just for information purposes)

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
9.0	Outlet pressure [bar (g)]	0	0.05	0.2	0.5
	Temperature [°C]	5	30	-	50
	Mean volume flow [m^3/h]	0	approx. 2	-	approx. 2
	Volume flow during desorption [m^3/h]	0	6	-	30
	Purity [%]	98	99.9	-	100
	Oxygen content [ppm]	0	30	100	21'000
	Dew point [°C]	5	30	-	50
9.1	Outlet pressure [bar (g)]	0	0.2	0.5	0.5
	Temperature [°C]	1	30	-	50
	Mean volume flow [m^3/h]	0	approx. 2	-	approx. 4
	Purity [%]	98	99.9	-	100
	Oxygen content [ppm]	0	30	-	21'000
	Dew point [°C]	5	30	-	50

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CO_2 product (before and after the Liquefaction)

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
Raw CO_2	Pressure [mmwc gauge]	0	25	-	100
	Temperature [°C]	1	15	-	25
	Massflow [kg/h]	0	4	-	8
	Purity [%]	98	99.9	-	100
CO_2 Out	Outlet Pressure [bar (g)]	6	14-17	-	21
	Temperature [°C]	-	-28	-	-55
	Massflow [kg/h]	0	4	-	8
	Purity [%]	99.99	99.995	-	100
	Nitrogen content [ppm]	0	30	-	50
	Dew point [°C]	-	-60	-	-

Exhaust air

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
9.2	Outlet pressure [bar (g)]	0.025	0.05	0.2	0.5
	Temperature [°C]	5	25	-	50
	Volume flow [m^3/h]	0	-	-	150
	Volume flow [Nm^3/day]	0	16	-	20
9.3	Outlet pressure [bar (g)]	0	0.01	0.02	6
	Temperature [°C]	5	25	-	50
	Volume flow [m^3/h]	0	-	-	-
	Volume flow [Nm^3/day]	0	-	-	-
To Vent	Outlet pressure [bar (g)]	6	7	-	21
	Temperature [°C]	5	25	-	50
	Volume flow [m^3/h]	0	-	-	-
	Volume flow [Nm^3/day]	0	-	-	-

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Electricity

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
10.1	Voltage [V, 3-phase]	380	400	-	420
	Current, fuse protection by client [A, 3-phase]*	0	30	-	32
	Frequency [Hz]	50	50	-	50
10.2	Voltage [V, 3-phase]	380	400	-	420
	Current, fuse protection by client [A, 3-phase]	0	123.2	-	125
	Frequency [Hz]	50	50	-	50
10.3	Voltage [V, 3-phase]	380	400	-	420
	Current, fuse protection by client [A, 3-phase]	0	25.6	-	32
	Frequency [Hz]	50	50	-	50
10.4	Voltage [V, 3-phase]	380	400	-	420
	Current, fuse protection by client [A, 3-phase]	0	5	-	16
	Frequency [Hz]	50	50	-	50
10.7	Voltage [V, 3-phase]	360	400	-	420
	Current, fuse protection by client [A, 3-phase]	0	9	-	16
	Frequency [Hz]	50	50	-	50

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Internet

No.	Property	Min-Value	Nominal-Value	Max-Value (Safety)	Max-Design-Value
11.1	Upload / Download [Mbit/s]	-	10	-	-

Control

No.	Input/ Output	Name	Type	Comment
12.1	In	Start CO_2 Production	Bool	If TRUE, CO_2 production and storage in the gas buffer will start until buffer is filled, if FALSE CO_2 production will stop.
	In	Acknowledge Error	Bool	If TRUE, this signal acknowledges internal errors of the plant if they are resolved.
	Out	Ready	Bool	TRUE: plant is turned on and CO_2 production can be started. FALSE: plant has to be turned on manually in order to be started.
	Out	CO_2 Production	Bool	TRUE: CO_2 production is running.
	Out	General Error	Bool	TRUE: CO_2 production is stopping or cannot be started due to an internal error.
	Out	Error code	Array(Bool)	Indicates the type of internal error
	Out	Operating Mode	Bool	TRUE: Plant is controlled by PCS. FALSE: Plant is controlled locally.
	Out	CO_2 Level	Real	Indicates the level of the CO_2 buffer in %
12.2	In	Emergency stop	2 opening contacts (4 wires)	Shuts down plant if at least one of the contacts is opened, PC and sensors still operating.

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3. GLOSSAR

CW	Climeworks
Status Dokument: Draft	Dokument ist noch nicht genehmigt und freigegeben
Status Dokument: Final	Dokument ist genehmigt und freigegeben
Kategorie Dokument: Secret	Dokument ist nur für den VR und die Geschäftsleitung zugänglich
Kategorie Dokument: Confidential	Dokument ist nur für explizit bestimmte CW-Mitarbeiter und Externe mit NDA (nur wenn zwingend erforderlich) zugänglich
Kategorie Dokument: Internal	Dokument ist nur für CW-Mitarbeiter zugänglich
Kategorie Dokument: Public	Dokument darf auch nach Extern gegeben werden]

4. CHANGE & REVIEW HISTORY

Rev	Chapter	Description	Date / Dep. / Name
V01		Offer stage version. To be confirmed during basic engineering.	2015-08-04 / O&S / Benjamin Keusch
V02		Offer stage version. Adapted to Demonstrator. To be confirmed during basic engineering.	2015-12-21 / O&S / Nic Repond
V03		Offer stage version. Re-Adapted to Collector. To be confirmed during basic engineering. Excluding internal connections to refrigeration cooler.	2016-02-08 / O&S / Benjamin Keusch
V04		Offer stage version. Several updates. To be confirmed during basic engineering.	2016-02-26 / O&S / Benjamin Keusch
V05		Mean volume flow of CO_2 corrected. To be confirmed during basic engineering.	2016-03-01 / O&S / Jan Wurzbacher
V06		Based on detail engineering	2016-11-24 / O&S / Benjamin Keusch
V07		Based on detail engineering	2017-03-15 / O&S / Benjamin Keusch
V08		Based on new liquefaction	2018-10-05 / O&S / Malin Siegwart
V09		Based on new liquefaction	2019-01-24 / O&S / Malin Siegwart

5. APPROVAL HISTORY

Rev	Chapter	Approver(s) / Dep.	Date
V01		Jan Wurzbacher / GL	2015-08-04
V02		Benjamin Keusch / O&S	2015-12-21
V03		Jan Wurzbacher / GL	2016-02-08
V04		Jan Wurzbacher / GL	2016-02-26
V06		Jan Wurzbacher / GL	2016-11-24
V08		Benjamin Keusch / O&S	2018-10-07
V09		Benjamin Keusch / O&S	2019-02-18

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APPENDIX D

ECT.01.18.PRS0203.REV03

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Project	ECT.01.18	**Document no.**	ECT.01.18.PRS0203.REV03.docx	**Level**	2

Client	Ecotricity Ltd.	**Document type**	Class A	**Attachments**	0

Title

Detailed Engineering Services and Construction of a Bio-Methanation Package Unit (Process+BoP)

Products & Waste Specifications

Notes:

Date	**Prepared by**	Signature	**Checked by**	Signature	**Approved by**	Signature
30 Jul. 19	M. Energico				G. Cardani	

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1 Products & Waste Specifications Summary

identification	fluid description	characteristics - composition	type	tie-in at	design temper. [°C]	design pressure [bar g]	Destination
PR01-BMT	Bio-methane	See Table 1	Product	B.L.	Amb.	16	To user 12mm compression fitting SS 316
WS01-HVN	Hood vent	Air	Vent	B.L.	60	0,5	Environment
WS02-LWS	Liquid waste	See Tables 2 & 3	Waste	B.L.	70	0,5	Treatment/other disposal
WS03-AAD	Adsorbent A Disposal	N/A	Waste	B.L.	Amb.	Atm.	Treatment/other disposal
WS04-ABD	Adsorbent B Disposal	N/A	Waste	B.L.	Amb.	Atm.	Treatment/other disposal
WS05-PVN	Process Vent	See Cap. 1.6	Vent	B.L.	Amb.	Atm.	Environment, H: 6 m from the ground
WS06-FSV	Flammables Safety Vent	See Cap. 1.7	Vent	B.L.	70	Atm.	Environment, H: 6 m from the ground
WS07-ISV	Inert Safety Vent	Argon	Vent	B.L.	Amb.	Atm.	Environment, H: 4m from the ground
WS08-CCV	Chemical Cabinet Vent	Air	Vent	B.L	Amb	Atm	Environment

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1.1 PR01 – BMT

"Bio-methane" refers to the final product leaving the plant through the purification unit, consisting mainly of *methane* (≥95% Vol.), *hydrogen* (≤5% Vol.), and some trace elements (≤0.001% Vol.). The expected compositions are reported in the table below:

Offgas composition (raw)	**Target**
CH_4	≥95% Vol.
H_2	≤5% Vol.
CO_2	≤0.001% Vol.
H_2S	
NH_3	
H_2O	

Table 1: Bio-methane composition.

1.2 WS01 – HVN

"Hood vent" refers to the air sucked from the chemical hood installed into the lab zone to minimize the hazard of dust inhalation, it may contains some traces of the Raw Materials (see doc. "**ECT.01.18.RMS0202.REV00**") in powder.

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1.3 WS02 – LWS

"Liquid Waste" is a mixture of all the liquid refuses of the plant. In particular, it collects:

1. The harvest solutions coming from the Bio-Reactor. It consists mainly of water, and some residual bulk chemicals (*Iron*, *potassium*, *magnesium*, *sodium*, *phosphorus*, *sulfur*, and *ammonium ion*), and some trace elements (*calcium*, *cobalt*, *copper*, *manganese*, *molybdenum*, *nickel*, and *zinc*). The composition is reported in the tables below:

Bulk chemicals	Expected concentration [mg/L]	Possible ranges [mg/L]
Fe	0.8	0.2 – 2.5
K	226.4	50 – 500
Mg	4.1	1.5 – 10
Na	568	250 – 1000
P	67.4	50 – 1500
S	27.4	20 – 100
NH_4+	540	250 – 1500

Table 2: Residual bulk chemicals in harvest.

Trace elements	Expected concentration [µg/L]	Possible ranges [µg/L]
Ca	234	200 to x (depends on water used for media)
Co	182.5	50 – 500
Cu	<157	50 – 500
Mn	<14	0 – 50
Mo	308.5	150 – 1000
Ni	1056.1	200 – 2000
Zn	4254	0 – 5000

Table 3: Residual trace elements in harvest.

2. The process water used for washing the T-105 after the liquid feeds preparation, it contains some traces of the Raw Materials (see doc. "**ECT.01.18.RMS0202.REV00**").
3. The exhaust NaOH solution coming from the Ex-situ Scrubber S-301 during the replacement of the CO03 NaOH. The expected pH of the exhaust solution is 14, it is corrosive to metals, containing mainly water and NaOH with Na_2CO_3, Na_2S traces.

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1.4 WS03 – AAD

"Adsorber A Disposal" refers to the exhausted Adsorbent A, used into the H_2S Filter FIL-301.
Main chemical composition and components traces shall be evaluated by dedicated analysis.
See the doc. **ECT.01.18.US0210.REV00** attachment "MSDS_Material_A" for the disposal information.

1.5 WS04 – ABD

"Adsorber B Disposal" refers to the exhausted Adsorbent B, used into the CO_2 / NH_3 Filter FIL-302 and FIL-303.
Main chemical composition and components traces shall be evaluated by dedicated analysis.
See doc. **ECT.01.18.US0210.REV00** attachment "MSDS_Material_B" for the disposal information.

1.6 WS05 – FSV

"Flammables Safety Vent" refers to all the flammable gaseous release from "Reaction and Purification Zone". Three different sources of release can be distinguished:

1. Release from the Pressure Safety Valves in "Reaction and Purification Zone" in case of overpressure deviation. The Flammable Safety Vent is the point of release where all the discharges of the pressure relief valves, summarized in the table below, are collected.

Unit	Tag	Fluid	Note
02	PSV-203	Biomethane (91%v CH_4, 5%v H_2, CO_2, H_2O)	ATEX (1) – Set Pressure = 16 barg
03-I	PSV-301	Biomethane (95%v CH_4, 5%v H_2)	ATEX (1) – Set Pressure = 16 barg
03-II	PSV-302	Biomethane (95%v CH_4, 5%v H_2)	ATEX (1) – Set Pressure = 16 barg
04	PSV-402	Calibration gas (95%v CH_4, 5%v H_2, H_2S and CO_2 in traces)	ATEX (1) – Set pressure = 4 barg
04	PSV-405	Biomethane (95%v CH4, 5%v H2)	ATEX (1) – Set pressure = 4 barg

Considering the discharge flowrate of the safety pressure valves the Safety Vent should last only few seconds.

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2. Release of the gas out of specification that cannot be sent to the Client's storage. It can take place during Plant Start-Up and more precisely during:
    a. Biology lag-phase, from 4 to 24 h, no feeding gases conversion, the release composition will be 80% H_2 and 20% CO_2 (by volume). Maximum flowrate 1650 Nl/h.
    b. Biology low conversion phase, from 4 to 8 h, exponential increasing of the feeding gases conversion into bio-methane, the composition changes continuously from 80% H_2 and 20% CO_2 to 95% CH_4 and 5% H_2 (product on spec.). The maximum flowrate decreases (according with the variation on the composition) from 1650 Nl/h to 340 Nl/h.
3. The inerting discharge of the filters during the adsorbent replacement operation. The expected composition is Argon with traces of process gases: methane, hydrogen, carbon dioxide, hydrogen sulfide, ammonia, water.

1.7 WS06 – ISV

"Inert Safety Vent" refers to the gaseous release from the Pressure Safety Valves in "Feed Preparation Zone" in case of overpressure deviations. Furthermore, it collects the release of pressure relief valve for the anaerobization of feed preparation tanks. The Inert Safety Vent is the point of release where all the discharges, summarized in the table below, are collected. The expected compositions of the release are:

Unit	Tag	Fluid	Note
01-II	PSV-109A	Argon	Set Pressure = 0,49 barg
01-II	PSV-109B	Argon	Set Pressure = 0,49 barg
01-II	PSV-109C	Argon	Set Pressure = 0,49 barg
01-II	PSV-109D	Argon	Set pressure = 0,49 barg
01-I	PSV-109E	Argon	Set pressure = 0,49 barg
01-I	PRV-105	Argon	Set pressure = 0,3 barg
01-II	PRV-109B	Argon	Set pressure = 0,3 barg

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1.8 WS07 – CCV

"Chemical Cabinet Vent" refers to the air sucked inside the chemical cabinet installed into the lab zone to minimize the hazard of dust accumulation. Inside the chemical cabinet the air is filtered. With the right maintenance of the chemical cabinet it is expected that no traces of Raw Materials (see doc. "**ECT.01.18.RMS0202.REV00**") are present.

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APPENDIX E

Gas Analysis Services Ltd report N210312 D&N H2 RGC4583 A

Gas Analysis Services Ltd.
Lomond Court,
Castle Business Park,
Stirling,
FK9 4TU.

Report for testing of Hydrogen at DandN.

Customer: DandN.

Location: Ecotricity/Sky Mining at Q Park, Stroud.

Sample Dates: 12th, 23rd & 29th March 2021.

Gases analysed: Hydrogen.

Report Date: 30th April 2021.

Report attachments: Reference cylinder certificate of analysis

Introduction

As part of a testing requirement, hydrogen was analysed at D&N facility. Oxygen and moisture contents were analysed on site with the remainder of testing performed in GAS laboratory from samples taken from D&N facility.

Methodology

All instruments used were in calibration at the time of test. All calibration gases used are directly traceable to the National Physical laboratory in the UK, a National Standards Authority. All testing was carried out with both equipment manufacturer's instructions and GAS procedures to ISO 14687-2.

Nitrogen / Hydrocarbons / CO

Equipment: Agilent 7890 Gas Chromatography 7890 with twin pHID detectors, 2ppm O2, 90% H2 Balance N2 reference standard used.
GC Calibrated at time of use.
Cylinder: 391475 Expiry Date: 28/Aug/25

Total Sulphur

Method: This was tested using GAS work instruction IN55324-Rev 1.
Equipment: An Agilent 7890B gas chromatograph and reference standard was used for this determination. Reference standard: 5ppm Dimethyl Sulphide, 5ppm Ethyl Mercaptan, 5ppm Dimethyl Sulphide, 5ppm Methyl Mercaptan Bal N2 Cyl 278583SG Exp 25/Aug/21.

Ethylene / Propene / Butane / 1,3-Butadiene / Trans-2-Butene / 2-Hexene / 3-Hexene / Benzene

Equipment: Samples taken were analysed back in the laboratory using Agilent 6890 Chromatograph with Flame Ionisation Detector Reference standard: 1.1% C3H8 in Air Cyl 2652873 Exp 14/Mar/21

Results

Component	Specification	Unit	CVD EX
N/A	**N/A**	**N/A**	**N/A**
Methane	INFO	ppm	1594
Carbon Dioxide	INFO	%	<0.01
Carbon Monoxide	INFO	N/A	ND
Nitrogen	INFO	%	4.9
Hydrogen	INFO	%	92.9
Ethylene	INFO	ppm	16,071
Ethane	INFO	%	<0.01
Acetylene	INFO	%	<0.01
n-Propane	INFO	%	<0.01
n-Butane	INFO	%	<0.01
i-Butane	INFO	%	<0.01
Oxygen	INFO	%	1.7
Propene	INFO	ppm	20
Propyne	INFO	ppm	5
1-Butene	INFO	N/A	ND
2-Methyl-1-Propene	INFO	ppm	7
1-Methylcyclopropane	INFO	ppm	52
3-Methyl-1-Pentene	INFO	ppm	5
2-Butene	INFO	ppm	3
Butane	INFO	ppm	3
1,3-Butadiene	INFO	ppm	3
Trans-2-Butene	INFO	ppm	3
1-Buten-3-yne	INFO	N/A	ND
Cyclopropyl acetylene	INFO	ppm	5
1-Hexene	INFO	ppm	2
2-Hexene	INFO	ppm	6
3-Hexene	INFO	ppm	3
Benzene	INFO	ppm	32
Toluene	INFO	ppm	<1

Conclusion

Analysis was completed for informational purposes.

Analyst: Nick Whitely / Frank Whelan / Regis Loubatiere

Report compiled by: Dan Riordan.

Report Date: 30th April 2021.

Report No: N210312 D&N H2 RGC4583 A.

Signed: Ashleigh Harte Date: 30APR21
Ashleigh Harte for Gas Analysis Services.

Approved by: Marie Carroll Date: 30 Apr 21
Marie Carroll for Gas Analysis Services

Revision History		
Revision	**Description**	**Date**
A	Initial Release	30/Apr/21

This report was completed in line with the requirements of MF-032 Rev 5

END.

APPENDIX F

D&N Installations & Design Ltd commentary on CVD exhaust gas

D&N INSTALLATIONS & DESIGN LTD

CVD exhaust monitoring at Sky Mining Stroud.

The CVD process involves exposing an atmosphere primarily consisting of hydrogen and methane to high temperature plasma under vacuum. The majority of the exhaust was found to be hydrogen.

The exhaust gases from one of the CVD machines in Sky Mining have been subjected to analysis. This analysis is detailed in the Report no: N210312 D&N H2 RGC4583 B. This gives a detailed breakdown of the gases found in the exhaust. The main component in the exhaust is hydrogen and the methane was found to have reacted to create a range of carbon-based species which included the formation of benzene. Ecotricity therefore have analytical determination of the quantity and identity of the species in the exhaust. For this reason, the volatile organic's have not been grouped together.

Ecotricity have performed a calculation based on the benzene emissions which puts the emitted benzene well below the 5 µg/m3 emission limit. A recalculation with the ethylene concentration of 16,071 ppm still gives an emission below the 5 µg/m3 emission limit.

No specific analysis has been performed for the following elements / compounds, however it is difficult to imagine why these would be present in the exhaust of the chamber as there are no obvious sources of these materials being processed within the vacuum chamber.

- arsenic
- cadmium
- chromium
- copper
- fluoride
- lead
- mercury
- molybdenum
- nickel
- selenium
- zinc

The following compounds have not been specifically analysed for.

Ammonia (NH_3)
Sulphur dioxide (SO_2)
Nitrogen oxide (NO_2)
Hydrogen fluoride (HF)
Nutrient nitrogen deposition.
Acidity deposition.

The levels of oxygen present in the CVD systems mean that it is very unlikely that SO_2 or NO_x would be generated. Equally the level of nitrogen in the CVD is very low meaning that it is unlikely that NH_3 would be generated. There is no fluorine used in the process meaning that HF formation is highly unlikely. The elements / compounds highlighted in the air quality directive will be discussed with our analytical company and if possible then the exhaust will be sampled for the compounds / elements listed to determine the levels of any emissions that are occurring.

Currently D and N believe that on the basis of the analysis that has been performed and the calculations pertaining to release quantities then Sky Mining is currently in compliance with UK legislation pertaining to air quality.

Report complied by Dr Darren Mennie

APPENDIX G

coolflow-dtx-pds

Coolflow DTX

Non Toxic Glycol Antifreeze

For process cooling & AC systems

Performance Properties

Coolflow DTX has been especially formulated for use in Process Cooling, Refrigeration and HVAC systems to exploit the advantages Ethylene Glycol has over Propylene Glycol - whilst delivering a non toxic solution. Specifically;

- More efficient heat transfer.
- Easier to pump, especially at low temperatures.
- Less volume for the same freeze protection.
- Cheaper per litre.

Non Toxic:

Although based on Ethylene Glycol, Coolflow DTX has been tested and classified as Non Toxic by an EPA certified laboratory. Previously Propylene Glycol was the only non toxic glycol available, that is no longer the case. Hydratech in alliance with Evans Cooling Systems, Inc. have developed and patented the DeTox™ additive. DeTox™ prevents Ethylene Glycol from being metabolised (during digestion) into toxic by-products, which cause kidney failure, blindness and death. Tests carried out on Coolflow DTX confirmed the toxicity was "so low that it was impossible to determine an LD50 value". The DeTox™ additive has very little effect on heat transfer or antifreeze performance. In fact similar volumes of Coolflow DTX or Ethylene Glycol are required to achieve a specific freeze protection.

Optimum Flow:

Coolflow DTX has improved heat transfer characteristics. Including lower Dynamic Viscosity and higher Thermal Conductivity. For detailed comparison please refer to the Fluid Performance Chart - available upon request.

Protection:

Coolflow DTX contains synergistic corrosion inhibitors to protect metals commonly found in such systems. It has been tested in accordance with BS5117 and found to meet BS6580 and ASTM D1384 corrosion standards. Coolflow DTX also contains scale and biological inhibitors to help prevent fouling - thus promoting long operational life and high thermal efficiency.

Physical Properties

Freeze Protection
-50°C depending on concentration.

Density
1.04 - 1.15 g/cm³ depending on inhibitors

pH
7.5 - 9.0 depending on inhibitors

Boiling Point
>100°C

Characteristics
a clear, slightly viscous liquid. It is mildly sweet to the taste and has a non-pungent but characteristic aroma

Biodegradability
Coolflow DTX mixtures are readily biodegradable (90% over ten days) and will not remain in the environment or bio-accumulate.

Container Sizes
Available in: 1, 5, 25, 205L drums & 1000L IBCs

Application

As per BSRIA guide BG 29/2012 all pipe-work systems should be clean and free from biological contamination and debris prior to commissioning. To minimise corrosion air ingress should be minimised. A pressurised system is best. Determine the total system volume and add Coolflow DTX to the system according to the minimum operating temperature required (see table). The minimum dose of Coolflow DTX should not be less than 22% of the system volume and the maximum does not normally exceed 60%. We recommend the use of deionised, distilled or UltraPure™ water for this dilution. Avoid water containing high levels of calcium salts or Chlorides [Cl-].

Coolflow DTX can be supplied as a Ready-To-Use solution.

Diluting Concentrate

When measuring the percentage concentration of Coolflow DTX in solution we recommend the use of a recently calibrated refractometer.

Frost Protection °C	v/v of Coolflow DTX %	Refractive Index
-10	22.0	1.356
-15	28.0	1.362
-20	33.0	1.367
-25	38.0	1.372
-30	42.0	1.376
-35	46.0	1.380

Fluid Management Services

To ensure inhibitor levels are being maintained and the system fluid is in good condition, we recommend periodic sampling and testing. Hydratech operate the Fluid Monitoring Program (FMP) as a free-of-charge service for all users of our products. For more information on the FMP please call or visit www.hydratech.co.uk.

Quality Assured

Coolflow DTX meets or exceeds the corrosion standards laid down in ASTM D-1384. Hydratech products are manufactured in accordance with ISO9001-2008 procedures.

Storage & Shelf Life

At least 3 years when stored in sealed containers, below 40°C and out of direct sunlight.

Health & Safety

Please refer to the associated Safety Data Sheet, which is available online via Login and/or by mail.

24/7 Technical Support

Technical support services and products to ensure ongoing system efficiency and protection.

tel. 01792 586800

sales@hydratech.co.uk

APPENDIX H

Scan of waste transfer note

GRUNDON

www.grundon.com

Advice Note / Consignor Declaration
Waste Transfer Note

(to comply with Section 34, Environmental Protection Act 1990)

Grundon Waste Management Ltd is defined as "The Carrier"
Waste Carrier Registration No: CBDU/SM3080SR
CBDU147323 AS OF 31/01/17
Issued by The Environment Agency
VAT Registration No: GB 785 4156 01

Grundon Waste Management Ltd
Thames House, Oxford Road, Benson, Wallingford, Oxon. OX10 6LX
Tel: 01491 834340 **Fax:** 01491 834319 **E-mail:** technical@grundon.com

Grundon Ref:	T2010080	Account No:	~~ECO1001~~ SKYMOST	Order Number:	PO-004723
Date:	07/01/2021	Advice Note No:	T201008000003	Consignment Note No:	SKYMING0002

Customer / Collection Address:
SKY MINING COMPANY LIMITED
Q-PARK
BATH ROAD
SOUTH WOODCHESTER
NR STROUD

Disposal Site:
GRUNDON WASTE MANAGEMENT LTD
EWELME TRANSFER STATION
GOULDS GROVE
EWELME
OXFORD OX10 6PJ

SKYM-001

Contact: KEVIN EMERY
Telephone No:
Facsimile No:
Licence No: WP3231SX
Booking Reference: jd 06/13
SIC: 26511

Description, Form and Quantity: Collection & Disposal
Attached Sheets: 0

07/01/21 - EXCHANGE 2 X IBC
18/12/20 - EXCHANGE 1 X IBC
23/10/20 - DELIVER 2 X 205L DRUMS, 2 X IBC AND 2 X 30L BUCKETS
LIST OF HAZ WASTE - DELIVER CONTAINERS

Ref:	Waste Description / Proper Shipping Name:	EWC:	Class(es):	UN Number:	PG:	Container Size:	No:	Quantity:
3	BASIC AQUEOUS WASTE CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (sodium hydroxide)	16 10 01*	8	3266	II	1000 LTR IBC(S)	2	2.00 IBC(S)

PPE Schedule:
Safety Glasses | PVC Gauntlets | High Visibility Vest | Safety Wellies

Additional Equipment:
Eye Wash | First Aid Kit | Hard Hat | Half Mask Respirator | Full Face Visor
Dust Mask | Disposable Suit | Chemical Suit | Safety Boots

Special Instructions:

EAC: 2X

Consignor Declaration
(The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations)

I confirm that in accordance with the relevant provisions of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations and any subsequent amendments thereof:

i. the dangerous goods as presented may be carried, and
ii. the dangerous goods and any packaging, intermediate bulk container or tank in which they are contained are in a fit condition for carriage and are properly labelled, and
iii. where several packages are packed together in an over-pack or in a single container, that this mixed packing is not prohibited

I (the Customer) do hereby declare that the service contracted for has been carried out to my complete satisfaction.
I confirm that I have fulfilled my duty to apply the waste hierarchy as required by regulation 12 of the Waste (England and Wales) Regulations 2011.

Signed: J. Woodward Print Name: J. WOODWARD Date: 7-1-21
by or on behalf of the Consignor above

Driver's signature on collection

Signed: A Mackie
Print Name: A. MACKIE
Vehicle Registration: OK69BUO
Arrival Time: 09.00 Departure Time:

Disposal Site Details

Driver's Name:
Driver's Signature:
Vehicle Registration:
Date:

EWC Received	Quantity (kgs)	Acc/Rej	R or D Code

Disposer's Name: ARRIVIUM Signed:

By law, a copy of this waste transfer note must be retained for 2 years

Carrier Copy

APPENDIX I

7000_C_0151 Signed connection agreement

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

CONNECTION AGREEMENT

THIS AGREEMENT is made the day of 2018

Between **Western Power Distribution (West Midlands) plc**
Registered in England and Wales No. 3600574
Whose **REGISTERED OFFICE** is at
Avonbank
Feeder Road
Bristol
BS2 0TB
("the Company")

And **Ecotricity (Next Generation) Limited**
Registered in England and Wales No. 03117225
Whose **REGISTERED OFFICE** is at
Lion House
Rowcroft
Stroud
Gloucestershire GL5 3BY
("the Customer")

Concerning the Customer's Premises known as
Bath Road
South Woodchester
WOODCHESTER
Gloucestershire GL5 5HT

Address for Notices	**Ecotricity (Next Generation) Limited**	**Western Power Distribution (West Midlands) plc**
	Lion House Rowcroft Stroud Gloucestershire GL5 3BY	Avonbank Feeder Road Bristol BS2 0TB

This agreement and the schedules to it shall be referred to as the "Agreement" and the "Schedules" respectively. The Agreement, the Schedules, and the National Terms of Connection shall together be referred to as the "Connection Agreement". The Company and the Customer shall together be referred to as the "Parties", and each a "Party".

The National Terms of Connection are available to view on the website: www.connectionterms.org.uk. Alternatively the Customer may request a copy from the Company by written request to the address for notices given above. The Customer confirms that they have read, fully understand and accept the terms of the National Terms of Connection.

Subject to the express provisions of this Agreement, Section 1 and either Section 2 (if the Customer uses whole current metering), or Section 3 (if the Customer uses C.T. metering) of the National Terms of Connection will apply as if set out in this Agreement and references in the National Terms of Connection to "this agreement" or to "this Agreement" shall be interpreted as if references to this Connection Agreement. Expressions used in this Agreement and the Schedules shall have the same meanings as if given to them in the National Terms of Connection.

To the extent that there is any conflict between this Agreement and the provisions of the Schedules or the National Terms of Connection, the order of precedence shall be as follows:
(a) this Agreement;
(b) the Schedules; and
(c) the National Terms of Connection.

The Company agrees to the Connection of the Customer's Installation to the Company's Distribution System on the terms and conditions of this Connection Agreement and in consideration of the Company's agreement to do so the Customer agrees to be bound contractually by the terms and conditions of this Connection Agreement. Details of the Premises, the Connection Points, the technical characteristics of the Connection Points and other matters are set out in the Schedules.

This Connection Agreement may be executed in any number of counterparts and by the Parties on separate counterparts, but shall not be effective until each Party has executed at least one counterpart. Each counterpart, when executed, shall be an original of this Connection Agreement and all counterparts shall together constitute one instrument.

Signed for Ecotricity (Next Generation) Limited	Signed for Western Power Distribution (West Midlands) plc
Signature.....	Signature.....
Print Name..... JOHN HILL	Print Name.....
Designation..... Electrical Projects Manager.	Designation Contracts and Agreements Manager

For Office Use Only

Scale: A DUoS LLF Code: 365 Supply Number Core: Import 1 4 7 0 0 0 0 9 1 0 2 6 0

Document Version 3 - March 2011 CROWN Reference:

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

SCHEDULE 1 - SPECIFIC TERMS FOR CONNECTION

Characteristics of the Supply of Electricity

Maximum Import Capacity:	**1200 kVA**
Maximum Export Capacity:	**0 kVA**
Voltage:	**11000 Volts**
Phase:	**Three Phase**
Frequency:	**50 Hertz**
Current:	**Alternating**

General

Connection Charges: The Customer will pay the Company a Connection Charge of £70,991.19 excluding value added tax.

The Maximum Import Capacity stated in Schedule 1 has been requested by the Customer and agreed by the Company. The Maximum Import Capacity will be fixed for 12 months from the date that this Agreement takes effect unless increased by agreement between the Customer and the Company, in which case the increased Maximum Import Capacity will be fixed for a further 12 months from the date of increase.

Enduring Terms

The Customer agrees that the Company shall, on the application of any person purporting to be an owner and/or occupier (or prospective owner and/or occupier) of the Premises, be entitled to disclose to such person the fact that this Connection Agreement contains terms which differ from the terms set out in the National Terms of Connection (www.connectionterms.org.uk).

The Customer shall, prior to selling or leasing its interest in the Premises (or otherwise permitting a third party to occupy the Premises), ensure that the existence and provisions of this Connection Agreement are brought to the attention of such third party. For information, any such third party should note that it may automatically be bound by the provisions of this Connection Agreement in accordance with the National Terms of Connection (www.connectionterms.org.uk).

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

SCHEDULE 2 - CONNECTION POINTS & ASSET USE

Connection Point:

The outgoing terminals of the Company's 11kV metering circuit breaker.

CONNECTION EXTENSION ASSETS

Relevant Connection Equipment:

Installation of 1x Schneider RN2 and metering unit
T300 and automation equipment
2 x 11kv 300 epr cable circuits

SHARED USE REINFORCEMENT ASSETS

Relevant Connection Equipment:

None.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

SCHEDULE 3 - GENERATING EQUIPMENT

1. The Company consent to the following generators being directly connected to the Company's Distribution System:

Type of Generation	Generation Unit Identification Name and/or Nonmenclature	Generation Unit Manufacturer, Make & Type	Installed Size of Generation (kW/per Unit)	No. of Units	No. of Phases	Commissioning Date	Long / Short Term Parallel or Stand-by Generation
None	None	None	None	None	None	None	None

APPENDIX J

Emergency Plan - Polluting Spillage

Emergency Plan – Polluting Spillage

Summary:	Procedures to be followed in the event of a polluting spillage or leak which may pose a safety risk or a pollution risk to the ground or surface water drainage system
Target Audience:	All Sky Mining employees or those carrying out activities on behalf of The Sky Mining Company
Next Review Date:	June 2023
Date issued:	**/02/2021
Author:	Jamie Woodward

Version Control

Date	Author	Version	Page	Reason for change
**/02/2021	Jamie Woodward	1.0		Baseline Document

1. PURPOSE

To provide instruction on procedures to be followed in the event of a polluting spillage or leak which may pose a safety risk or a pollution risk to the ground or surface water drainage system.

2. LOCATION OF KITS

The Sky Mining spill kits can be found within the machine hall opposite Eco 3 on the glass wall, under the stairs leading out to the gas yard and in the conservatory at the North end of the building.

3. PROCEDURE

Any person discovering a polluting spillage/leak or flood

- If possible DO NOT enter any area where there is evidence of a potential polluting spillage
- DO NOT use or touch any electrical appliances, switches etc.
- DO NOT touch any contaminated water/waste/oil/fuel
- Evacuate the area safely if required to do so
- DO NOT re-enter the building/area until authorised to do so by senior staff

Reporting a Polluting Spillage Outside of Office Hours

- Contact Glevum Security on 01452 729594

4. ACTION TO TAKE BY RESPONSIBLE PERSONNEL

Sky Mining Senior Staff Responsibilities

- Responsibility for ensuring that equipment is serviced and maintained correctly
- Responsibility for ensuring that spillage equipment is available in the immediate vicinity of equipment containing polluting chemicals such as Glycol.
- Responsibility for helping to ensure a safe and effective delivery of any potentially polluting chemicals.
- Responsibility for ensuring that, in the event of a fire attended by the Fire Service, all reasonable precautions and efforts are made to help ensure that fire water run-off (which may contain pollutants) does not enter the surface drainage system, where it could ultimately enter a water course
- Annual training of Sky Mining staff via a simulated polluting spillage exercise.
- Identification of drain systems to help identify likely areas of potential impact. Coloured marking of drains / drain covers to indicate: Blue: surface water drains; Red: foul water drains.

- Ensure that any incidents occurring on company premises that have a potential risk of pollution to the environment are dealt with in a safe manner to ensure minimal environmental impact
- Assess the situation quickly and calmly, taking measures to protect life, including your own
- If safe to do so, try and control the spill to prevent escape to the drainage system by any practical means i.e. by using the spill kit. Do not attempt to deal with any fuel or oil spill without appropriate safety glasses and gloves. If possible and safe to do so, stop the flow of further liquid and isolate the area.
- Do not leave the spill site unattended.
- Contact Ecotricity Maintenance Technician or 3rd party contractor as appropriate to assist with locating the root cause of the Spillage and taking the appropriate action.
- Isolate any water supply and electrics to the potentially contaminated area
- Notify IT of the incident and of any possible power outages etc that could affect servers or server rooms
- If affected area is an office space, then alternative location for staff is required to maintain BAU.
- Notify Managers/Senior management of incident with information on cause and plan to ensure Business Continuity.
- Where spillages involving fuel or oil or other pollutant substances have entered the drainage system, Sky Mining must contact the following without delay: -
    - Surface Water Drain: Report the spillage to the Environment Agency on 0800 807 060
    - Foul Drain: Report the spillage to Severn Trent on 0800 783 4444
    - Combined Drain: Report the spillage to Severn Trent on 0800 783 4444
    - Unknown drain type or potential spillage into water course: contact both the Environment Agency and Severn Trent
    - Should a spillage occur, DO NOT hose it down. Complete spillage clean-up using spill kit provided and ensure that surface drains are covered using the mats or covers provided.
- Where the Fire Brigade will attend the site and may use water to put out a fire, if it is safe to do so prepare the area that is likely to be affected by any fire water run-off by covering surface water drains with the mats or covers provided. These have been designed to prevent liquid from passing through into the drainage system.

Post Incident

- Collect all the waste residues and contaminated absorbents and dispose of them in the appropriate hazardous waste bin. Ensure that our waste disposal contractors (Grundon's) are advised and can collect any hazardous waste as soon as possible.
- Ensure that used spill kit components are restocked without delay.
- A Post Incident Review process should be triggered as soon as practicable after the incident. Refer to procedural document: Emergency Plan: Post Incident Review.

APPENDIX K

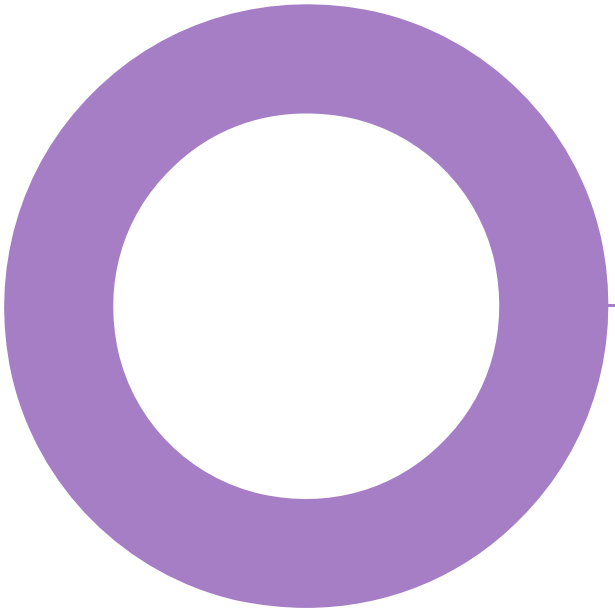
6755_P0002_01_Q Park - Noise planning Assessment

HOARE LEA

Q-Park Plant.
South Woodchester.
Ecotricity Group Ltd.

ACOUSTICS
NOISE PLANNING ASSESSMENT

REVISION 3 – 26 MARCH 2018



Audit sheet.

Rev.	Date	Description	Prepared	Verified
1	16/01/2018	First version for comment	MMC	RC
2	31/01/2018	Revision following comments	MMC	
3	26/03/2018	Updated with final layout	MMC	

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Document reference: REP-1007046-MMC-20180326-Q Park - Noise planning Assessment-Rev 3.docx

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Executive summary.

Hoare Lea (HL) was commissioned by Ecotricity (Next Generation) Limited to conduct a noise assessment of new plant to be installed at the Q-Park site in South Woodchester, near Stroud.

Hoare Lea determined baseline background noise levels at the nearest noise-sensitive dwellings with a survey at four different representative locations. Predictions of noise from the main potential sources of fixed plant were made at the nearest sensitive locations, based on indicative information. This allowed the development of a noise control strategy for the site and the definition of allowable noise levels for different items of equipment. Mitigation measures include the provision of a solid screen on the north side of the development.

The assessment demonstrated that the predicted rated noise levels for the proposed plant units, following mitigation, were below or similar to typical day- or night-time background noise levels in the area. This is consistent with the criteria recommended by Stroud District Council. Furthermore, taking into account the context, these predicted levels correspond to a low impact according to the BS 4142 standard and would not exceed the Lowest Observed Adverse Effect Level discussed in relevant noise policy.

This assessment was based on indicative plant selection as the site design is still at an early stage, but operational noise could be controlled through a planning condition, using plant selection, design and standard noise control measures. There is therefore no reason for the proposed scheme to be refused on noise grounds.

1. Introduction.

Hoare Lea (HL) was commissioned by Ecotricity (Next Generation) Limited to conduct a noise assessment of new plant to be installed at the Q-Park site in South Woodchester, near Stroud. The assessment has been undertaken to support a planning application, define noise criteria and assess the likelihood of compliance with the relevant standards at the nearest residential property during operational hours of the equipment.

The report provides details of the assessment and sets out the findings.

2. Basis of assessment.

2.1 General Planning Policy on Noise.

The Noise Policy Statement for England (NPSE)[1] sets out the general vision and aims of Government policy in this regard. It promotes the effective management of noise to avoid significant impacts and mitigate/minimise adverse impacts of noise on health and quality of life. It discusses how this should be interpreted "*within the context of Government policy on sustainable development*". This is consistent with the aims set out in the planning context in the National Planning Policy Framework (NPPF)[2] document.

The NPSE does not set specific noise limits but introduces a number of categories into which noise may be considered to fall:

- NOEL – No Observed Effect Level
- LOAEL – Lowest Observed Adverse Effect Level: *the level above which adverse effects on health and quality of life can be detected.*
- SOAEL – Significant Observed Adverse Effect Level: *the level above which significant adverse effects on health and quality of life occur*

The Planning Practice Guidance - Noise (PPG-N)[3] document provides more specific planning guidance on noise assessment and management in line with the above general policy. It explains the hierarchy of noise impacts in relation to the above NOEL, LOAEL and SOAEL. It also provides guidance on factors that may influence the response to noise, including: the absolute level of the noise and the time of day it occurs; the number and frequency/pattern of discrete noise events; the character and frequency content of the noise; and the character of the area.

PPG-N provides actions for each Effect Level category aimed at proposed development. If the level of noise is below LOAEL then '*No specific measures* (are) *required*'. If noise is between LOAEL and SOAEL the measures should be taken to '*mitigate and reduce to a minimum*'. Levels of noise above SOAEL are to be avoided and prevented if they exceed a level described to be an Unacceptable Adverse Effect.

[1] The Noise Policy Statement for England (NPSE), Department for Environment, Food and Rural Affairs, 2010.

[2] National planning policy framework (NPPF), Department for Communities and Local Government, 2012.

[3] Planning Practice Guidance - Noise, Department for Communities and Local Government, 2014.

2.2 BS4142:2014.

The British Standard 4142:2014 'Method for Rating and assessing industrial and commercial sound' (BS 4142) provides an objective method for assessing the impact of noise from industrial and commercial operations. It also describes means of determining noise levels from fixed plant installations and determining the background noise levels that prevail on a site.

The assessment method is based on subtraction of the measured background noise level from the rating level determined. The rating level is the source noise level (either measured or predicted) corrected for tone or character (if necessary). The likelihood of adverse impact increases as the Rating Level exceeds the background as indicated in the following table:

Table 1 - Significance Criteria for BS 4142 Assessment

Rating Level	BS 4142 assessment
Equal to or below background	Low impact, depending on context
+5dB above background	Adverse impact, depending on context
+10dB or more above background	Significant adverse impact, depending on context

It should be noted that the assessment method applies to free field external sound levels

Conversely, the lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

Where the initial estimate of the impact needs to be modified due to the context, all pertinent factors should be taken into consideration. This includes: the absolute level of the sound; the character of the sound produced and that prevailing in the area; and the sensitivity of the receptor(s).

2.3 Consultation.

HL understand that Stroud Council's general preference is for noise levels from the proposed plant, when assessed in accordance with the above standard (BS 4142), not to exceed existing background noise levels. This would generally correspond to a low impact and be clearly below the criteria for adverse impact described in Table 1 above. In terms of noise policy, this would therefore equate to a level below the LOAEL.

3. Description of site and surroundings.

3.1 General description.

The site is located in South Woodchester along the A46 Bath Road, as illustrate below (Figure 1). Nearby buildings are mostly commercial\industrial, with a number of neighbouring residential properties which are considered sensitive to noise. The nearest noise sensitive receptor (NSR) is approximately 75 m from some of the proposed plant areas. The proposed site and plant layout is presented in Appendix B.

The site is one of a number of other industrial units and operations in the area, which has a generally urban setting strongly influenced by road traffic noise as well as intermittent industrial noise.

3.2 Baseline survey.

An acoustic survey has been conducted at the site to quantify the prevailing noise conditions at locations representative of the closest noise sensitive receptors.

Subjectively at each measurement position, road traffic on the A46 Bath Road appeared as the dominant continuous noise source. At positions away from the A46 individual road traffic movements on the local roads (Station Road, High Street and Frogmarsh Lane) contributed to the noise climate.

Noise of industrial nature from fixed plant installations and operational activities associated with the commercial uses on the industrial estate accessed off Station Road were audible during lulls in the traffic whilst on Station Road.

3.2.1 Methodology.

The survey comprised unattended and attended survey measurements at four positions at locations representative of the closest NSR to the development site. HL undertook long-term unattended measurements between Wednesday 18th October and Monday 23rd October 2017, and short-term unattended and attended measurements on Wednesday 18th October 2017.

The long-term unattended measurements were undertaken at a single location on the boundary between Q-Park and Station House. This measurement location is labelled as Position 1. Due to the relative distances between the continuous noise source (A46 Bath Road) and the NSR, background sound levels at this location are considered representative of Station House, the dwellings on Little Britain Farm and at Broadmead. Noise at this position was dominated by traffic movements on the A46 Bath Road.

Short-term unattended measurements were made at a single location to the southwest of the development site, in the front curtilage of Sennen Heights. This measurement location is labelled as Position 2. Background sound levels at this position are considered representative of the receptors along Frogmarsh Lane and receptors off Culver Hill due to the relative distances between the continuous noise source (A46 Bath Road) and the receptors. Noise at this position was dominated by traffic movements on the A46 Bath road, punctuated by traffic movements on Frogmarsh Lane.

Attended measurements were undertaken at locations on High Street and Station Road, labelled Position 3 and Position 4 respectively. The measurements at Position 3 are considered representative of the dwellings along High Street; the measurements at Position 4 are considered representative of the dwellings on Station Road to the west of the cycle track intersection. Noise at both positions was dominated by traffic movements on the A46 Bath road, punctuated by traffic movements on the adjacent local road. Traffic on Station Road included HGV movements. Noise of industrial nature from fixed plant installations and operational activities associated with the commercial uses on the industrial estate on Station Road were audible during lulls in the traffic at Position 4.

The survey positions are shown in Figure 1 below. All measurements were undertaken at ground level with the microphones at a height of approximately 1.5 metres above the ground. The microphones were under free-field conditions being positioned away from acoustically reflective surfaces, other than the ground.

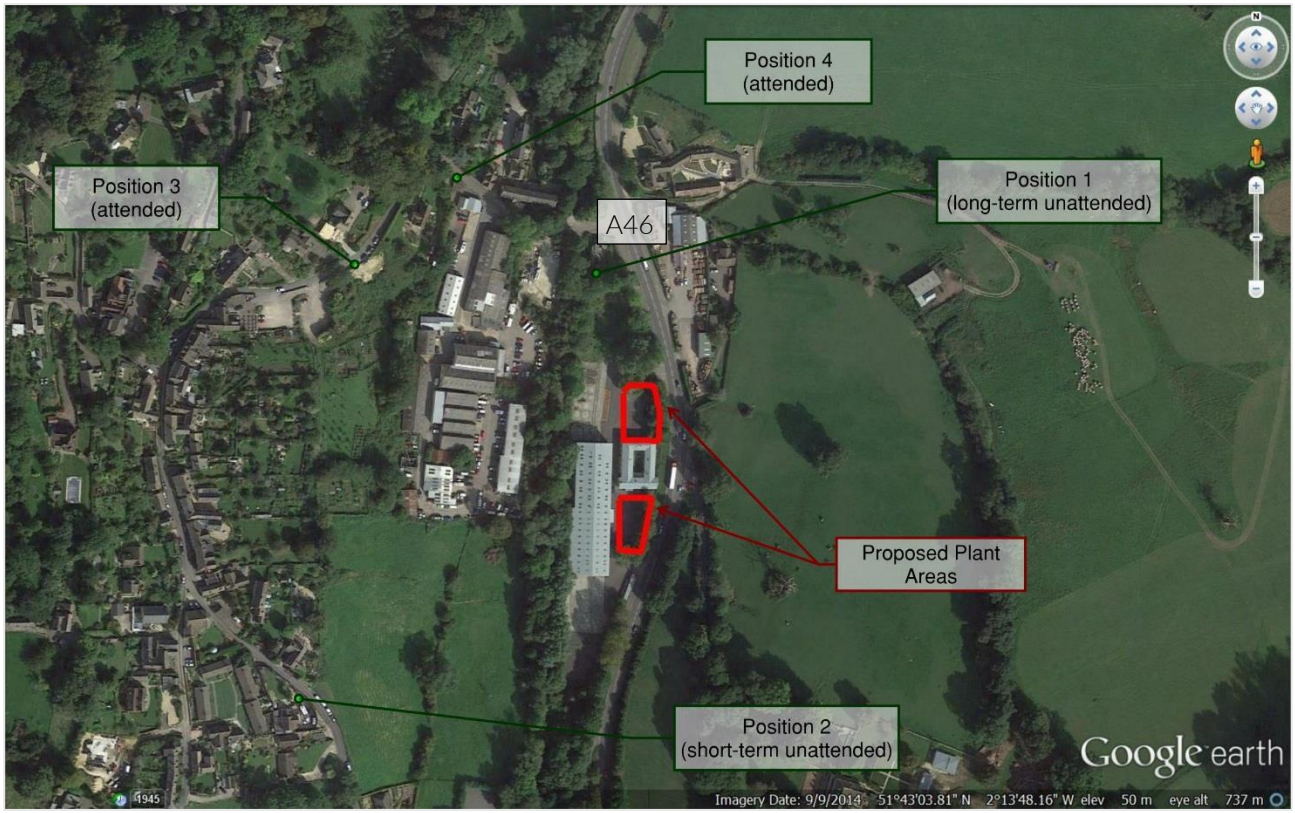


Figure 1: Aerial photograph showing location of proposed plant installations and noise measurement positions.

Measurements recorded by the unattended sound level meters at Positions 1 and 2 included contiguous fifteen-minute duration samples of broadband A-weighted residual sound levels ($L_{Aeq,15\ min}$) and background sound levels ($L_{A90,15\ min}$). Continuous one second duration measurements were also recorded at Position 1.

Measurements at Positions 3 and 4 included disaggregated fifteen-minute duration samples of broadband A-weighted residual sound levels ($L_{Aeq,15\ min}$) and background sound levels ($L_{A90,15\ min}$).

Weather conditions were not measured on site but were monitored remotely. During the survey weather conditions were changeable. There were some periods of inclement weather with precipitation and/or wind speeds greater than 5 m/s. To minimise uncertainty in the assessments, measurements recorded during inclement weather have been analysed and removed if thought to have resulted in an increase in the measured noise level.

The survey equipment was field calibrated immediately before and immediately after the measurement period; no significant drift in level was found to have occurred. The measurement instrumentation used is listed in Appendix C.

3.2.2 Results.

The measured noise level time history for the unattended survey location at Position 1 is included in Appendix D.

Periods of rain and wind speeds exceeding 5 m/s were recorded during the survey. Measurements during Thursday 19th October showed an increase in noise due to weather and have been excluded from the assessments.

3.2.2.1 Residual Sound Levels.

The measured free-field external ambient sound levels at Position 1 are summarised below.

Date	Daytime (07:00 to 23:00)	Night-time (23:00 to 07:00)
Wednesday 18th October 2017	60 dB $L_{Aeq,7\ h\ 15\ min}$	51 dB $L_{Aeq,8\ h}$
Thursday 19th October 2017	63 dB $L_{Aeq,16\ h}$	53 dB $L_{Aeq,8\ h}$
Friday 20th October 2017	61 dB $L_{Aeq,16\ h}$	53 dB $L_{Aeq,8\ h}$
Saturday 21st October 2017	61 dB $L_{Aeq,16\ h}$	51 dB $L_{Aeq,8\ h}$
Sunday 22nd October 2017	59 dB $L_{Aeq,16\ h}$	52 dB $L_{Aeq,8\ h}$
Monday 23rd October 2017	67 dB $L_{Aeq,2\ h\ 45\ min}$	-

Table 1: Broadband ambient sound levels measured at Position 1.

Typically, at Position 1 the daytime residual sound level was 61 dB $L_{Aeq,16\ h}$ and the night-time residual sound level was 52 dB $L_{Aeq,8\ h}$.

The measured residual sound levels measured at Positions 2 to 4 are tabulated below:

Position	Start Time	Residual Sound Level
Position 2 – Frogmarsh Lane	15:45	54 dB $L_{Aeq,1\ h\ 45\ min}$
Position 3 – High Street	15:44	54 dB $L_{Aeq,15\ min}$
	16:21	55 dB $L_{Aeq,15\ min}$
	17:00	55 dB $L_{Aeq,15\ min}$
Position 4 – Station Road	16:02	62 dB $L_{Aeq,15\ min}$
	16:42	58 dB $L_{Aeq,15\ min}$
	17:17	61 dB $L_{Aeq,15\ min}$

Table 2: Summary of residual sound levels measured during the short-term unattended and attended surveys, Wednesday 18th October.

The residual sound levels at Positions 1 and 4 are comparable at c. 61 dB(A). The residual round levels at Positions 2 and 3 are comparable at c. 54 dB(A).

3.2.2.2 Background Sound Levels.

In line with the requirements of BS 4142, in order to *"quantify what is typical during particular time periods"*, a statistical analysis of the measured background sound levels has been undertaken. The periods of interest have been taken as daytime (07:00 to 23:00) and night-time (23:00 to 07:00). The fifteen-minute duration background sound values measured during the day will never be higher than the $L_{A90,1\ hour}$ for that period so represent a worst-case. The measured 15 minute values will be used in place of the 1 hour reference time interval required by BS 4142.

Statistical analysis charts of the measured background sound levels at Position 1 are included below:

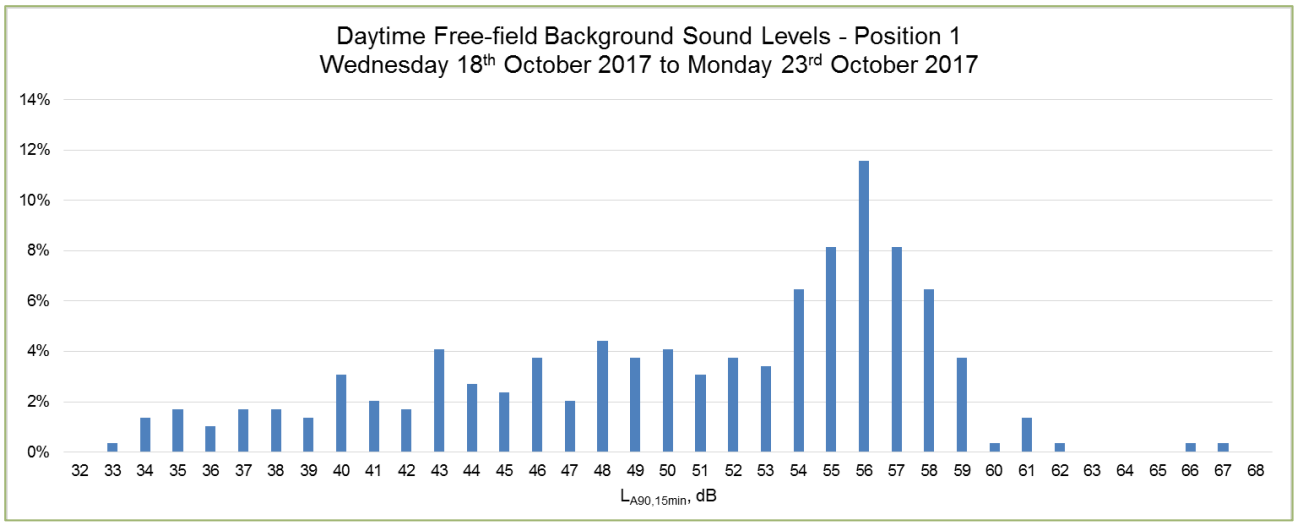


Figure 2: Statistical analysis of the daytime background sound levels at Position 1.

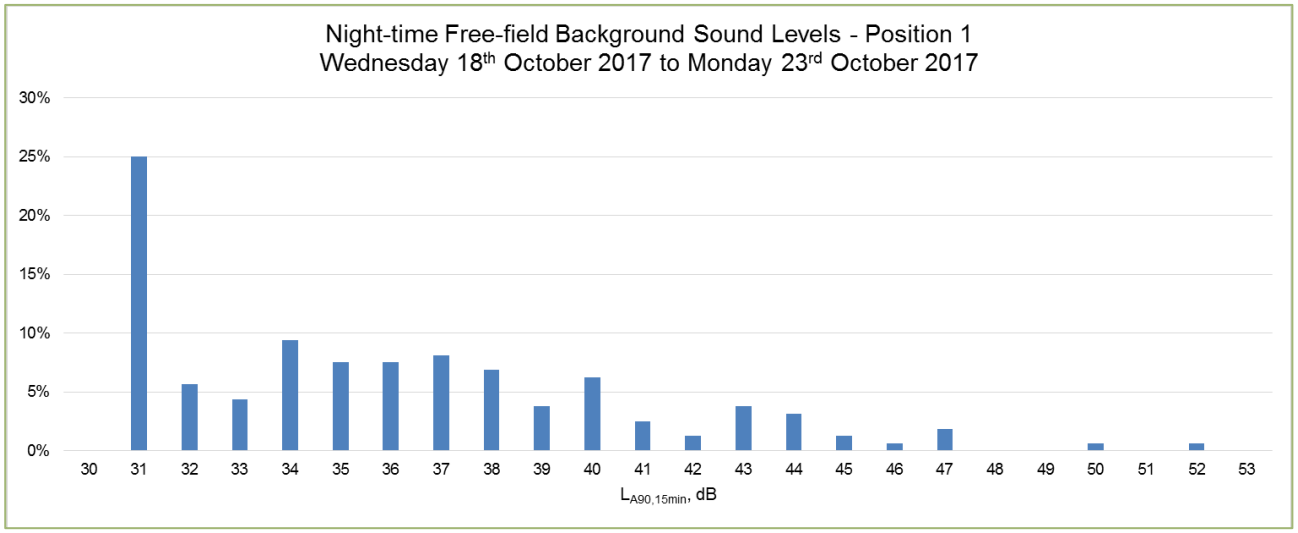


Figure 3: Statistical analysis of the measured night-time background sound levels at Position 1.

From the above statistical analysis charts and the time history shown in Appendix C, given the context of the site, the following typical lower background sound levels have been determined representative for the periods of interest at Position 1:

- Daytime 45 dB $L_{A90,1\ hour}$
- Night-time 31 dB $L_{A90,15\ min}$

From analysing the time history chart, it can be demonstrated that evening (19:00 to 23:00) background sound levels are typically 43 dB $L_{A90,1\ hour}$.

The measured background sound levels measured at Positions 2 to 4 are tabulated below:

Position	Start Time	Background Sound Level
Position 2 – Frogmarsh Lane	15:45	50 dB $L_{A90,1\ h}$ (typical)
Position 3 – High Street	15:44	47 dB $L_{A90,15min}$
	16:21	49 dB $L_{A90,15min}$
	17:00	49 dB $L_{A90,15min}$
Position 4 – Station Road	16:02	50 dB $L_{A90,15min}$
	16:42	49 dB $L_{A90,15min}$
	17:17	49 dB $L_{A90,15min}$

Table 3: Summary of background sound levels measured during the short-term unattended and attended surveys, Wednesday 18th October.

The background sound levels measured at Positions 2 to 4 are comparable. Background sound levels at Positions 2 to 4 are typically lower than those at Position 1. When comparing the corresponding background sound levels measured at Position 1 with those at Positions 2 to 4, the difference is typically c. 6 dB(A). However, during the quiet periods of the night-time, the influence from road traffic noise on the A46 Bath road is expected to be minimal and therefore similar background noise levels are likely to be experienced at location further away from the A46 as those measured at location 1.

On this basis, the following typical background sound levels can be assumed for receptors away from the A46 Bath Road:

- Daytime 39 dB $L_{A90,1\ hour}$, evening periods, 37 dB $L_{A90,1\ hour}$
- Night-time 31 dB $L_{A90,15\ min}$

3.3 Proposed plant noise operational noise limits.

Based on the preference of the local authority (Section 2.2), it is proposed that noise emission from fixed plant at the site are limited to the following levels:

Position	Noise limit – day time	Noise limit – night time
Dwellings along A46: Station House, the dwellings on Little Britain Farm and at Broadmead	43 dB $L_{Ar,\ 1\ hour}$	31 dB $L_{Ar,\ 15\ min}$
Dwellings further away from A46, along Frogmarsh Lane, off Culver Hill, High Street and Station Road to the west of the cycle track intersection.	37 dB $L_{Ar\ ,\ 1\ hour}$	31 dB $L_{Ar,\ 15\ min}$

Table 4: Noise limits (rated noise level, L_{Ar}) derived from the baseline noise survey

Day-time noise limits were based on the lower levels typically experienced during evening periods, as a conservative measure.

4. Plant noise assessment.

During the daytime (07:00 to 23:00) the assessment is carried out over a reference time of 1-hour and night-time (23:00 to 07:00), the assessment is carried over a reference time period of 15 minutes.

4.1 Fixed plant – predictions.

The design of the equipment at the site remains at an early stage, with plant selection/design still to be finalised in many cases, and therefore detailed noise emission information was generally not available. For the purposes of the present assessment and determining a noise control strategy, an assessment was made based on indicative or typical noise emission values, Table 5 lists the different sources of mechanical noise and their assumed noise emission levels.

Plant area	Type	Quantity	Assumed Sound power level (SWL)		SWL after mitigation	
			Day	Night	Day	Night
North plant area	Fan	1	81	81	81	76
	smaller chillers	2	78	78	78	73
	Fan	1	84	64*	84	64*
	Chiller	1	88	88	88	81
	Compressor	1	79	79	79	74
	Liquefaction	1	79	79	79	74
	Chiller	1	87	87	87	80
	Fans	1	79	79	79	72
	Compressor	1	79	79	79	74
Building courtyard plant	HVAC system	2	78	78	78	78
South plant area	Chillers	2	90	90	90	85
	UPS	5	72	72	72	72
	HVAC system	5	66	66	66	66
	transformer	3	61	61	61	61
	Low Voltage transformer	1	72	72	72	72
	Gas generator	1	93	93	90	83

**Fan operating in energy saving mode*

Table 5 – assumed noise emission levels

Although most of the plant will be operating mainly during the day-time, it is possible that some units will be required to operate at night, although this may be at a lower duty: therefore, different noise emission levels

were considered for both day and night. Mitigation was considered in some cases, and as most of the plant selection is at an early stage, this mitigation is thought likely to be achieved through selection of quieter units, or measures such as sound insulated enclosures, attenuation or silencer packs.

A number of noise producing equipment items will be installed within the existing Q-Park building but as these will be enclosed it is assumed that negligible levels of breakout. As can be seen from the plan of Appendix B, many of the NSRs will be screened from the plant units by existing buildings on the Q-Park site which are due to be retained, and are two storey height or more, providing significant screening (at least 15dB). In addition, a solid screen is proposed around the northern perimeter of the north plant area: see Appendix B. This would interrupt the line of sight from the main noise-generating plant items to the nearest NSRs: a reduction of 10 dB has therefore been assumed to account for this.

The predictions have been undertaken as point sources assuming hemispherical propagation and calculated to the NSRs which are approximately 80 m to 200 m from the plant locations. The predictions assume that all plant items are operating simultaneously, which may not necessarily be the case but represents a worst-case scenario. Predictions results are set out in Tables 6 to 8 below.

We did not consider that it was necessary to add a character correction to derive the predicted rating noise level as the proposed plant was not expected to be operating with a tonal character or intermittently (in such a way as to attract attention) if operating normally. A possible exception would be the proposed transformer but the predictions show this represents a negligible or low contribution to the expected noise levels. Furthermore, as discussed below, the predicted noise levels are clearly below the measured existing ambient noise level, therefore reducing the likelihood that features in the noise will be audible.

4.2 Fixed plant – assessment.

The comparisons set out in Tables 6 to 8 show that predicted rated plant noise levels are below or similar to the derived typical background noise levels determined from the baseline survey, and therefore below the noise limits set out in Table 4. As set out in Section 2, this means the noise from the facility represents a low impact, depending on the context. This also means that the noise is below the LOAEL (described in section 2.1) and that therefore no additional measures are required in accordance with relevant planning guidance.

BS 4142 requires an evaluation of the context in addition to this numerical assessment and provides guidance in this regard. In the present case, the general character of the existing area, being dominated by industrial activity and influenced by road traffic noise, will tend to reduce the potential impact even further. Tables 1 and 2 show that existing ambient noise levels in the area are typically, 55-60 dB L_{Aeq} for day-time periods, and marginally above 50 dB L_{Aeq} at night. The predicted levels from the proposed plant (less than 40 dB L_{Aeq}) will therefore be more than 10 dB below existing ambient noise levels. Absolute predicted levels are also a consideration, particularly at night, and the predicted L_{Aeq} levels from the plant alone are clearly below the level of 40 dB(A) which is recommended for the protection of sleep in the World Health Organisation (WHO) Night Noise Guidelines (2009). These points reinforce the conclusion reached of a low impact of noise from the proposed development.

4.3 Moving plant.

Vehicle movements will largely be staff vehicles, the exception being an estimated bi-monthly delivery of gas bottles by a light goods vehicle during the daytime period. As the site area is strongly influenced by road traffic noise and existing commercial activities, the impact of this volume of vehicle movement from the development will be negligible in practice.

Plant area	Type	Screening (dB)	Distance (m)	Calculated SPL	
				Day	Night
North plant area	Fan	10	75	25	20
	smaller chillers	10	75	26	21
	Fan	10	75	28	8
	Chiller	10	75	32	25
	Compressor	10	75	23	18
	Liquefaction	10	75	23	18
	Chiller	10	75	31	24
	Fans	10	75	23	16
	Compressor	10	75	23	18
Building courtyard plant	HVAC system	15	100	18	18
South plant area	Chillers	15	140	27	22
	UPS	15	150	12	12
	HVAC system	15	150	6	6
	transformer	15	150	-1	-1
	LV transformer	15	190	3	3
	Gas generator	15	190	21	14
		L_{Aeq} total (dB)		38	31
		Noise limit (L_{A90})		43	31
		Difference		-5	0

Table 6 – Noise predictions – Station Cottage / Little Britain Farm

Plant area	Type	Screening (dB)	Distance (m)	Calculated SPL	
				Day	Night
North plant area	Fan	10	140	20	15
	smaller chillers	10	140	20	15
	Fan	10	150	22	2
	Chiller	10	150	26	19
	Compressor	10	150	17	12
	Liquefaction	10	150	17	12
	Chiller	10	140	26	19
	Fans	10	140	18	11
	Compressor	10	140	18	13
Building courtyard plant	HVAC system	15	190	12	12
South plant area	Chillers	15	220	23	18
	UPS	15	200	10	10
	HVAC system	15	200	4	4
	transformer	15	150	-1	-1
	LV transformer	15	250	1	1
	Gas generator	15	250	19	12
		L_{Aeq} total (dB)		33	26
		Noise limit (L_{A90})		37	28
		Difference		-4	-2

Table 7 – Noise predictions – the Limes (Station Road)

Plant area	Type	Screening (dB)	Distance (m)	Calculated SPL	
				Day	Night
North plant area	Fan	10	240	15	10
	smaller chillers	10	240	15	10
	Fan	10	240	18	-2
	Chiller	10	240	22	15
	Compressor	10	240	13	8
	Liquefaction	10	240	13	8
	Chiller	10	240	21	14
	Fans	10	240	13	6
	Compressor	10	240	13	8
Building courtyard plant	HVAC system	15	220	11	11
South plant area	Chillers	15	200	24	19
	UPS	15	200	10	10
	HVAC system	15	200	4	4
	transformer	15	200	-3	-3
	LV transformer	0	200	18	18
	Gas generator	0	200	36	29
		L_{Aeq} total (dB)		37	30
		Noise limit (L_{A90})		37	31
		Difference		0	-1

Table 8 – Noise predictions – Frogmarsh lane.

5. Conclusions.

Hoare Lea determined baseline background noise levels at the nearest noise-sensitive dwellings with a survey that comprised a combination of attended and unattended measurements at four different representative locations. Predictions of noise from the main potential sources of fixed plant were made at the nearest sensitive locations, based on indicative information. This allowed the development of a noise control strategy for the site and the definition of allowable noise levels for different items of equipment. Mitigation measures include the provision of a solid screen on the north side of the development.

The assessment demonstrated that the predicted rated noise levels for the proposed plant units, following mitigation, were below or similar to typical day- or night-time background noise levels in the area. This is consistent with the criteria recommended by Stroud District Council. Furthermore, taking into account the context, these predicted levels correspond to a low impact according to the BS 4142 standard and would not exceed the Lowest Observed Adverse Effect Level discussed in relevant noise policy.

This assessment was based on indicative plant selection as the site design is still at an early stage, but operational noise could be controlled through a planning condition, using plant selection, design and standard noise control measures. There is therefore no reason for the proposed scheme to be refused on noise grounds.

Appendix A – Acoustic Glossary.

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). Therefore, a logarithmic scale is used to describe sound pressure levels and also sound intensity and power levels. The logarithms are taken to base 10. Hence an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pascals). Subjectively, this increase would correspond to a doubling of the perceived loudness of sound.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for the sound pressure are Nm^{-2} or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure - *p*. The power is proportional to the square of the sound pressure.

The Sound Pressure Level

The lowest sound pressure possible to hear is approximately 2 10^{-5} Pa (2 ten billionths of an atmosphere).

It therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound

$L_p = 10 \log(p^2 / p_{ref}^2) = 10 \log(p / p_{ref})^2 = 20 \log (p / p_{ref}) (1)$

Where;

L_p = *sound pressure level (dB)*

p = *sound pressure (Pa)*

p_{ref} = *2 10^{-5} - reference sound pressure (Pa)*

Doubling the sound pressure level is an increase of 6 dB.

Sound Power Level (Lw)

The total sound power radiated by a source, in decibels.

Frequency

The frequency (cycles per second) of a sound is expressed in hertz (Hz).

Wavelength

The wavelength of sound is the distance between analogous points of two successive waves.

HVAC

Heating, Ventilation and Air Conditioning

UPS

Uninterruptable power supply

LV

Low voltage

Sound Pressure Level of some common sources

Source	Sound Pressure Level *dB*
Threshold of hearing	0
Rustling leaves	20
Quiet whisper	30
Home	40
Quiet street	50
Conversation	60
Inside a car	70
Loud singing	80
Motorcycle (10 m)	90
Lawn mower (1m)	100
Diesel truck (1m)	110
Amplified music (1m)	120
Jet plane (1m)	130

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

A-Weighting

The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies. An A- weighted value would be written as dB(A), or by including A in the parameter term.

$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level. Over a defined time period (T), it is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal. The $L_{eq,T}$ can be seen to be an "average" sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an 'A' weighted noise level in dB(A) with the parameter term $L_{Aeq,T}$. It is commonly used to describe all types of environmental noise sources.

$L_{10,T}$

The $L_{10,T}$ is a parameter defined as the sound pressure level exceeded for 10% of the measurement period T. It is a statistical parameter and cannot be directly combined to other acoustic parameters. It is generally used to describe road traffic noise.

$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period T. It is a statistical parameter and cannot be directly combined to other acoustic parameters. It is generally used to describe the prevailing background noise level or underlying noise level.

$L_{max,T}$

The $L_{max,T}$ is maximum noise level measured during the specified period T.

Façade

A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

Fast /Slow Time Weighting

Sound level meters can take averages using fast (125 millisecond) or slow (1 second) response times.

Rating Level $L_{Ar,Tr}$

Specific sound level plus any adjustment for the characteristic features of the sound.

Background Noise Level L_{A90}

A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.

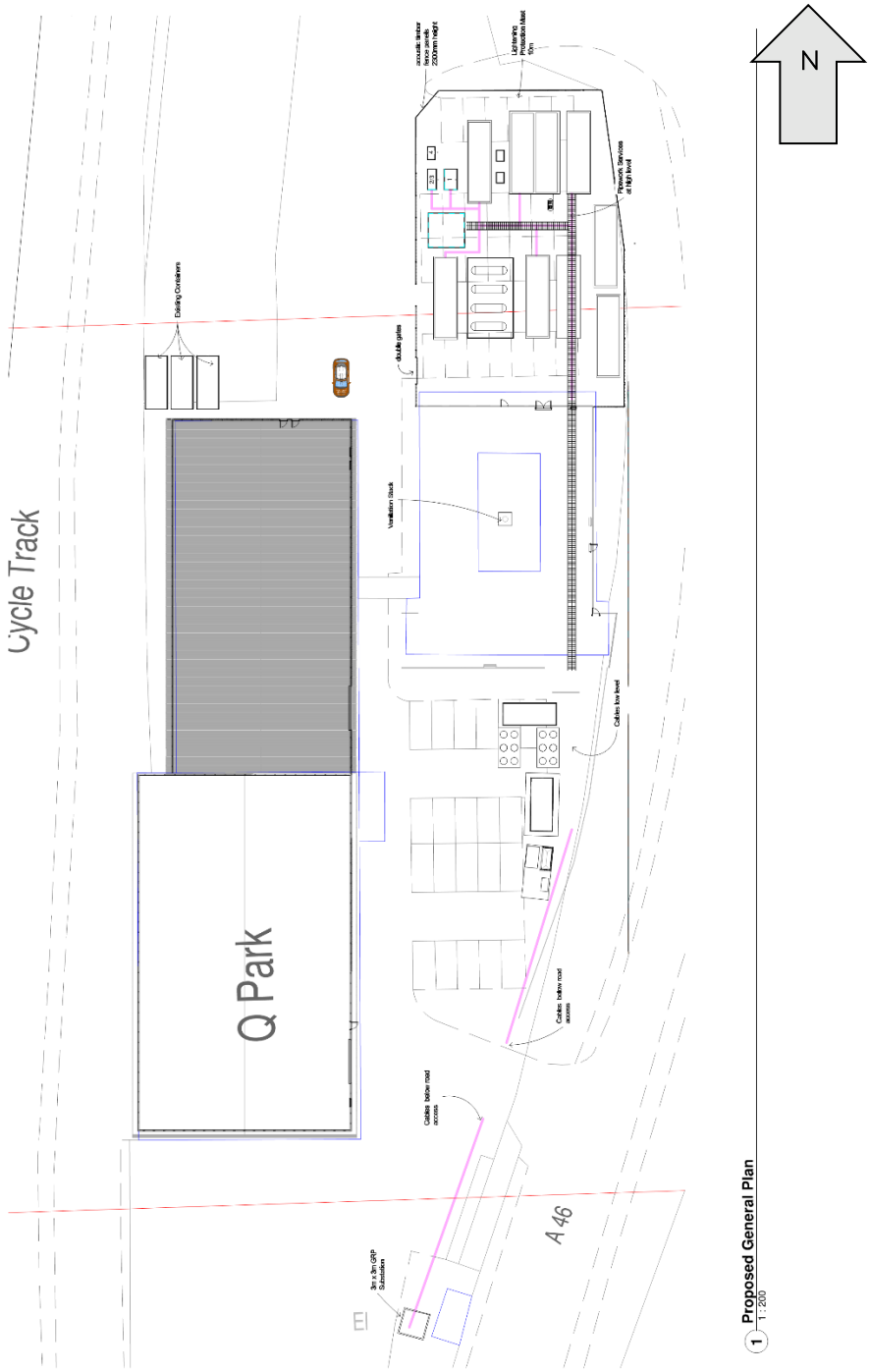
Specific Sound Level $L_{Aeq,T}$

Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr

Residual Sound Level $L_{Aeq,Tr}$

Equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T.

Appendix B - site layout.



Appendix C – Noise Survey Equipment.

Position 1 – Station House (long-term unattended)
Rion NL-52 Sound Level Meter (serial number 01265405)

Rion NH-25 Pre-amplifier (serial number 65307)

Rion UC-59 Microphone (serial number UC-59)

Position 2 – Frogmarsh Lane (short-term unattended)
Rion NA-28 Sound Level Meter (serial number 01260203)

Rion NH-23 Pre-amplifier (serial number 60106)

Rion UC-59 Microphone (serial number 00286)

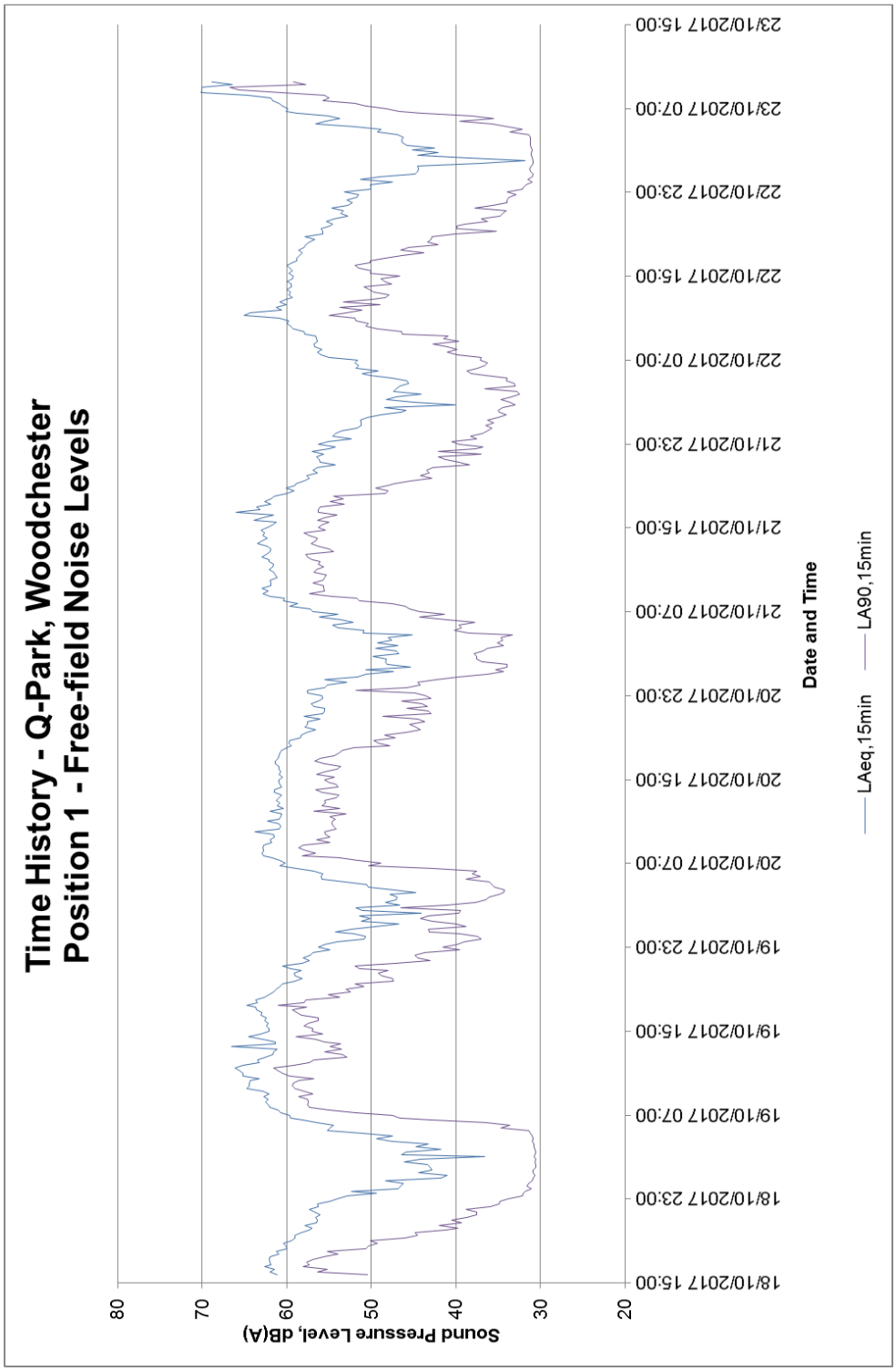
Position 3 – High Street & Position 4 – Station Road (attended)
Brüel and Kjær Type 2260 Sound Level Meter (serial number 1875558)

Brüel and Kjær ZC 0026 Pre-amplifier (serial number 3246)

Brüel and Kjær Type 4189 Microphone (serial number 2607952)

All Positions
Rion NC-74 Sound Calibrator (serial number 34304644)

Appendix D – Noise Level Time History (Position 1).



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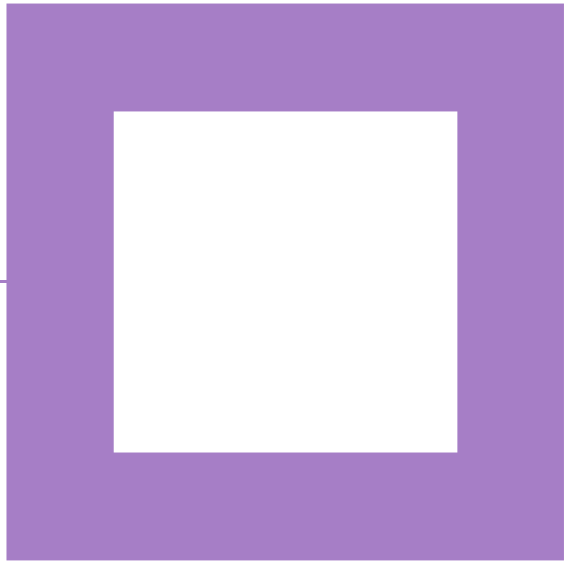
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